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GROWTH AND DEVELOPMENT OF MUSCLES, BONES AND FAT OF GUINEA FOWL *(NUMIDA MELIAGRIS GALEATA*) 	**Original Research, B2** **Y. H. Elhashmi, A. El Amin, F. A. Omer** *Online J. Anim. Feed Res.*, 2(1): 06-09, 2012 **ABSTRACT:** *This study was conducted to evaluate the growth pattern of muscles, bones and fat of guinea fowl. Eighteen day old chicks were reared for 22 weeks and serial slaughters were done every four weeks for evaluation. Results showed that the feed conversion ratio was 1:5, highest feed intake at 13-14 weeks of age and highest weight gain at 8-10 weeks. Carcass yield was 69%. The great mass of muscle was found in the thorax, highest bone percentage was found in the pelvis and the flank had high percentage of fat. Thorax and hind limb had high growth rate when compared with pelvis, wing, neck and flank.* ***Key words:*** *carcass yield, body regions, serial slaughter*	
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ANTI-NUTRIENT FACTORS, PERFORMANCE AND SERUM BIOCHEMISTRY OF BROILER CHICKS FED RAW AND FERMENTED *ALCHORNEA CORDIFOLIA* SEEDS	**Original Research, B4** **Emenalom,O.O.,Obiora, A.B.,Okehie,U.N.** *Online J. Anim. Feed Res.*, 2(1): 17-22, 2012 **ABSTRACT:** *This study was carried out to determine some anti-nutrient factors in differently processed Christmas bush (Alchornea cordifolia) seeds and the effect of the processed seed meals on the performance and blood chemistry of broiler chicks fed from 1 to 35 day of age. Ground and fermented, and dehulled Christmas bush (CB) seed meals were analyzed for their anti-nutrient contents whereas ground and sieved (GS), ground-sieved and fermented (GSF) and non-sieved and fermented (NSF) seed meals were incorporated into starter broiler diets to replace 10% of maize, respectively. Fermented and dehulled CB seed meals contain 574.4 and 21.3mg/100g phytic acid, respectively. Cyanide was not identified in any of the meals. Dehulling*	

 	*eliminated the anthraquinone and tannin contents whereas fermentation only eliminated the tannin content. None of the methods completely eliminated the saponin, cardiac glycoside, flavonoid and alkaloid contents of the seed meals. With GS seed meal, broilers had lower average daily weight gain (P<0.05) than the control group. Feed intake decreased (P<0.05) but feed conversion ratio was not different when compared with control. Inclusion of GSF seed meal improved growth and feed intake when compared with the NSF seed meal and by day 35, growth and feed intake were comparable to those of the control birds. Blood plasma levels of alanine aminotransferase, alkaline phosphates and aspartate aminotransferase increased with GS CB seed meal diet, while serum calcium decreased. Neither raw nor fermented seed meals altered other measures of the blood chemistry. It is concluded that CB seeds contain toxic anti-nutrient compounds and that sieving out the hulls in the ground raw seed meal before fermentation improved the feeding value of the seeds for broilers at 10% replacement for maize.* ***Keywords**: Alchornea seed; Anti-nutrients; Broilers; Fermentation; Performance; Serum chemistry*	
SURVEY OF PRODUCTION AND USE OF POULTRY LITTER IN KHARTOUM STATE, SUDAN 	**Original Research, B5** **MB Elemam, AM Fadelelseed, OMA Abdelhadi, AO Idris, I Bushara and AM Salih** *Online J. Anim. Feed Res.*, 2(1): 23-26, 2012. **ABSTRACT:** *A survey of chicken litter production was undertaken by hand submitted questionnaire. The survey covered 219 farms out of 612 registered in Khartoum state to provide information on amount and use of litter. The survey revealed that most poultry farms followed similar management practices. About 58.94% of litter production was estimated to come from broiler houses and 41.06% from layer houses. It was estimated that 70% of the litter production is litter-based and about 30% are droppings collected without litter. The amount of litter produced was estimated to be 95097.58 ton/year and 87.1% of this amount was used as fertilizer. Samples of broiler litter were collected and proximate composition was conducted to investigate the nutrient quality of broiler litter. Results obtained on dry matter (DM) and ether extract (EE) showed that there are significant (P<0.05) differences among three locations (Khartoum, Khartoum-North and Omdurman). However, there are no significant differences on other chemical compositions.* ***Key words:** Poultry litter, survey, chemical composition.*	
Regression Analysis of Linear Body Measurements on Live Weight in Sudanese Shugor Sheep 	**Original Research, B6** **A .M .Musa, N.Z. Idam and K.M. Elamin** *Online J. Anim. Feed Res.*, 2(1): 27-29, 2012 **ABSTRACT:** *In this research, linear regression models were improved for estimation of body weight using various linear body measurements from Sudanese Shugor sheep. Simple regression models were formed when Body weight (Bwt) was dependent variable and heart girth(HG), height at withers(HTW) and height at hip(HTH) as independent variables. The best derived regression prediction equation for estimation of body weight determinate by using beta (β) as the constant based on number of variables used for the equation, mean square error (MSE) and Coefficient of determination (R^2). The model including the most appropriate measurements such as heart girth, height at wither and height at hip were the best fitted model(β = -47.54, MSE = 9.39 and R^2=0.61) for estimation of body weight in Sudanese Shugor sheep in this study.* **Keywords:** *Linear body measurements, Body weight, regression analysis, Shugor sheep, Sudan.*	
APPARENT DIGESTIBILTY COEFFICIENT OF PELLETED FISH FEED INCORPORATED WITH WATER HYACI NTH (*Echhornia crassipes)* 	**Original Research, B7** **M.E. A-Rahman Tibin, A.B. Abol-Munafi, A. Mat Amiza, Kh.H. Hamid, H.M. Adam Sulieman** *Online J. Anim. Feed Res.*, 2(1): 30-33, 2012 **ABSTRACT:** *The objective of this study to determine the apparent digestibility coefficients (ADC_S) of dry matter, protein, gross energy and fiber of five pelleted fish feed incorporated with different levels(0%,10%,15%,20% and 25%) of water hyacinth (Echhornia crassipes) on performance of red Tilapia fingerlings, using chromium dioxide as an inert bio- marker. Feeds were prepared to be iso-nitrogenous (35.00%± 0.20) and iso-caloric (kcal/kg 4700.00±0.52). Proximate compositions of test feeds, fecal matter and chromium contents also were determined. Results revealed the maximum value of ADCs for dry matter (DM) was found in reference feed (68.09%), while the minimum value was found in (test diet 4) 4 (50.36%). Similarly, the maximum ADCs values for crude protein content, gross energy, ether extract and crude fiber were found in control feed, while the minimum values were found in the feed 4. The survival rate was found to be significantly low among studied fish fed with feed 4. The study has shown that red tilapia efficient maximum digestion to nutrients is only up to 20% inclusion of water hyacinth in the feed.* *Keywords: Apparent digestibility, pelleted, water hyacinth and fish*	
EFFECT OF FROZEN *Daphnia magna* DIET MIXED WITH PROBIOTIC PROTEXIN ON GROWTH AND SURVIVAL OF RAINBOW TROUT (*Onchorhynchus mykiss*) FRY REARED UNDER	**Original Research, B8** **Sharareh Ahmadvand, Hojattollah Jafaryan, Amin Farahi, and Sheyda Ahmadvand** *Online J. Anim. Feed Res.*, 2(1): 34-39, 2012 **ABSTRACT:** *Effect of probiotic Protexin was experimentally tested on growth and survival of rainbow trout fry reared under controlled conditions. Experiments to determine the effect of different levels of probiotic (2×10^4 (T_1), 2×10^5 (T_2) and 2×10^6 (T_3) CFU/g^{-1}) on growth and survival rates of rainbow trout in comparing with those of*	

CONTROLLED CONDITIONS 	*control diet containing no probiotic were carried out under laboratory conditions. In this trail, frozen Daphnia magna was considered as a basal diet for fry feeding. Rainbow trout offered the control diet exhibited the same growth and feed utilization with all experimental treatments, and no significant differences (P>0.05) in growth were observed among fish groups fed various levels of the probiotic. There was no effect of probiotic inclusion level on water quality. There was no effect of probiotic supplementation on survival at the end of experiment in T_1 and T_3, but survival rate in T_2 was higher than other groups, significantly (P<0.05). Viability against high temperature stress was affected by dietary probiotic inclusion, as supplemented diets by probiotic revealed the better and more efficient results in fish survival. Viability of T_2, T_3 and control in challenging with high salinity was homogenous, while T_1 showed the significant difference (P<0.05) with others, properly.* **Keywords:** *Probiotic, growth, survival, rainbow trout (Oncorhynchus mykiss)*	
Relationships between haemoglobin (Hb) type and productive and reproductive performance of Rahmani ewes and lambs 	**Original Review, B9** **M. Abd-Allah, H. A. Hassan and M.A. Al-Baroady** *O Online J. Anim. Feed Res.*, 2(1): 40-44, 2012 **ABSTRACT:** *Two hundred Rahmani ewes and seventy-one lambs used to study the relationship between the type of haemoglobin and some productive and reproductive traits. Distribution of Hb types and allelic frequencies were higher for type AA of ewes, while for lamb's type BB was higher than type AA. Fertility rate was higher in ewes with the type of haemoglobin AA than ewes with type AB or BB. Hemoglobin type, year of mating and breed of sire were not significant effects on fertility, while, age of dam and season of mating had a significant (P<0.01 or P<0.05) effect on fertility. Autumn season was the best season in fertility (84%) compared to (60%) in summer and (64%) in winter season. Ewes sired by Rahmani rams had the highest fertility (73%) compared to those sired by Chios rams (66%). All factors (Haemoglobin type, age of dam, year of lambing, season of mating, and breed of sire) had no significant effect on litter size at birth. However, ewes with Hb BB produced more lambs than either ewes with HB AB or ewes with Hb AA. Also, ewes aged 4 years had the highest litter size at birth. Ewes mating during autumn season produced more lambs than those mating during summer. Haemoglobin type was not significant effect on body weights of Rahmani lambs and F1 cross ½ C ½ R at all ages studied. Rahmani lambs with Hb AA had the lowest value of birth weight (4.05 kg vs. 4.14; 4.3 kg) compared lambs with Hb AB or BB, while lambs with Hb BB had highest weight at weaning , 6, 9 and 12 months of ages. F1 (½ C ½ R) lambs with Hb AA had the highest weight at birth, 6, 9 and 12 months of age, while lambs with Hb BB had the highest weight at weaning age. Haemoglobin type was not significant effect on daily gain at all periods studied for both Rahmani and F1 (½ C ½ R) lambs. Generally, Rahmani and (½ C ½ R) lambs with Hb AB had the lowest value of daily gain at all periods studied than lambs with Hb AA or Hb BB.* ***Keywords:*** *haemoglobin type, Rahmani ewes, reproductive performance*	
GROWTH PERFORMANCE OF DESERT SHEEP UNDER GRAZING CONDITIONS IN NORTH KORDOFAN STATE 	**Original Research, B10** **M.A.M. Tibin, I.M. Tibin, and I. Bushara** *Online J. Anim. Feed Res.*, 2(1): 45-49, 2012 **ABSTRACT:** *The experiment was conducted to study the effect of changing the nomadic husbandry practices during summer with feed supplementation and water restriction on the performance, carcass characteristics of desert sheep (Hamari sub type). Thirty desert sheep of about 8 month age were randomly allocated to three groups (ten animals each, 5 males and 5 females), group (A) watered daily and supplemented with concentrates, (B) watered daily only and (C) watered every 2- 3 days and was considered as control (the normal nomadic husbandry). The results included that average final live weights were significantly (P<0.05) different among the groups and were not significantly affected by sex but males in group A were heavier than the other two groups. The tail length, height at withers, heart girth, chest depth and body length were significant (P<0.05) different between the three groups. The average daily live weight gain was significantly (P<0.05) different among the groups, and the highest rate of gain was in A followed by B and C, respectively. The average daily live weight gains obtained were significantly (P<0.05) different between females and males of groups A, B and C. The males gave higher daily live weight gains than females. These results concluded that management strategy which involves shorter watering intervals and feed supplementation will probably reflect positively on the performance of Hamari sheep under range conditions.* ***Keywords****: Dessert sheep, growth performance, Body linear measurements, concentrate ration, Sudan*	
SYNERGISTIC EFFECTS OF DIETARY GLUCOSAMINE AND PLANT / ANIMAL PROTEINS ON THE GROWTH PERFORMANCE OF ASIAN CATFISH (*CLARIAS BATRACHUS*) JUVENILES 	**Original Research, B11** **S. Chowdhary, P. P. Srivastava, S. Mishra, A. K. Yadav, R. Dayal And W.S. Lakra** *Online J. Anim. Feed Res.*, 2(1): 50-57, 2012 **ABSTRACT:** *A 84-days feeding trials was conducted to evaluate the use of animal and plant protein, in combination with glucosamine source for Asian Catfish, Clarias batrachus (av. wt. 0.22±0.01 to 0.24±0.07g). Six (31.18 to 43.51 % crude protein, 369 to 399 kcal/100g, and crude lipid 0.0 to 6.69%) practical feeds were formulated. The animal and plant protein component of the feeds was progressively added with glucosamine 0.0, 0.5, 5.0 and 10.0 % with fish meal, silkworm pupae, soybean meal and casein (F-1, PAG 0:100:0.5; F-2, PAG 0:100:5.0; F-3, PAG 0:100:10.0; F-4, PAG 100:0:0.5; F-5, PAG 100:0:5.0; F-6, PAG 100:0:10.0; The experimental feeds were fed to triplicate groups of fingerlings at 10% body weight per day and results were compared with control feed. Growth performance and feed utilization efficiency of catfish, fed with animal proteins are better than those of plant protein. The best growth*	

	among the animal protein group (F-1 to F-3) was recorded in F-2 followed by F-3 and F1 containing glucosamine @5.0, 10.0 and 0.05 %. Amongst the plant protein fed fishes showed best in F6 followed by F5 and F4. The survival was improved in glucosamine supplemented feeds ranging from 49 ± 3.2 to 85 ±1.7 whereas the control showed 41±1.8 %. Results indicate that animal protein rich feeds were much acceptable than alternative plant protein sources for the Asian catfish, Clarias batrachus and the potential for replacing animal protein with soybean meal in the feeds of fish need more evaluation along with synergistic effects of growth promoter like glucosamine. ***Key words:*** *Clarias batrachus, glucosamine, animal protein, plant protein, growth*	
Induced Spawning of Silver Carp, *Hypophthalmichthys molitrix* Using Hormonal Analogues with Dopamine Antagonists 	**Original Research, B12** **Waleed N. El-Hawarry, Baheg R Nemaatallah, Asaad M Shinaway** *Online J. Anim. Feed Res.*, 2(1): 58-63, 2012 **ABSTRACT:** *A study was made to investigate the effects of using carp pituitary extract, human chorionic gonadotropin, luteinizing hormone releasing hormone analogues (Receptal), with or without dopamine antagonists on the spawning performance parameters of silver carp. Results of the current study indicted successful induction of spawning silver carp using different spawning agents. The breeding response and fecundity were comparable among all treatment groups. Moreover, the current experiment clearly indicated that the use of hCG, or mammalian LNRH together with dopamine antagonists was more effective in induction of ovulation and increasing fecundity and hatching rate compared to the other spawning stimulators used in the current study. The results also demonstrated that using dopamine inhibitors potentiate the effect of the hormones used for spawning induction together with reduction of its dose (i.e. dose of carp pituitary extract, human chorionic gonadotropin). Meanwhile, it is well established that domperidone is preferred than metoclopramide as a dopamine antagonists for spawning induction of fish. In view of these results it is clear that not only carp pituitary extract, human chorionic gonadotropin but also the mammalian LHRH analogue (i.e. Receptal) was effective to induce spawning in silver carp. This is important in the view of the fact that mammalian LNRH analogues are available more widely and their price is much more attractive. This would result in cost reduction of induced breeding by using mammalian LNRH analogues in combination with a dopamine antagonist or alone.* ***Keyword:*** *Silver carp, induced spawning, human chorionic gonadotropin, luteinizing hormone releasing hormone analogues, dopamine antagonists.*	
COMPARATIVE UTILIZATION IMPACT OF VARIOUS DIETARY LIPIDS, ON GROWTH INDICES, IN STRIPED MURREL, *CHANNA STRIATUS* (BLOCH) FINGERLINGS 	**Original Research, B13** **R. Dayal, P. P. Srivastava, A. Bhatnagar, S. Chowdhary, A.K. Yadav and W. S. Lakra** *Online J. Anim. Feed Res.*, 2(1): 64-69, 2012 **ABSTRACT:** *A 84-day feeding trial was conducted to evaluate the utilization impact of dietary omega – 3 HUFA as a dietary energy source by fingerlings of striped murrel, Channa striatus on the growth study and tissue composition. There were seven treatments (L3HUF, H3HUF, MUSOL, LINOL, MIXOL, SATOL AND NATFO), each having two replicates, stocked with 100 fingerlings in circular plastic pools (300l capacity). The six feeds were formulated with basic ingredients (Soybean meal, 41%; soluble starch, 25%; Casein, 20%; carboxy-methyl-cellulose, 2%; papain, 0.5%; vitamin and mineral mix, 3.5%) with iso-energetic (19.3 kJ/g, F1-F6) diets and results were compared with natural food fed fishes. The isocaloric diets were formulated from semi-purified ingredients with six different types of oil supplement which were fed to replicate groups of fishes ad libitum. Based on the protein efficiency ratio (PER), specific growth rate (SGR), average per day increment (PI) and food conversion ratio (FCR), and, it was observed that C. striatus fingerlings utilized dietary lipid. The LINOL showing best growth performance followed by H3HUF, MUSOL on the basis of SGR and PER were significantly ($p<0.05$) influenced in striped murrel, Channa striatus. But lower SGR levels were obtained with diets containing L3HUF, MIXOL, SATOL and NATFO. This study suggests that the lipid from unsaturated origins could be effectively utilized by striped murrel fry with a better resultant growth.* ***Key words:*** *lipid, utilization, growth, Channa striatus*	
Possibilities of using MORINGA (*Moringa oleifera*) LEAF MEAL AS A PARTIAL SUBSTITUTE FOR FISHMEAL IN BROILER CHICKENS DIETS 	**Original Research, B14** **H.K. Zanu, P. Asiedu, M. Tampuori, M. Abada And I. Asante** *Online J. Anim. Feed Res.*, 2(1): 70-75, 2012. **ABSTRACT:** *A six-week feeding trial involving 180 2-week old Cobb broiler chicks was conducted to partially replaced fishmeal with Moringa (Moringa oleifera) leaf meal. The birds were randomly assigned in equal numbers in a Completely Randomized Design (CRD) to four dietary treatments containing 0, 5, 10, and 15% Moringa leaf meal (MLM). Each treatment was replicated three times giving 15 birds per replicate. Feed and water were supplied ad libitum. The parameters measured include feed intake, final weight, weight gain, feed convention efficiency, carcass traits, hematology, serum biochemistry and meat quality.. Final weight, weight gain, feed conversion efficiency were significantly ($p<0.05$) declined with increasing level of MLM. None of the carcass traits measured was affected by addition of MLM. Mean corpuscular hemoglobin (MCH) was the only hematological parameter that showed significance ($p<0.05$) difference in treatment groups. Triglycerides, Low Density Lipoprotein (LDL) and Very Low Density Lipoprotein (VLDL) differed significantly ($P<0.05$). Also, Incorporation of MLM significantly ($P<0.05$) affected moisture, crude protein and crude fat of meat of experimental birds. Cost benefit analysis showed that incorporation of MLM increased profit margins. Based on the data obtained in this study it can be concluded that Moringa oleifera when partially used to replace fishmeal may hamper growth rate of broiler chickens. However, addition of MLM does not adversely affect*	

	mortality, carcass traits and blood variables. ***KEYWORDS**: Moringa, Performance, Haematology, serum biochemistry and Meat quality.*	
Evaluation of false yam (*Icacina oliviformis*) leaves on the growth performance of weaner rabbits (*Oryctolagus cuniculus*)  	**Original Research, B15** **T. Ansah, A.A. Emelia, G. Deku and P.K. Karikari** ***Online J. Anim. Feed Res.*, 2(1): 76-79, 2012** **ABSTRACT:** *This study was conducted to determine the effect of Icacina oliviformis leaf meal (IOLM) on the growth performance of weaner rabbits. Twenty-one (21) weaner rabbits with an average initial weight of 661g were used in a completely randomized design. The feeding trial lasted for 56 days at the livestock unit of the University for Development studies. The chemical analysis was carried out at the Spanish Laboratory of the University for Development studies. The variables measured were feed intake, apparent nutrient digestibility and body weight gain. The average daily feed intake showed a significantly (P<0.05) higher intake for T2 (129.27g) compared with T0 (125.11g). Average daily body weight gain was significantly (P<0.05) higher for T0 (17.65g) compared to T2 (10.83g). However there was no significant difference (P>0.05) between T0 (17.65g) and T1 (13.33g).There was a significantly (P<0.05) higher crude protein digestibility for T0 (84.68%) compared to T1 (80.99%) and T2 (67.08%). Apparent digestibility for CP and EE decreased with increase in the level of IOL in the diet. Based on the results of this study, IOL can be used as a feed ingredient in the diet of rabbits at 5% without any detrimental effects.* **Keywords:** *Icacina oliviformis, Rabbits, performance, apparent digestibility*	
BIOSECURITY PRACTICES IN ALGERIAN POULTRY FARMS 	**Review Article, B16** **N. Alloui, A. Ayachi** *Online J. Anim. Feed Res.*, 2(1): 80-83, 2012 **ABSTRACT:** *The objective of this study was to determine the level of adoption within the Algerian poultry farms (broiler chickens, laying hens) of a range of standard biosecurity practices (isolation, traffic control, decontamination, vaccination…). Quantitative and qualitative evaluation of the biosecurity in the poultry houses has been analyzed thanks using method developed by the French Food Safety Agency. Factorial analysis has permitted to determine four classes of poultry farms. Class 1 and 2 (55%) regroup poultry farms very badly maintained, with breeders which do not respect the elementary hygiene measures (precarious buildings, impure water, non-respect of the sanitary vacuum, badly disinfection, presence of contamination vectors, bad elimination loose chickens…). The two classes are a score between, 0 - 100 points and UFC (faecal streptococci) > 25. Class 3 and 4 regroup 45% of poultry farms and demonstrates that the number of faecal streptococci colonies /25 cm^2 is the lowers (3<UFC<9) and (10<UFC<25) respectively. In these farms, the sanitary teams apply very rigorous barriers of security and decontamination. Visual score attributed for these classes represents unfortunately score between, 100-200 points. The decline of production performances (mortality, feed conversion, and laying rate) especially observed in the poultry farms, class 1and 2, because of failings sanitary barriers in production period.* ***Keywords**: poultry farms, biosecurity, production performances, Algeria*	
Biochemical And Non-Specific Immune Parameters Of Healthy Nile Tilapia (*Oreochromis Niloticus*), Blue Tilapia (*Oreochromis Aureus*) And Their Interspecific Hybrid (♂ *O. Aureus X* ♀ *O. Niloticus*) Maintained In Semi-Intensive Culture System 	**Original Research, B17** **Waleed N. El-Hawarry** *Online J. Anim. Feed Res.*, 2(1): 84-88, 2012 **ABSTRACT:** *Oreochromis niloticus, Oreochromis aureus and their interspecific hybrid tilapia (♂ O. aureus x ♀ O. niloticus) maintained under semi-intensive culture system were compared in a preliminary study to explore the variations in blood biochemical and non-specific immunological parameters. Comparisons were performed after one week of acclimation ("base-line" level). Serum cholesterol, albumin, SGPT and SGOT level were significantly higher (P < 0.05) in the purebred O. aureus than the purebred O. niloticus and their crossbred hybrid. The tested genotypes showed no significant difference (P > 0.05) in total protein, globulin and urea. Additionally, the levels of ALT and uric acid were significantly higher (P < 0.05) in both ♂O. aureus and the crossbred hybrid (♂O. aureus x ♀O. niloticus). On the other hand, the level of creatinine was significantly higher in the purebred O. niloticus followed by the crossbred hybrid and then the purebred O. aureus but still without a significant difference (P > 0.05) between the latter two genotypes. The phagocytic activity and phagocytic index were significantly higher (P < 0.05) in the crossbred hybrid (♂O. aureus x ♀O. niloticus) than the other purebred genotypes. The differences identified suggest that hybrid families from the two species would be used to construct a segregating population for genetic analysis of immunological traits in tilapia. But still, a larger sample size obtained from populations cultured under different managemental practices should be used and challenged to learn if the differences are large enough to produce a segregating population for genetic analysis of immunological traits and disease resistance.* ***Keywords:** Purebred, Oreochromis niloticus, Oreochromis aureus, inter-specific hybrid tilapia normal blood biochemical reference, phagocytic activity, phagocytic index.*	
Production potentials and the physicochemical composition of selected duck strains: a mini review	**Original Research, B18** **Adzitey F.** *Online J. Anim. Feed Res.*, 2(1): 89-94. 2012. ***ABSTRACT:** Physicochemical composition of meat is an important factor in human nutrition and contributes to the choice of food by mankind. In recent times humans are much conscious of the health benefits of what they consume. Emphasize on the consumption of balance diets have been given much attention. The consumption of*	

organic foods, vegetables, fruits, foods high in fibre, foods of animal origin with less fat and cholesterol are among the food stuffs being upheld. Poultry meat, eggs and products are widely consumed worldwide without much religious restrictions. The high consumption of poultry meat is partly due to it ease for preparing different dishes and the development of a wide range of processed ready-to-eat meals incorporated with chicken as a major protein source. Poultry meat (white meat) is known to be healthier than red meat probably due to its low calorie and lipid contents. Duck meat is comparable to that of chicken despite being red meat and it is a close alternative source of protein and other nutrients for humans. Duck meat is high in protein, iron, selenium and niacin; and lower in calories compared to many cuts of beef. This mini-review reports on the production potentials of ducks and the physicochemical composition of selected duck strains. It also reports on world duck population.

Key words: *Duck meat, consumption, health benefits, nutrition, physicochemical*

Effect of date pits on the performance of Sudanese desert lambs

Original Research, B19

Yagoub YM, Elemam MB. 2012.

Online J. Anim. Feed Res., 2(1): 95-97.

ABSTRACT: *Twelve Sudanese desert lambs with an average live weight of 20.9 kg were divided into three groups of equal number to study the effect of date pits level on the performance of Sudanese desert lambs. The study was conducted at small ruminant research unit in the Faculty of Agricultural Technology and Fish Sciences, Al-Neelain University Khartoum, Sudan. Three iso-nitrogenous and iso-caloric diets containing graded levels of date pits (0%, 5%, and 10%) were randomly assigned to the lambs groups. Feeding was on ad libitum for 45 days. Performance of experimental lambs did not significantly influenced with introduction of date pits.*

Key words: Lambs, date pits, chemical composition, performance

Estimation of live body weight from linear body measurements for Farta sheep

Original Research, B20

Taye M, Bimerow T, Yitayew A, Mekuriaw SH, Mekuriaw G.

Online J. Anim. Feed Res., 2(1): 98-103. **2012.**

ABSTRACT: *A study, to develop regression models for prediction of body weight from other linear body measurements, was conducted in Esite, Farta and Lai-Gaint districts of South Gondar, Amhara region. Records on body weight (BW) and other linear body measurements (Body Length (BL), Wither Height (WH), Chest Girth (CH), Pelvic Width (PW) and Ear Length (EL)) were taken from 941 sheep. Non-linear, simple linear and multiple linear regression models were developed using Statistical Package for Social Sciences (SPSS version 12.0). For the multiple linear regressions, step-wise regression procedures were used. Predicting models were developed for different age, sex and for the pool. Positive and significant (P<0.01) correlations were observed between body weight and linear body measurements for all sex and age groups. Among the four linear body measurements, heart girth had the highest correlation coefficient (except ear length) in all age and sex groups which is followed by body length, height at wither and pelvic width. Heart girth was the first variable to explain more variation than other variables in both sex and age groups. The models developed had a coefficient of determination of 0.26 to 0.89; the highest coefficient of determination was depicted for male while the lowest was for dentition groups having two permanent incisors. Regression models in general were poor in explaining weight for the dentition groups above one pair of permanent incisors. Heart girth alone was able to estimate weight with a coefficient of determination of 0.77, for both sexes and the pool. The coefficient of determination of the fitted equations (in general) decreased as the age of sheep advances indicating that the fitted equations can predict weight for younger sheep with better accuracy than for older ones. In general, much of the variation in weight was explained when many traits were included in the model. However, for ease of use and to avoid complexity at field condition, it is possible to use heart girth alone as a predicting tool. As a method to estimate weight using linear body measurements, it is possible to use these linear body measurements for selection in an effort to improve body weight of Farta sheep. In addition, the difference in the correlation coefficients between weight and other linear measurements for different age groups indicates the possibility of using different body measurements at different ages to predict weight and use for selection as well.*

Key words: *Farta sheep, body weight, linear body measurements, regression model*

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EFFECT OF DIETARY SUPPLEMENTATION OF *Melissa Officinalis* and *Aloe Vera* ON HEMATOLOGICAL TRAITS, LIPID OXIDATION OF CARCASS AND PERFORMANCE IN RAINBOW TROUT (*Oncorhynchus Mykiss*)

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ABSTRACT: *This was conducted investigate the effect of feeding lemon balm (Melissa officinalis) and Aloe (Aloe vera) on growth performance, hematological parameters and oxidative stability of rainbow trout. 360 uniform rainbow trout (20.87±0.25 g) were divided into 3 groups, and fed standard diets supplemented with ground lemon balm (2%, L group) or supplemented with Aloe (1%, A group) and without supplementation (Control, C group). Growth performance and body composition were not influenced by plant supplementation. Survival rate of fish was promoted in diets supplemented with herbs, significantly (P<0.05). A significant enhancement (higher value) of WBC and Hct was found in supplementation compared with control (P<0.05). However, any significant differences (P>0.05) were not observed in RBC and Hb in treatments (P>0.05). Results of thiobarbituric acid value (TBA) showed that lemon balm and Aloe herbs could be protective against lipid peroxidation in fish meat during chilling storage (4 °C, 7 days).*

Key words: *Lemon balm (Melissa officinalis), Aloe (Aloe vera), plants supplementation, Rainbow trout (Oncorhynchus mykiss)*

ORIGINAL ARTICLE

INTRODUCTION

The increasing pressure on the aquaculture to reduce or eliminate feed antibiotics as growth enhancers has initiated new research to find safe and efficient natural alternatives. This new generation of feed additives includes herbs and their essential oils and extracts (Brenes and Roura, 2010). Herbal additives contain substances which increase also appetite and digestion (Barreto et al., 2008). There has been published many studies have confirmed that the addition of plants or their extracts in the diets has a beneficial effect to improve growth parameters and protect from diseases in aquaculture. (Shalaby, 2004; Sasmal et al., 2005; Johnson and Banerji, 2007, Farahi et al. 2010, Sudagar et al., 2010; Kasiri et al., 2011).

Medicinal plants are the main sources of natural antioxidants. Generally, fish fat contains higher levels of polyunsaturated fatty acids (PUFA). This is due to the relatively high content of phospholipids in the membrane structure of the muscle cells (Bystricky and Dicakova, 1998). Just a higher degree of unsaturation of fatty acids in muscle membranes is related to increasing of their susceptibility to oxidation of meat and meat products (Marcincak et al., 2010). Lipid oxidation is one of the primary mechanisms of quality deterioration in food, especially in meat products (Gorelik et al., 2008). Therefore, there is a need to increase the antioxidant capacity of muscles, what can be achieved by feeding of antioxidant active substances. Using of natural antioxidants in fish diets is a simple method to achieve higher antioxidant stability, improve sensory properties and prolongate the storage of fish. Important source of natural antioxidants is plant material; lemon balm is common among herbs with high proportion of antioxidant active substances (Marcincak et al., 2008a).

The effect of feeding of lemon balm (*Melissa officinalis*) and Aloe (*Aloe vera*) on growth performance of rainbow trout, body composition, fatty acid profile, and oxidative stability of produced fish was investigated.

To cite this paper: Farahi A, Kasiri M, Sudagar M, Soleimani Iraei M, Zorriehzahra SMJ. 2012. Effect of dietary supplementation of *Melissa officinalis* and *Aloe vera* on hematological traits, lipid oxidation of carcass and performance in rainbow trout (*Oncorhynchus mykiss*). *Online J. Anim. Feed Res.*, 2(1): 01-05.
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MATERIALS AND METHODS

Experimental design and fish

The study was carried out at Ghezelkohpayeh fish farm, Haraz, Iran. 360 uniform rainbow trout (20.87±0.25 g) were purchased from a commercial hatchery. Fishes were randomly divided into 3 groups (n=120) in 3 replications, each containing 40 fish. The rainbow trout were transferred to the place of experiment and acclimated for 2 weeks. During the acclimation, fish were fed the experimental diet to satiation twice a day at 09:00 and 15:00. After acclimation, fish were fasted for one day, batch weighted and randomly distributed among nine troughs. Water temperature was 14-16°C, O_2 7-8 mgl^{-1}, pH 7-8 and light: dark cycle of 12: 12 h was maintained during the feeding trial.

The dietary treatments consisted of the same diets. The ingredients and chemical composition of the diets are shown in Table 1. Experimental group (L group) was fed using diet with addition of ground lemon balm in dose 20 g per 1 kg of diet. Experimental group (A group) was fed using diet with addition of Aloe in dose 10 g per 1 kg of diet. Control group (C group) was fed basal diet without any supplementation. During the experiment, fish were fed the experimental diet to satiation third a day at 08:00, 12:00 and 16:00.

Table 1 - Formulation and proximate composition of the basal diets

Ingredients	(%)
Fish meal	50
Wheat meal	20
Soybean meal	12
Fish oil	10
Vitamin premix [a]	1.5
Mineral premix [b]	1.5
Filler	5
Proximate composition	
Crude protein	40.48
Crude lipid	17.60
Ash	11.26
Wet	1.48
Energy (kJ)	3.83

[a] Vitamin A, 3600000 IU; Vitamin D3, 800000 IU; Vitamin E, 14.4 g; Vitamin K3, 0.8 g; VitaminB1, 0.71 g; Vitamin B2, 2.64 g; Vitamin B6, 1.176 g; Vitamin B9, 0.4 g; Niacine, 11.88; Ca D-pantothenate, 3.92 g; Choline chloride, 100 g; Vitamin B12, 6 mg; H2, 4mg. [b] Mn, 39.68 g; Zn, 33.88 g; Fe, 20 g; Cu, 4 g; I, 397 mg; Se, 80 mg; Choline chloride, 100 g.

Chemical composition

Proximate composition of diets and tissues were specified by using the Association of Analytical Chemists (AOAC, 2003) methods. Dry matter was determined by oven drying at 550°C. The crude protein was determined by measuring nitrogen (N×6.25) using the Kjeldahl method. Lipids were isolated in ground samples (fish carcass) with petroleum ether with Soxhlet apparatus and were determined gravimetrically (Folch et al., 1957).

Hematological Analysis

The indices used to evaluate the hematological profile were included; white blood cell count (WBC), red blood cell count (RBC), hemoglobin concentration (Hb) and hematocrite (Hct). The procedures were based on methods described for fish hematology (Houston, 1990).

Evaluation of thiobarbituric acid assay

To determine the lipid oxidation changes of thigh meat, the method of thiobarbituric acid value (TBA) determination, expressing the degree of secondary damage of lipids, contingent upon the oxidation of unsaturated fatty acids, was used. Examination of samples was carried out on 1, 4, and 7 days of storage at chilling conditions (4°C). The extent of lipid oxidation was evaluated as thiobarbituric acid reactive substances (TBARS) by the method of Marcinčák et al. (2004). TBARS values were measured spectrophotometrically at 532 nm (Helios γ, v. 4.6, Thermo spectronic, Cambridge, UK). Results were quantified as malondialdehyde (MDA) equivalents (mg $MDA.kg^{-1}$ muscle).

Calculations and statistical analysis

The following variables were calculated: Body weight increase (BWI) = Wt – W0; Specific growth rate (SGR) = (ln Wt – ln W0) ×100 t^{-1}; Feed conversion ratio (FCR) = total dry feed consumed (g) / total wet weight gained (g); HSI : [wet liver wt. (g) ×100] / wet body wt. (g); Wt and W0 were final and initial fish weights (g), respectively; and t is the experimental period in days.

All the data were analyzed statistically using SPSS Software, Version 16.00. One-way analysis of variance (ANOVA) with the post hoc Duncan's multiple comparison tests was used to evaluate statistical significance of differences among the control and experimental groups. The results are given as means, standard error of the mean (SEM) and $P<0.05$ was considered as statistically significant difference.

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RESULTS

Fish growth performance

The effect of lemon balm (*Melissa officinalis*) and Aloe (*Aloe vera*) supplementation on body weight, feed conversation ratio (FCR), specific growth rate (SGR) and hepatosomatic index (HSI) are presented in Table 2. No differences (P>0.05) were observed among treatments in growth parameters.

Table 2 - Performance of rainbow trout (mean ± SD) in experimental groups

Parameters	Control	Group L	Group A
BWI	82.97±4.39	80.70±7.30	84.06±3.18
FCR	1.17±0.05	1.23±0.06	1.13±0.01
SGR	1.22±0.06	1.15±0.2	1.28±0.04
HIS	2.37±0.44	2.33±0.35	2.32±0.41

Values in the same row are not significantly different (P > 0.05). Group L= ground lemon balm, Group A= Aloe

Survival rate

As far as Figure 1 is concerned, remarkable difference (P<0.05) in fish survival was observed, as significant promotion was obtained in plants supplementation trails.

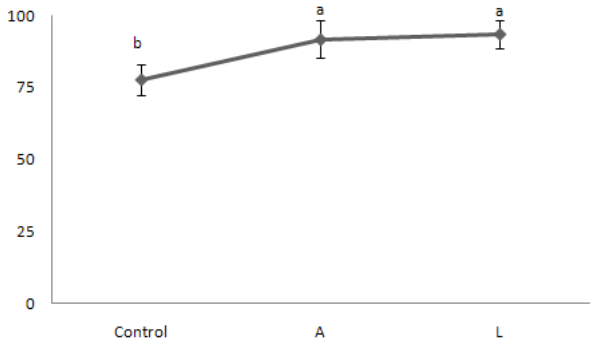

Figure 1 - Survival rate (Mean ± SD) in experimental groups

Chemical composition

As can be seen in the Table 3, results showed that plants supplementation had no influence on the carcass (P>0.05).

Hematological parameters

A significant enhancement of WBC and Hct was found in supplementation compared with control (P<0.05). Inversely, any significant differences (P>0.05) were observed in RBC and Hb in treatments.

Table 3 - Body composition of fish in experimental groups

Parameters	Control	Group L	Group A
Crude protein	17.44±0.22	17.83±0.87	17.47±0.25
Crude lipid	6.20±1.30	5.79±0.30	5.50±0.18
Ash	3.75±0.25	4.10±0.45	3.93±0.41
Wet	72.45±1.10	72.28±0.18	72.1±1.25

Values in the same row are not significantly different (P > 0.05). Group L= ground lemon balm, Group A= Aloe

Lipid oxidation of stored meat

Table 4 shows results of the determination of TBA value measured in fish muscles stored in refrigerator (4°C, 1, 4 and 7 days). On the first day of samples storage were levels of TBA products (TBARS), expressed as the amount of MDA, generally low in all groups. However, already on the first day of storage, the amount of TBARS in both experimental groups (A, L) was lower compared to control (P<0.05). Following storage of samples, caused that TBARS values in all groups were gradually increased (P<0.05), but the amount of TBARS in the control group was significantly higher in comparison with experimental groups (P<0.05). The lowest levels of TBARS and thus the lowest fat damage throughout the storage period were recorded in samples A.

Table 4 - Hematological parameters of fish in experimental groups

WBC (×10³/ μL)	19.00±5.20^{b}	41.66±10.43^{a}	38.45±7.25^{a}
RBC (×10⁶/ μL)	0.69±0.26	0.82±0.30	0.72±0.27
Hb (g/dL)	9.37±1.82	8.04±0.35	7.17±0.08
Hct (%)	26.34±5.04^{b}	52.47±8.25^{a}	49.25±5.16^{a}
WBC (×10³/ μL)	19.00±5.20^{b}	41.66±10.43^{a}	38.45±7.25^{a}

Values in the same row are not significantly different (P > 0.05). Group L= ground lemon balm, Group A= Aloe

DISCUSSION

The effect of medicinal herbs and their essential oils or extracts on the growth performance of fish has been described by Salah et al. (2008), Farahi et al. (2010) and Kasiri et al. (2011). Though these studies have stated the promotion of growth parameters by usage of plants supplementation diets, our study revealed that there are not any differences in growth parameters in experimental groups. The resulting growth promoting effect of plants or plant extracts used as feed additives depends on their proper concentrations, composition of basal diet and management and husbandry conditions (Barreto et al., 2008, Nasir and Grashorn, 2010). Our study was carried out at ideal experimental conditions, which could affect the degree of growth promotion.

To cite this paper: Farahi A, Kasiri M, Sudagar M, Soleimani Iraei M, Zorriehzahra SMJ. 2012. Effect of dietary supplementation of *Melissa officinalis* and *Aloe vera* on hematological traits, lipid oxidation of carcass and performance in rainbow trout (*Oncorhynchus mykiss*). *Online J. Anim. Feed Res.*, 2(1): 01-05.
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Nasir and Grashorn (2010) indicate that feeding *Nigella sativa* and a combination *Nigella sativa* and *Echinacea purpurea* extract did not affect carcass of broilers. Similarly, our findings implied that no remarkable effect of plants supplementation diets was found on body composition of fish. However, Farahi et al. (2010) reported the significant effect of garlic addition to the diets on body composition of rainbow trout.

Many studies showed that application of medicinal plants supplementation diets cause hematological parameters to improve, clearly (Salah et al., 2008; Sudagar et al., 2010; Farahi et al., 2011). Our results revealed that amount of WBC and Hct were enhanced in the groups A and L. As a result, we can assert that immunity of fish was increased in these group compared with control. Having had better hematological characteristics and immunity, survival rate in groups A and L was promoted, obviously. As far as fish survival is concerned, mortality at the end of experiment was declined by medicinal herbs supplementation diets. This result is in agreement with Salah et al. (2008) and Kasiri et al. (2011).

Lipid oxidation in meat and meat products (apart from microbial spoilage) is the primary process by which quality loss occurs. Recently, scientific research has been focused on the use of antioxidant properties of natural plants and their extracts in animal nutrition due to the stabilization of fat in produced meat (Marcincak et al., 2008b; Lahucky et al., 2010; Luna et al., 2010). The results of the present study indicate that lemon balm and Aloe had a positive effect on the oxidative stability of fish meat during chilling storage. The lower lipid oxidation of experimental groups could be related to the antioxidant characteristics of plants. Lemon balm and Aloe are rich in phenol compounds that exhibit antioxidant properties (Sokol- Letowska et al., 2006; Marcincak et al., 2008a). Studies have shown that phenol compounds (flavonoids, proanthocyanidins) have the capacity to act powerful antioxidant activity by scavenging free radicals and terminating oxidative reactions (Sayago-Aerdi et al., 2009). Florou-Paneri et al. (2006) investigated the effect of feeding oregano and oregano extract on oxidative stability of turkey meat. They also noted that the administration of 10 $g.kg^{-1}$ ratio of oregano or 200 $mg.kg^{-1}$ of oregano extract reduced fat oxidation, while at higher dosages oxidation is lower.

CONCLUSION

To sum up, considering the fact that application of *Melissa officinalis* and *Aloe vera* was not efficient in growth performance of rainbow trout, we strongly suggest that application of these plants is beneficial for immunity and survival rate of fish. So, economical efficacy was promoted.

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GROWTH AND DEVELOPMENT OF MUSCLES, BONES AND FAT OF GUINEA FOWL *(NUMIDA MELIAGRIS GALEATA)*

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ORIGINAL ARTICLE

ABSTRACT: *This study was conducted to evaluate the growth pattern of muscles, bones and fat of guinea fowl. Eighteen day old chicks were reared for 22 weeks and serial slaughters were done every four weeks for evaluation. Results showed that the feed conversion ratio was 1:5, highest feed intake at 13-14 weeks of age and highest weight gain at 8-10 weeks. Carcass yield was 69%. The great mass of muscle was found in the thorax, highest bone percentage was found in the pelvis and the flank had high percentage of fat. Thorax and hind limb had high growth rate when compared with pelvis, wing, neck and flank.*

Key words: *carcass yield, body regions, serial slaughter*

INTRODUCTION

Growth is often measured as live weight gain per unit time, (Berg and Butterfield, 1976). Live weight could be a useful measure of growth as it is highly predictive of the amount of desirable edible products such as muscles. Carcass weight is more useful than live weight and the components of the carcass when measured, give a true picture of the benefit from the animal. Carcass composition is measured by the proportion of components, muscles, bones, fat and connective tissues.

Factors that affect carcass composition are slaughter weight; breed or genetic differences, sex and plane of nutrition, Nheta et al. (1997) said that sex has no effect on the growth rate of birds. The carcass is the most important unit in meat studies, since it finally settles the value of the meat animal, both for the farmer and the butcher, (Callow, 1948). The muscle is the most important tissue in the animal; because it is most desired by the consumers and superior carcasses have a maximum yield of muscle, minimum of bone and an optimum amount of fat (Berg and Butterfield, 1976). Hammond (1932) stated that during their lives animals have two sets of muscles; early developing and late developing ones. So there must be causes for the changes in the proportion of individual muscles as animals grow. The growth of muscles can be measured by comparison of weights of the individual muscles on serial animal slaughters, and dissected throughout the lifespan of homogenous animals (weight, breed and sex) raised on a similar plane of nutrition. This method compares the percentage values of weight of individual muscles or muscle groups relative to total muscle weight at various stages of development (Berg and Butterfield, 1976). The growth patterns of the tissues show that the bones growing at a steady, but slow rate, the muscle grow relatively fast, so that the ratio of muscle to bone increases. In poultry the first ossification takes place 12 – 24 hours later in the form of laminae of bone which eventually fuse to form a thin, compact cylinder which is the periosteal bone collar (Hall, 1987). Long bone growth is a complex process which takes place in the growth plates located at the end of these bones; it consists of cartilage cells which form a template over which bone is laid. Fat is the most variable tissue in the carcass and it varies even in its partitioning among various depots and alters markedly throughout growth; therefore it has the greatest influence on both the amount of each of the other tissues in the carcass at any particular weight and the proportionate size of cuts. Fat comprises a relatively small amount of the carcass at birth and then increases so that it approaches and occasionally in very fat animals surpasses muscle tissues in absolute amount, (Berg and Butterfield, 1976).

The production of guinea fowl commercially has gained momentum in many countries, for poultry wild meat is a profitable enterprise in various parts of the world. Some surveys indicated that interest in guinea fowls meat in the United States of America appears to be increasing (Hughes, 1980). In order to be successful, efficient ways of production must be sought. To produce guinea fowls as meat bird, we have to know and understand their growth

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characteristics and patterns to allow the design of optimum management practice. The wild guinea fowls of West Africa is regarded as the original of the domestic stock. There are two common varieties, the Pearl and the White. The birds rarely weigh over three and half bounds although appearing larger. The carcass of Guineas produces a relatively large amount of meat. There is good demand for guinea fowls in the large markets (Platt, 1997). Guinea fowl as a meat bird has proven to be a viable and profitable enterprise, thus providing opportunity for commercialization in many parts of the globe. A survey run by Nahashon et al. (2004) indicated that the interest in guinea fowls as an alternative to poultry and especially broilers in the United States, appears to be increasing

MATERIALS AND METHODS

Twenty three day-old Guinea fowl (*Numida meliagris galeata*) chicks were obtained by fertilized egg collection and incubation in a small capacity (100 eggs) incubator. Hatched chicks (23-25 days) were brooded for one week. Chick mortalities were five percent. Eighteen chicks were chosen for the experiment on basis of health, activity and homogeneity in weights. The birds were lodged in a pen of dimensions 1.5X2.0X2.0 m. divided equally to three compartments. The birds were divided to three groups each of six birds to ease management. The pen sides were guarded by a mesh-wire of fine openings set over a half-meter brick wall up to the roof which was made of corrugated zinc sheets. The ground was concrete with sand bedding. The pen was equipped with chick and then poultry feeders and waterers. The birds were phase-fed. For two weeks as an adaptation period with starter broiler ration (crude protein 20% and metabolizable energy 11.65 Mj/kg), phase after the grower ration (crude protein 17.11%, metabolizable energy 8.58Mj/ kg), was fed for 16 weeks of age. A finisher ration (crude protein 16%, metabolizable energy 6.01 Mj /kg) was fed for four weeks till the experimental feeding was concluded. Feed offer frequency and intake records followed that of the first experiment.

Weekly body weights were recorded to the nearest 0.5 g at 7:00 am before feeding, using a small pressure balance. One bird from each of the three groups was selected for slaughter every four weeks for further carcass analysis and muscle groups study. The bird was controlled by tying its legs. The slaughter procedure followed the Muslim practice using a sharp knife to cut the right and left jugular veins and carotid arteries. The blood was collected and weighed after the bleeding was complete. After immersion in tepid water, the feathers were plucked and the skin was removed. The head was removed at its articulation. The abdomen was eviscerated and thorax was opened, (Griffiths and Purcell, 2008). Carcass data was taken. The hot carcass was divided into right and left halves and the left side was divided into six regions (hind limb, pelvis, flank, thorax, neck and wing) and their muscles were separated.

RESULTS AND DISCUSSION

Average performance values of the guinea fowls are shown in Table (1) Final weight was (1.256±0.11 kg) and the feed conversion ratio was approximately 1:4.8.

Nahashon et al. (2006) describe the growth patterns of the French Guinea fowl and reported the maximum growth rate 0.22 kg at the 9th week of age, and the weight of the body at this level was found to be 2.05 kg. In this study, the average weight gain per week was 0.115 at the 10th week of age, and later the rate of weight gain declined gradually. Adeyemo and Oyejola (2004) found that the weight gain in guinea fowls reared for about 30 weeks was 0.834 (0.28 kg per week). This result was similar to that of this study. The different result obtained by Nahason et al. (2006) in this respect may be due to the different breed of guinea fowls.

Feed conversion ratio of guineafowl was 1:4.8, and this result was quite low when compared with that obtained by Adeyemo and Oyejola (2004) which was a range between 2.56 to 2.86. This may be due to the level and quality of protein content of the ration in the study.

Table 1 - Average performance values of Guinea fowls raised to 22 weeks of age

Item	Value
Initial weight (kg)	0.280±0.001
Final weight (kg)	1.256±0.110
Daily weight gain (kg)	0.009±0.005
Daily feed intake (kg)	0.043±0.010
Feed conversion ratio	1: 4.80

Figure 1 shows average values of feed intake and weight gain (kg) of Guinea fowls raised to 22 weeks of age. The highest feed intake was at weeks 13 and 14 (average of 0.37 kg). The highest gain in weight was achieved from the eighth to the tenth week of age (average of 0.115 kg) and the lowest gains were during the first and the 22nd weeks of age which were 0.014 and 0.011 respectively. The feed intake of the guinea fowls (*Numeda m. galeata*) gradually reached the peak (0.371 kg) at 13 to 14 weeks of age before it dropped gradually. The lowest feed intake was in the first week of age which was 0.112 kg. Nahashon et al. (2005) found that the average feed intake of French guinea fowls was 0.142 kg during the first week of age, and then it increased gradually until it

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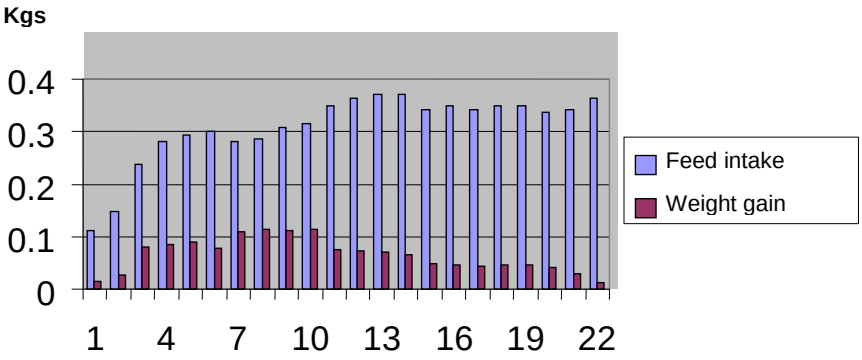
reached 0.518 kg at the 8th week of age. The difference between the results may be due to the energy protein ratio in the ration.

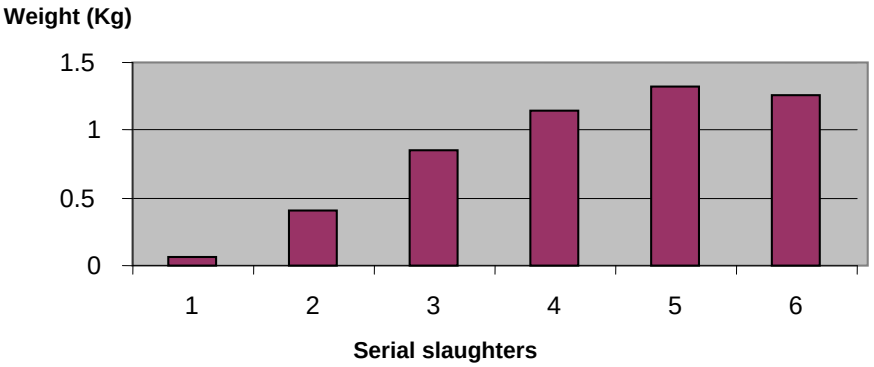
The slaughter weights of the six slaughters (of three birds each) are shown in Figure (2) The slaughter weights of the six slaughters were 0.068±0.003, 0.401±0.009, 0.853±0.015, 1.138±0.020, 1.324±0.116 and 1.256±0.11 kg.

Figure 1 - Average values of feed intake and weight gain (kg) of guinea fowls raised to 22 weeks of age



The slaughter weights of the six slaughters (of three birds each) are shown in Figure 2. The slaughter weights of the six slaughters were 0.068±0.003, 0.401±0.009, 0.853±0.015, 1.138±0.020, 1.324±0.116 and 1.256±0.11 kg.

Figure 2 - Slaughter weights (kg) of the six slaughters of the Guinea fowl



The hot carcass weights (kg) of the six serial slaughters of the guinea fowls are shown in Figure 3. Hot carcass weights were 0.027±0.002, 0.256±0.005, 0.535±0.016, 0.772±0.026, and 0.834±0.053 and 0.667±0.222 kg. Roberson et al. (2003) found the carcass yields (dressing percentage) of Guinea fowl to average 76.6% at the 16th week of age and 75.9% at 18th week of age. This study showed that the carcass yield of Guinea fowl was 69% at 22nd week of age and 63% at 18th week of age. The differences follow those occurring in the weight gains.

Figure 3 - Hot carcass weights (kg) of the six serial slaughters of the Guinea fowls

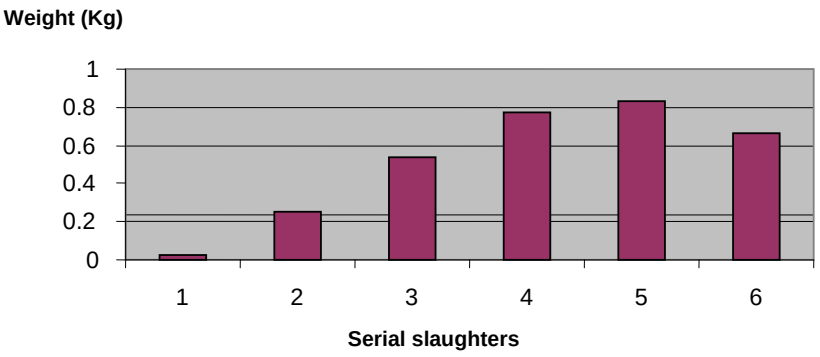


Table 2 shows body regions absolute weights (kg) and their percentages from the left side weight and body region tissues percent of the left side region weight at terminal slaughter. The thorax comprised the highest percentage from the left side of the carcass (42%) followed by the hind limb (32%) and the flank had the lowest percentage (1%). The thorax and the hind limb had a great mass of muscle (83 and 80% respectively). The highest bone percentage was obtained from the pelvis (51%). No bones were dissected in the flank, but high percentage of fat.

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Table 2- Body regions absolute weights (kg) and their percentages from the left side weight and body region tissues percent of the left side region weight at terminal slaughter

Region	Weight	Percentage	Muscle %	Bone %	Connective tissues %	Fat %
Pelvis	0.026±0.001	6	42	51	5	0
Thorax	0.167±0.003	42	83	14	1	1
Flank	0.006±0.001	1	59	0	37	4
Hind limb	0.128±0.002	32	80	15	2	3
Wing	0.040±0.002	10	52	41	5	3
Neck	0.034±0.002	8	50	45	3	0

Figure 4 shows the average values (kg) of different body region weights of Guinea fowls raised to 22 weeks of age. Regions thorax and hind limb have higher growth rates when compared to other regions. This may be due to the high musculature in these two regions.

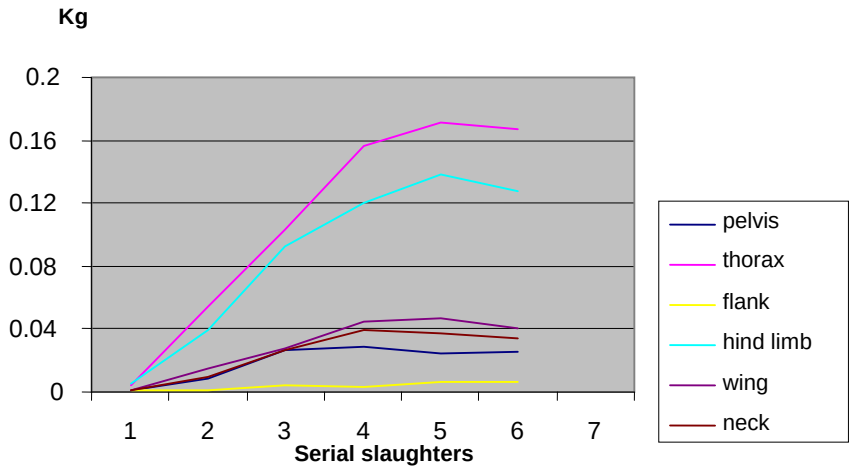

Figure 4 - Average values (kg) of different body region weights of guinea fowls raised to 22 weeks of age.

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EFFECT OF SALT CONCENTRATION LEVEL AND SEASON ON CHEMICAL COMPOSITION OF WET-SALTED FERMENTED FISH SPECIES

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ABSTRACT: *The study was conducted to investigate the effect of salt concentration level and season on chemical composition of wet-salted fermented product (local name; fassiekh) processed from new two fish species (Labeo spp, local name; Debs, Schilbe spp local name Shilbaya) compared with popular fassiekh fish species (Hydrocynus spp, local name: Kass), in reducing the over fishing and use of Alestes and Hydrocynus spp.in fassiekh production in the Sudan. A assorted of 12 Kgs of each of three fassiekh fish species group, consisted of Hydrocynus spp; (25 -30 cm in total length), Labeo spp (20 -25 cm in total length) and Schilbe sp. (17 -22 cm in total length) were collected from Jebel Aulia Dam landing. Fish species were transferred to Khartoum fishing company for processing of fassiekh product. The samples were divided into 3 batches with three replicates. Each batch was treated with different common salt concentration level (20%, 25%, 33% and 0% as a control). The findings of the study clearly revealed, the chemical composition of fresh salted-fermented product showed no significant differences between Labeo and Hydrocynus spp. while Schilbe sp. recorded significantly higher fat content. The salt concentration level on studied fish species resulted in an increase in crude protein and ash content than fresh fish. The highest salt level (33%) resulted in significantly lower moisture content, and produced well wet-salted fermented product with reasonably long storage shelf life. The effect of different season's production time on wet-salted fermented product showed no significant differences in final product of wet-slated fermented fish species chemically. But there were differences in the duration of processing time, depending on ambient temperature. The study concluded that, the best fish species for production of fassiekh product was the Labeo sp. in winter time with 25% slat concentration level treatment. The second and third were Hydrocyun sp. and Shelibe sp. respectively at the same slat concentration level of treatment and season time.*

Key words: *salt concentration levels, season, chemical, composition, wet- salted Fermented, fish species*

ORIGINAL ARTICLE

INTRODUCTION

Water constitutes about 71.0% of the earth's surface and has always been an important actual and potential source of food. There is an increasing demand for aquatic resources and fish products as dietary protein source around the World (Feldhusen, 2000). Fish as a foodstuff is very rich in protein and amino acids that very well meets human dietary requirements (Heen and Kreuzer, 1962; Borgtrom, 1962). Fish do also help in enhancing other animal protein when converted to fish meal and then used as feed for poultry and fish produce protein in commercially more attractive forms.

Fish consumption patterns in many African countries show relatively higher levels in the coastal countries than in the hinterland. The average annual fish consumption in the west African coastal region for example is approximately 20 kg per capita. In the hinterland countries for example Chad, Mali and the Sudan, per capita fish consumption is low, ranging from 2 to 9 kg per annum, where ; the main source of animal protein is red meat. Sudan is one of the developing countries it has limited economic and technological aspects in this sector.

The Natural Fisheries of Sudan are divided into two main sectors: The inland and marine fisheries (Fisheries Department Report, 1995). The primary fishing ground being the group of the reservoirs of the north and the vast swamps area (the Nile Sudd) of the south the reservoirs occupy about 3000 km2 and swamps about 17.000 km2.

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The potential holding capacity of these resources has been estimated of 104.700 tonnes of fresh fish annually. At present, only 29% of this potential is exploited, about 98% is used as fresh and 2% used as processed, and nearly 8,000 tones is processed in to salted and dried fish (Fessiekh and Kejeick). Most of the Fessiekh of the Sudan, representing about 70 percent of total output, is exported to Egypt but Kejeick is consumed locally except in the Southern Region.

Most processors of these products use simple artisanal technologies for processing, fermentation, packaging and storage. These methods usually date back in history and were introduced in the country by settler communities during the Turko-Egyptian occupation. These methods are easily transferred either by tradition within a family or through non-formal training, as a result of the mode of technology transfer in all the country there is a lack of use of a definite salt concentration level, hygienic conditions and standardization in production processes. Product quality differs from another to batch or from one locality to another in all the country.

The major goal for the food processing industry is to provide safe, wholesome and acceptable food to the consumer. Control of microorganisms is essential to meeting this goal. This control is partly exerted through processing and preservation techniques that eliminate microorganisms or prevent their growth. It is also required that the basic hygienic level during processing is high and that efficient cleaning and disinfecting procedures that eliminate spoilage and pathogenic bacteria are used. Many food pathogenic and spoilage bacteria are able to attach to food contact surfaces (Fonnesbech Vogel et al., 2001).

Hydrocynus and *Aletes* species are the main two species use of in the Fassiekh production in the Sudan. These species were over fished specially areas near to highly populated towns and already almost fully exploited. The Fishery Administration report - Khartoum State (2005) pointed to the attrition of the salted fish by illegal fishing that threatens the extinction of this kind of fish so that, other kind of fish needs to be discovered as replacement.

The main objective of this study was to investigate the effect of season, fish species and salt concentration level on chemical attributes of salted -fermented (Fassiekh) fish species (*Labeo spp*, local name; Debs, *Schilbe spp* local name Shilbaya) compared with popular fassiekh fish species (*Hydrocynus spp*, local name, Kass), to help in reducing the over fishing and use of *Alestes and Hydrocynus spp*. in fassiekh production.

MATERIALS AND METHODS

Locality

The sampling site was chosen at Jebel Aulia Dam (45 Km south of Khartoum-Sudan), on the White Nile, which it's the major source of fessiekh production. The potential of Jebel Aulia reservoir is around 14000 tons a year (Yousif, 1988).

Fish samples

A total of 39 Kg of assorted fresh fish samples consisting of *Hydrocynus spp.* (25 -30 cm in total length), *Labeo spp.* (20 -25 cm in total length) and *Schilbe sp.* (17 -22 cm in total length) were obtained from Jebel Aulia dam landing area. These samples were transferred to Khartoum fishing company (well equipped company) for processing.

Fessiekh preparation

Fresh fish samples were carefully and individually gutted and cleaned to rid them of any adhesive material using untreated river water. Treated samples were divided in to 9 batches. These batches were put in Baskets and treated with different common salt (solar salt which was obtained from Port Sudan on the Red Sea- east of Sudan) percentage levels (20%, 25%, 33%; and 0% as of control). The salt of different percentage levels for each group was spread over the whole mass of fish body with special emphasis on the gill area and the cavity of the gutted specimens. The treated samples were stacked in layers, separated by layers of salt.

The fish were left to undergo fermentation for 3 days. Within the first few hours of fermentation, juice was withdrawn from fish by osmotic action of the salt and evacuated. The fermented products were transferred to other experimental tanks and left for 15 days in summer and 25 days in winter. The final product was lighter in its colour and has tougher consistency. Random samples of final fessiekh product for both seasons were taken, secured and wrapped tightly in separated plastic bags, then send to the meat laboratory, University of Khartoum, Faculty of Animal production for proximate analysis. The sensory evaluation was conducted and done at Khartoum fishing company.

Chemical analysis

The gross chemical composition of samples were determined according to standard methods of AOAC (1990).

Statistical analysis

The results of effect of season, salt percentage level on major chemical components of studied fish species were also determined by simple linear regression analysis using statistical package for social science (SPSS, version 9 as described by Gomez and Gomez 1984).

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RESULTS

The present study was carried out to investigate the effect of different salt percentage levels (0%, 20%, 25% and 33%) on chemical composition and physical attributes of Fassiekh fish species (*Hydrocynus spp., Labeo spp,and Schilbe spp.*) at different seasons time (summer and Winter). The data Tables 1, 2, 3, 4, 5 and 6 shows mean values of the proximate analysis of Fassiekh species during the study period.

These findings revealed that, there was a distinctive variation in chemical composition between fresh fish species (control) and salted wet-fermented studied fish species (fasseikh product).

Table 1 - Effect of salt percentage level and season on dry matter content of fassiekh fish species during the study period

Treatment		Dry matter	
Salt	**Fish spp**	**Summer**	**Winter**
Control 0%	*Labeo*	21.3	20.3
	Schilbe	24.6	39.3
	Hydrocyon	25.6	29.3
20% Salt	*Labeo*	47.0	40.6
	Schilbe	50.9	54.8
	Hydrocyon	47.8	43.7
25% Salt	*Labeo*	49.4	44.3
	Schilbe	55.6	58.0
	Hydrocyon	49.9	43.9
33% Salt	*Labeo*	53.4	48.8
	Schilbe	57.0	59.0
	Hydrocyon	51.5	47.5
Main effect			
Salt	Control	26.72±8.8^{d}	
	20% Salt	47.45±5.2^{c}	
	25% Salt	50.18±5.5^{b}	
	33% Salt	52.83±4.4^{a}	
	Significance	0.00	
Fish spp	*Labeo*	40.63±12.2^{c}	
	Schilbe	49.91±11.6^{a}	
	Hydrocyon	42.35±10.6^{b}	
	Significance	0.00	
Season	Summer	44.49±12.5	
	Winter	44.11±11.7	
	Sign. level	NS	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.01) different.

Table 2 - Effect of salt concentration level and season on moisture content of fasseikh fish species during the study period

Treatment		Moisture	
Salt	**Fish spp**	**Summer**	**Winter**
Control 0%	*Labeo*	78.7	79.7
	Schilbe	72.9	60.7
	Hydrocyon	74.4	80.4
20% Salt	*Labeo*	53.1	59.4
	Schilbe	49.1	45.2
	Hydrocyon	52.3	56.3
25% Salt	*Labeo*	50.6	55.7
	Schilbe	44.4	42.0
	Hydrocyon	50.2	53.5
33% Salt	*Labeo*	46.6	51.2
	Schilbe	43.0	41.0
	Hydrocyon	48.5	52.5
Main effect			
Salt	Control	74.46±7.2^{a}	
	20% Salt	52.55±5.2^{b}	
	25% Salt	49.38±4.9^{c}	
	33% Salt	47.10±4.3^{d}	
	Significance	0.00	
Fish spp.	*Labeo*	59.37±12.2^{a}	
	Schilbe	49.77±10.9^{b}	
	Hydrocyon	58.48±11.5^{a}	
	Significance	0.00	
Season	Summer	55.31±12.2	
	Winter	56.44±12.4	
	Sign. level	NS	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.01) different

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Table 3 - Effect of salt concentration level and season on crude protein content of fasseikh fish species during the study period

Treatment		Crude protein	
Salt	**Fish spp**	**summer**	**winter**
Control 0%	*Labeo*	19.7	15.1
	Schilbe	18.0	19.2
	Hydrocyon	22.2	15.2
20% Salt	*Labeo*	25.8	26.3
	Schilbe	19.1	26.8
	Hydrocyon	26.0	17.4
25% Salt	*Labeo*	25.9	16.9
	Schilbe	23.4	18.9
	Hydrocyon	26.6	21.5
33% Salt	*Labeo*	27.1	24.3
	Schilbe	19.2	19.4
	Hydrocyon	25.9	29.2
Main effect			
Salt	Control		
	20% Salt	23.55±4.9[a]	
	25% Salt	22.19±5.9[a]	
	33% Salt	24.17±5.0[a]	
	Significance	0.00	
Fish spp	*Labeo*	22.62±4.9[a]	
	Schilbe	20.49±3.8[b]	
	Hydrocyon	23.00±6.8[a]	
	Significance	0.025	
Season	Summer	23.22±3.7	
	Winter	20.85±6.4	
	Significance	0.00	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.05) different

Table 4 - Effect of salt concentration level and season on fat content of fassiekh fish species during the study period

Treatment		Fat	
Salt	**Fish spp**	**summer**	**winter**
Control 0%	*Labeo*	0.8	1.2
	Schilbe	7.6	20.5
	Hydrocyon	4.1	4.9
20% Salt	*Labeo*	0.8	1.3
	Schilbe	8.6	13.3
	Hydrocyon	1.3	5.3
25% Salt	*Labeo*	1.7	2.2
	Schilbe	10.3	13.3
	Hydrocyon	0.4	1.5
33% Salt	*Labeo*	1.8	1.6
	Schilbe	10.4	15.0
	Hydrocyon	0.5	1.0
Main effect			
Salt	Control	6.48±6.8[a]	
	20% Salt	3.43±4.1[b]	
	25% Salt	4.98±5.1[ab]	
	33% Salt	5.06±6.0[ab]	
	Significance	0.00	
Fish spp	*Labeo*	1.43±0.9[b]	
	Schilbe	11.13±5.2[a]	
	Hydrocyon	2.35±3.2[b]	
	Significance	0.00	
Season	Summer	4.02±4.0	
	Winter	5.92±6.8	
	Significance	0.00	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.01) different

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Table 5 - Effect of salt concentration level and season on ash content of fassiekh fish species during the study period

Treatment		Ash	
Salt	**Fish spp**	**Summer**	**Winter**
Control 0%	*Labeo*	1.3	2.3
	Schilbe	0.8	0.9
	Hydrocyon	1.2	1.1
20% Salt	*Labeo*	17.9	16.9
	Schilbe	16.7	14.8
	Hydrocyon	15.7	16.8
25% Salt	*Labeo*	19.4	19.9
	Schilbe	18.0	15.4
	Hydrocyon	20.1	16.3
33% Salt	*Labeo*	20.5	19.1
	Schilbe	18.0	17.5
	Hydrocyon	20.9	16.3
Main effect			
Salt	Control	1.31±0.7[c]	
	20% Salt	16.47±1.6[b]	
	25% Salt	18.38±1.8[a]	
	33% Salt	18.69±2.9[a]	
	Significance	0.00	
Fish spp	*Labeo*	14.69±7.6[a]	
	Schilbe	12.74±7.3[c]	
	Hydrocyon	13.71±7.7[b]	
	Significance	NS	
Season	Summer	14.19±7.8	
	Winter	13.23±7.2	
	Significance	NS	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.01) different

Table 6 - Effect of salt concentration level and season on crud fiber content of fassiekh fish species during the study period

Treatment		Crude fiber	
Salt	**Fish spp**	**Summer**	**Winter**
Control 0%	*Labeo*	0.8	10.8
	Schilbe	4.9	17.3
	Hydrocyon	2.3	10.3
20% Salt	*Labeo*	2.7	13.7
	Schilbe	6.6	8.9
	Hydrocyon	5.4	16.9
25% Salt	*Labeo*	5.1	16.7
	Schilbe	3.6	7.0
	Hydrocyon	3.9	15.6
33% Salt	*Labeo*	3.0	18.2
	Schilbe	6.0	7.1
	Hydrocyon	1.3	11.7
Main effect			
Salt	Control	7.71±6.0	
	20% Salt	9.05±5.4	
	25% Salt	8.65±6.9	
	33% Salt	7.88±6.1	
	Significance	NS	
Fish spp	*Labeo*	8.88±6.7	
	Schilbe	7.68±4.4	
	Hydrocyon	8.42±6.9	
	Significance	NS	
Season	Summer	3.79±2.5	
	Winter	12.85±5.1	
	Significance	**	

Key: a,b,c,d means within the same column followed by the different superscripts are significantly (P < 0.01) different

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DISCUSSION

The study of nutritional value of wet-salted fermented product (fassiekh) in relation to different fassiekh product fish species at various salt concentration level plays an important role in fish industry, marketing, preservation and processing. With this concept three fresh water fish species, the more dominant Fasseikh fish species in the Sudan (*Labeo sp., schilbe sp. and Hydrocynus* sp.) were selected for this study to evaluate their chemical characteristics after being treated by different salt concentration levels at different seasons time of (winter and summer). The proximate composition parameters of these fassiekh product fish species are provided in Tables 1, 2, 3, 4 and 5.

Fresh samples (control) of the studied species (*Labeo sp., schilbe sp. and hydrocynus sp.*) in Table 1 have moisture content 78.7±0.4, 72.9±4.2, 74.4±2.7 respectively. These mean values are within the normal range and are in line with many authors (Iskander, 1982, Omer, 1984, Dirar, 1993, Eltom, 1989).

Moisture content has no nutritional value but is essential in describing food composition, preservation and to some extent shelf life (Pike and Brown 1967). Also the moisture content is a factor to be considered in the assessment of salted fish. The level of moisture content of studied species treated with different salt percentage levels (20, 25, 33%) showed distinct variation among the studied species (*Labeo spp*, 53.1±1.4, 50.6±1.3, 46.6±1.1 respectively for summer while in winter 59.4±0.5, 55.7±0.9, 51.2±1.1, respectively), (*Schilbe spp*,49.1±2.5, 44.4±1.6, 43.0±1.6 respectively for summer and 45.2±4.1, 42.0±0.9, 41.0±0.6 respectively for winter), (*Hydrocyuns spp*, 52.3±1.7, 50.2±0.3 and 48.5±1.1 respectively for summer and 56.3±3.2,53.5 ±0.4, 52.4 ±0.4 respectively for winter, all these findings within the range reported by many authors (Agab and Bashir, 1989, El tom 1989, Mahmoud, 1977, Kofi, 1992a).

The lower mean value of moisture content was recorded 41.0 ±0.6 with 33% salt concentration level for *Schilbe* species in winter. The highest was recorded 59.4±0.5 with 20% salt concentration level for *Labeo* species at winter season. This variation could be attributed to increase of salt level .i.e. the increase of salt concentration level (33%) resulted in significantly lower moisture content and longer shelf life.

As for the crude protein content, the chemical analysis revealed that the protein content of each species *Labeo spp* (25.8±0.6, 25.9±0.6 and 27.4±1.3 for summer, and 26.3 ±3.3, 16.9±3.3 and 24.3 +3.8 respectively for winter), *Schilbe spp* (19.1±0.3, 23.4±1.9 and 19.2±3.7 for summer, and 26.8±3.6, 18.9±0.6 and 19.4±3.9 respectively for winter), *Hydrocyuns spp*. (26.0±1.5, 26.6±1.2 and 25.9±3.6 for summer, and 17.4±6.3, 21.5±12.4 and 29.2±4.8 respectively for winter). These little variations in findings were not significantly different when compared to the range values recorded for many Nile fish species as wet product (Babiker, 1981, Mac, 1992, Awouda, 1984). Also when these results were compared with the findings of same fish species studied by Agab and Bashir 1989, El tom, 1989 and Mahmoud, 1977 data were found within the range for Fassiekh product.

The effect of salt concentration level resulted an increase of crude protein significantly. The lower value was recorded 16.9±3.3 for *Labeo spp* at 25% and the highest one was 29.2±4.8 for *Hydrocyuns spp* at 33% salt concentration level. The discrepancy in protein level might be due to different salt concentration level (20%, 25% and 33%) and climatic condition.

There was a significant difference in fat contents among studied fish species treated with different salt percentages level and fresh fish species (Tables 3-5).This could be attributed to the fish species type, nutritional status and season. These variations were more pronounced between different salt percentage levels of *Schilbe spp* and *Hydrocynus spp*. Lower values of fat content which appeared in the studied fish species of Fasseikh might possibly be due to loss of fat with exuded fluids due to the osmotic effect. The effect of different season on fat content is clearly explicated in (Table 6) which normally varies considerably even for the same fish at different seasons. Fat content was significantly higher in fish species caught in winter (1.6, 13.0, 3.1%) than in summer ones (1.3, 9.2, 1.5%) as in *Labeo, Schilbe and Hydrocynus spp.* respectively. These results are in accordance with the findings of Johnston (1994) who found that, the fat content varies widely from species to species and from season to season. Remijo (1992) and Dirar (1993) reported a higher value of fat content (3.5% and 6.7% respectively) for salted-fermented fish*;* these findings are agreement with the present study, which showed considerable variations among the studied species. The fat content could exceed the 6.7% for salted-fermented fish as in this study. In this study fat content was significantly higher in *Schilbe* spp (11.1%) than *Hydrocynus spp* (2.3%) and *Labeo spp* (1.4%).

Ash content as a nutrient element is important in metabolic process, but has little value as food item (Karar, 1997).The effect of salt concentration levels (0%, 20%, 25%, 33%) on wet salted-fermented fish had significantly higher ash content17.4%, 19.6%, 19.8% in *Labeo spp*.; 0.82%, 15.7%, 16.7%, 17.7% ; *Schilbe spp.*, 16.3%, 18.8%, 18.6% *Hydrocynus spp* than fresh fish species 2.0%, 1.1% and 2.0% respectively. The ash content of the salted-fermented fish in this study was in agreement with Kofi (1992) who reported that the ash content could be ranged between (1.3 - 22.5%).

The effect of season on chemical composition of fassiekh product as in Table 5 indicated that there was no significant difference in ash content among the studied fish species in summer and winter (14.7%, 12.7%, and 13.7%) repetitively.

In conclusion the present study clearly revealed that proximate chemical compositions of the salted-fermented fish showed that, there were no significant differences among studied species *Labeo* and *Hydrocynus*, while *Schilbe* showed significantly higher in fat content, at different salt concentration percentages.

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The effect of salt concentration levels on the studied species resulted in an increase of crude protein and ash content than fresh fish. The highest salt level (33%) resulted in significantly lower moisture content, and produced well-salted-fermented fish with reasonably long storage life. which normally vary considerably even in the same fish species at different seasons.

The effect of different seasons on salted-fermented fish showed that, there were no significant differences in final product of wet-fermented fish species chemically. But there were differences in the duration of processing time, depending on ambient temperature.

From this study we could conclude that, the best fish species for production was the *Labeo spp*. in winter at 25% slat concentration level treatment. The second and third was *Hydrocyun spp*. and *Shelibe spp*. respectively at the same slat concentration and seseason.*The Labeo sp. and Shelbie spp.* could be substitute the present fassiekh fish species such as *Alestes and Hydrocyun spp*.

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ANTI-NUTRIENT FACTORS, PERFORMANCE AND SERUM BIOCHEMISTRY OF BROILER CHICKS FED RAW AND FERMENTED *ALCHORNEA CORDIFOLIA* SEEDS

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ABSTRACT: *This study was carried out to determine some anti-nutrient factors in differently processed Christmas bush (Alchornea cordifolia) seeds and the effect of the processed seed meals on the performance and blood chemistry of broiler chicks fed from 1 to 35 day of age. Ground and fermented, and dehulled Christmas bush (CB) seed meals were analyzed for their anti-nutrient contents whereas ground and sieved (GS), ground-sieved and fermented (GSF) and non-sieved and fermented (NSF) seed meals were incorporated into starter broiler diets to replace 10% of maize, respectively. Fermented and dehulled CB seed meals contain 574.4 and 21.3mg/100g phytic acid, respectively. Cyanide was not identified in any of the meals. Dehulling eliminated the anthraquinone and tannin contents whereas fermentation only eliminated the tannin content. None of the methods completely eliminated the saponin, cardiac glycoside, flavonoid and alkaloid contents of the seed meals. With GS seed meal, broilers had lower average daily weight gain (P<0.05) than the control group. Feed intake decreased (P<0.05) but feed conversion ratio was not different when compared with control. Inclusion of GSF seed meal improved growth and feed intake when compared with the NSF seed meal and by day 35, growth and feed intake were comparable to those of the control birds. Blood plasma levels of alanine aminotransferase, alkaline phosphates and aspartate aminotransferase increased with GS CB seed meal diet, while serum calcium decreased. Neither raw nor fermented seed meals altered other measures of the blood chemistry. It is concluded that CB seeds contain toxic anti-nutrient compounds and that sieving out the hulls in the ground raw seed meal before fermentation improved the feeding value of the seeds for broilers at 10% replacement for maize.*

ORIGINAL ARTICLE

Key words: *Alchornea seed; Anti-nutrients; Broilers; Fermentation; Performance; Serum chemistry*

INTRODUCTION

Christmas bush *(Alchornea cordifolia*) is a tropical browse plant that forms a good proportion of the ever green vegetation of the humid tropical zone of southern, Nigeria. It is locally known as 'Ububo' by the Igbo speaking tribe of south- eastern, Nigeria (Udedibie and Opara, 1998; Okoli et al., 2002). The plant produces prolific quantities of foliage and seeds in many countries including Nigeria (Iwu, 1993), Equatorial Guinea (Sebater, 1977), Republic of Guinea (Sugiyama and Koman, 1992), and Japan (Huffman, 2002) among others. The foliage including the seeds is frequently consumed in the field by Gorillas and Chimpanzee (Sebater 1977; Sugiyama and Koman, 1992) and is commonly used in zero-grazing by local villagers for the feeding of small ruminants (Udedibie and Opara, 1998; Okoli et al., 2002). It is also used by local inhabitants for the cure of many diseases of man (Lamikara et al., 1990; Iwu, 1993). However, the seeds are little known and used in the diets of humans and other monogastric animals such as chickens and pigs because there is little or no information on their production, chemical compositions, processing, marketing or use.

Published data indicates that the raw seeds contain 13% crude protein and 14Mj/KgDM gross energy and are toxic when fed to broilers, causing reductions in growth, feed intake and increased mortality (Emenalom et al., 2009). The authors also reported that the raw seeds with hulls contain 973.8mg/100g phytic acid and also show the presence of saponins, anthraquinone, cardiac glycosides, steroids, flavonoids, tannins and alkaloids. One report indicated that toxic and anti- nutritional factors in seeds are concentrated in some part of the seeds and may be reduced by pretreatments such as dehulling (Rao and Deosthale, 1982) or fermentation (Ibrahim et al., *2002*). . The

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advantages of adding such processed non conventional feedstuffs to poultry diets have been demonstrated using jack bean (Udedibie et al., 1998), pigeon pea (Efule and Obioha, 1999), velvet bean (Emenalom et al., 2006) and Christmas bush (Emenalom et al., 2011) among others. Meanwhile Christmas bush seeds have not been subjected to any form of pretreatment to determine its anti-nutritional factors or feeding value.

This study was therefore designed to determine the presence or otherwise of some anti-nutritional factors in fermented and dehulled CB seed meals and also the performance and blood chemistry of broiler chicks fed 10% ground and sieved, ground-sieved and fermented, and non- sieved and fermented seed meals as replacement for maize.

MATERIALS AND METHODS

Source of seeds

Christmas bush seeds used for this experiment were harvested from the wild in bushes around the Teaching and Research Farm of the Federal University of Technology, Owerri, Nigeria where the experiment was carried out. Owerri is located in the rainforest zone of Nigeria (5° 29' N and 7° 02' E) and an elevation of 90.91m. The environment has an annual rainfall of 2641mm, temperatures of 27.4°C and relative humidity of 86.6%. The seeds were harvested alongside with the stalk.

Seed processing

The seeds with stalks were sun dried for 4 -6 days (depending on the intensity of the sun) on concrete slabs. The dried seeds with hulls were then detached from the stalks and divided into two batches. The first batch was dehulled and ground into meal while the second batch was ground with the hulls using a hammer mill and further subdivided into three parts. The first part was sieved using a 2mm sieve to remove coarse hulls. The second part was sieved, soaked in water for 48 hours at room temperature, drained into a jute bag, pressed and allowed to stand for 12 hours under pressure. The third part was soaked in water without previous sieving and treated as the second part above. The second and third parts were both sun dried on concrete slabs until they were crispy at touch.

Anti-nutrient analysis

Samples of the fermented seed meal with hulls and dehulled seed meal were screened for the presence of cyanide, phytic acid, saponnin, anthraquinone, cardiac glycoside, steroids, flavonoids, tannins and alkaloids at the Department of Biochemistry and Applied Molecular biology, National Veterinary Institute VOM, Jos, Nigeria.

Experimental diets

Four experimental broiler starter diets were formulated such that the control diet contains no CB seed meal. Diets 2, 3 and 4 contain 5.2% (10% replacement of maize) of raw ground and sieved (RGS), sieved and fermented (SF) and non sieved and fermented (NSF) CB seed meals, respectively. The ingredient composition of the diets is shown in table 1.

Experimental birds and design

One hundred and twenty (120) day old Anak broilers procured from Amazing Grace Farm, Owerri, Nigeria were used for the experiment. The birds were divided into four groups of 30 birds each. Each group was further divided into three replicates of ten birds each. The birds were then randomly assigned to the four experimental diets in a completely randomly design and housed in a 2 x 1m pens covered with wood shavings as the litter material. The pens were cover with black polythene for the first two weeks to control heat and wind and provided with lantern and stoves as sources of light and heat, respectively. Feed and water were given *ad libitum*. The experimental lasted for 35 days.

Data collection

The birds were weighed at the beginning of the experiment and weekly thereafter. Feed intakes were taken daily. At 35 day of age, three birds per treatment were randomly selected, and blood samples were collected from their brachial wing vein with syringes and needles between 8:00 am and 9:00 am. Some blood biochemical parameters including AST (aspartate amino transferase), ALP (alkaline phosphatase) ALT (alanine amino transferase), total protein, calcium, phosphorus and uric acid were evaluated. The Federal Medical Center, Owerri, performed the blood analyses.

Data analysis

The data generated in the experiment were subjected to one way analysis of variance (ANOVA). The standard error of means (Steel and Torrie, 1980) was used in the separation of means

RESULTS

Fish growth performance

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The effect of lemon balm (*Melissa officinalis*) and Aloe (*Aloe vera*) supplementation on body weight, feed conversation ratio (FCR), specific growth rate (SGR) and hepatosomatic index (HSI) are presented in Table 2. No differences (P>0.05) were observed among treatments in growth parameters.

Fermented CB seed meals with hulls, and dehulled seed meal contain 574.41 and 21.29mg /100g phytic acids, respectively and show the presence of tannins, saponins, cardiac glycosides, steroids and flavonoids (Table 2). Cyanide was not identified in any of the meals. Dehulling eliminated the anthraquinone and tannin contents whereas fermentation only eliminated the tannin content. None of the methods completely eliminated the saponin, cardiac glycoside, flavonoid and alkaloid contents of the seed meals.

Table 1 - Ingredient Composition of experimental diets (0-5 weeks)

Ingredients (%)	Control 0%	RGS 10%	GSF 10%	NSF 10%
Maize	52.00	46.80	46.80	46.80
Soybean meal	30.00	30.00	30.00	30.00
Alchornea seed meal	0.00	5.20	5.20	5.20
Fish meal	5.00	5.00	5.00	5.00
Brewers dried gain	5.00	5.00	5.00	5.00
Palm kernel cake	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00
Wheat offal	2.00	2.00	2.00	2.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Vitamin premix[1]	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total *Calculated analysi*	**100.00**	**100.00**	**100.00**	**100.00**
Phosphorus	0.92	0.93	0.93	0.94
Calcium	1.31	1.31	1.31	1.31
Ether extract	3.75	3.79	3.60	3.64
Crude fibre	4.57	4.74	4.60	4.64
Crude protein	22.83	22.87	22.80	22.78
ME (Keal/kgDM)	2853.33	2851.87	2838.09	2830.90

[1]Guarantied chemical analysis per kg of feed: Vit.D3. 400g, Vit.E.8g, Vit. K. 30.4g, Vit.B_1.0.32g, Vit.B_2. 0.56g, Vit. B_6. 4g, Calpathonerate 1.6g, Folic acid 0.16g, Biotin 8mg, Chlorine 18g, Zinc 7.2g, Copper 0.32g, BHT 32g, Iodine 0.25g, Cobalt 36mg, Selenium 16mg, Oxytetracycline 100mg and Vit.C.25g. *RGS: Raw ground and sieved seed meal. GSF: Ground sieved and fermented seed meal. NSF: Non- sieve and fermented seed meal*

Table 2 - Effect of fermentation and dehulling on the anti- nutrient contents of *Alchornea* seeds

Components	Ground raw (GR)	Ground and fermented (GF)	Dehulled (D)
Phytic acid (mg/100g)	973.80	574.41	21.29
Cyanide	-ve	-ve	-ve
Saponins	+ve	+ve	+ve
Anthraquinone	+ve	-ve	-ve
Cardiac glycoside	+ve	+ve	+ve
Steroids	+ve	+ve	+ve
Flavonoid	+ve	+ve	+ve
Tannin	+ve	+ve	-ve
Alkaloid	+ve	+ve	+ve

Where

-ve = negative; +ve = positive

Birds fed SF Christmas bush seed meal diet had a higher (P<0.05) feed intake than those fed RGS and NSF diets (Table 3) whereas those fed RGS Christmas bush seed diet had lower (P<0.05) feed intake than the other birds. Body weight gain of birds fed the control diet was highest but compared statistically (p>0.05) with those of birds fed SF Christmas bush seed meal diet, but the value however, differed (P<0.05) from those of birds fed RGS and NSF seed meal diets. Birds fed RGS seed meal diet recorded the lowest weight gain and gained 75.2 and 73.6% of the control and SF seed meal diets, respectively. There were no significant differences in feed conversion ratio among birds fed the control and fermented Christmas bush seed meal diets. Mortality value was relatively high in RGS seed meal diet group when compared with other dietary groups.

Of the blood analyses done, increased plasma levels of AST, ALP and serum calcium were observed in birds fed CB seed meal diets (Table 4). ALT values were lower (p<0.05) in birds fed fermented seed meal diets than those fed the control and RGS seed meal diets.

Birds fed RGS seed meal diets had a statistically lower (P<0.05) AST and ALP than the control. Values of total protein, phosphorus and uric acid were similar among the dietary groups.

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Table 3 - Performance of starter broilers fed differently processed *Alchornea* seed meal (0- 5 weeks)

Parameter	Control 0%	RGS 10%	GSF 10%	NSF 10%	SEM
Initial body weight (g)	33.3	36.0	36.0	36.0	-
Final body weight (g)	726.7^{a}	536.7^{c}	716.7^{a}	643.3^{b}	23.85
Body weight gain (g)	693.7^{a}	500.7^{c}	680.7^{ab}	607.3^{b}	27.30
Feed intake (g)	1519.8^{ab}	999.5^{c}	1618.7^{a}	1317.0^{b}	38.64
Feed conversion ratio	2.2^{ab}	2.0^{b}	2.4^{a}	2.3^{ab}	0.08
Mortality rate[1]	23 (5)	39 (7)	22 (4)	22 (4)	-

^{a,b,c}: means within a row with different letter superscript differ significantly (P<0.05). RGS, GSF and NSF are as in table1; SEM: Standard error of means. [1]Number of birds is presented in parenthesis.

Table 4 - Serum chemistry of broiler fed *Alchornea* seed diet (0 – 5 weeks)

Parameters	Control 0%	RGS 10%	GSF 10%	NSF 10%	SEM
Alanine aminotransferase (ALT)(iu/l)	24.0^{a}	26.0^{a}	16.5^{b}	16.5^{b}	2.14
Aspartate aminotransferase (AST)(iu/l)	34.0^{b}	54.0^{a}	53.5^{a}	42.5^{b}	3.33
Alkaline phosphatase (ALP) (iu/l)	302.0^{b}	624.5^{a}	317.5^{b}	500.5^{ab}	97.50
Serum total protein (g/dl)	4.70	4.00	3.00	3.45	0.67
Serum calcium (ca^{++}) (mg/dl)	7.90^{c}	8.90^{bc}	11.60^{a}	9.40^{b}	0.48
Phosphorous (mg/dl)	3.65	3.10	3.05	3.25	0.21
Uric acid (gm/dl)	1.80	2.05	1.70	1.50	0.25

^{a,b,c}: means within a row with different letter superscript differ significantly (P<0.05). RGS, GSF and NSF are as in table1; SEM: Standard error of means

DISCUSSION

The result of the anti- nutrient screening showed that dehulling reduced the phytic acid level eliminated the tannin content in CB seeds (Table 2). Emenalom et al. (2009) reported that raw CB seeds with hulls contain 973.8mg/100g phytic acid and showed the presence of anthraquinone and tannin among others. It therefore follows from the present result that more than 97% of the whole seed phytic acid is located in the hulls hence the very low level of phytic acid and absence of tannin recorded in the dehulled seed meal. Similar reduction in tannin has been reported in dhal pulses (Rao and Deosthale, 1982) thus indicating that under this treatment condition, tannin and phytic acid in CB seed can be reduced or eliminated. The reduction in the phytic acid level by fermentation agrees with similar report in literature (Ibrahim et al., 2002) but dehulling was more efficient than fermentation as indicated in the present result.

Little systematic research has been done on the nutritional quality of CB seed for any monogastric species. Raw CB seed with hulls are deleterious to starter broiler at 5% dietary inclusion level (Emenalom et al., 2009). Fermenting the seed meal with hulls only partially improved the nutritional quality of the seeds for finisher broiler at 10% dietary inclusion level (Emenalom et al., 2011). However, the method of processing that will produce optimal result has not been established.

In the present study, it was found that inclusion of RGS CB seed meal in diets for starter broilers had major effects on body weight gain and serum chemistry. Body weight and feed intake were substantially depressed when RGS seed meal replaced 10% of maize in the ration consumed by starter broiler chicks fed to five weeks of age. The growth depressing factors present in the RGS seed meal are unknown, but part of the adverse negative effect may be explained by lack of knowledge about availability, especially amino acids in the seeds, although the diets were nutritionally balanced based on the data available. On the other hand, a large part of the negative effect of the raw seeds on growth is undoubtedly explained by one or more of the toxic factors present in the seed (Table 2). Moreover, the presence of possibly, other unidentified anti-nutrient factors in the seeds may have also contributed to the poor performance of the birds.

Differences were observed however, between raw and fermented CB seeds on growth and feed intake. Consumption of SF seed meal diet gave a much better body weight gain and feed intake than NSF seed meal diet, thus indicating the negative effects of RGS and NSF seed meals in the inhibition of metabolic processes leading to growth, apart from an equally depressed effect on appetite. Thus the marked growth depression from feeding the RGS and NSF seed meal diets cannot be entirely explained by decreased feed intake considering the fact that chicks on NSF seed meal diet had a statistically similar feed intake with the control. This suggests that the effects of CB seed on metabolic processes should be examined further.

Feed conversion was not markedly affected by both raw and fermented CB seed meal diets. Contrary to the improved feed conversion ratio observed in the present study, Emenalom et al. (2011) reported depressed feed conversion ratio for starter and finisher broilers fed raw and fermented seed meals with hulls, respectively. This show that sieving out some of the coarse hulls from the raw seed meal or sieving before fermentation, both encouraged better feed conversion ratio than non-sieved and fermented seed meal. The 39% mortality recorded in birds fed RGS seed meal diet may not be blamed totally on toxic or anti-nutritional factors since the control diet group had similar mortalities.

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Dietary raw ground and sieved CB seed meal diets caused several changes in blood chemistry. Plasma ALT decreased significantly with fermented CB seed meal diets while ALP and AST increased. The enzyme ALT is a cytoplasmic enzyme whose increase in blood plasma frequently signals either liver or muscle damage (Lumeji, 1997). Therefore a factor in raw CB seeds apparently causes either hepatic or muscular damage. On the other hand, alkaline phosphates (ALP), another indicator of liver damage (Kramer and Hoffman, 1997) also increased in broiler fed RGS seed meal diet. This observation coupled with the increase in ALT and AST may argue more strongly for the occurrence of muscle or liver damage in chicks fed raw, but not fermented CB seed meal diets. All these are metabolically related to the detoxification processes carried out by the liver and they strongly indicate the presence of toxic compounds in the blood of the chicks whose livers could not properly eliminate them.

The total protein, phosphorous and uric acid contents were not markedly affected by both raw and fermented CB seed meal diets but varied among the treatments. The serum calcium level increased significantly in chicks fed SF seed meal diet. The reason(s) for the varied level of serum calcium in the diets is not known but could be attributed to varied metabolic activities in the chicks fed the different diets. However, there appears a reciprocal relationship between serum calcium and phosphorous in chicks fed the different diets. Increase in inorganic phosphorous are known to be associated with a decrease in serum calcium which is in line with the findings of this research.

Generally, birds fed sieved and fermented CB meal diet grew as well as the control. This suggest that sieving off the coarse hulls or dehulling before fermentation reduced some feed inhibiting and growth depressing factor(s) found in the non-sieved and fermented seed meal and allowed starter broiler chicks to tolerate the 10% replacement of maize in the diet. Thus it appears that when properly sieved and fermented CB seed could be possibly used in commercial broiler rations. It was also evident by comparing the feed intake and growth of broilers fed non-sieved and fermented CB seed meal diet that the sieved and fermented seed meal diet has less drastic effect on growth. Other measures such as feed intake and feed conversion ratio were also better in broilers fed sieved and fermented seeds compared to non-sieved and fermented. Since fermented CB seeds have been studied very little in any species including chickens, it is not known what factor(s) depressed growth or which were destroyed by fermentation. However, we analyzed CB seeds for some phytochemical compounds (Table 2). Dehulling and fermentation of undehulled seed meals only reduced the phytic acid levels and eliminated anthraquinone content of the raw seed with hulls, while dehulling alone eliminated the tannin content. Therefore, the improvement in broiler performance can be partially explained by a reduction in the anti-nutritional factors, although the exert quantities removed were not determined.

CONCLUSION

Christmas bush seed meal contains some anti-nutrient compounds that were not completely destroyed by dehulling or fermentation. The partial replacement of maize by 10% raw ground and sieved CB seed meal produced a highly significant detrimental effect on starter broiler chicks' performance as was shown by extreme low rate of growth and feed intake, high ALT, AST and ALP values. Of all the treatments applied to CB seeds, sieving before fermentation was the best and superior to other processing methods in term of broiler chicks' performance and blood chemistry. The effect of higher dietary inclusion levels of the sieved and fermented CB seed meal in broiler diets should be investigated while exploring other processing methods.

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SURVEY OF PRODUCTION AND USE OF POULTRY LITTER IN KHARTOUM STATE, SUDAN

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ABSTRACT: *A survey of chicken litter production was undertaken by hand submitted questionnaire. The survey covered 219 farms out of 612 registered in Khartoum state to provide information on amount and use of litter. The survey revealed that most poultry farms followed similar management practices. About 58.94% of litter production was estimated to come from broiler houses and 41.06% from layer houses. It was estimated that 70% of the litter production is litter-based and about 30% are droppings collected without litter. The amount of litter produced was estimated to be 95097.58 ton/year and 87.1% of this amount was used as fertilizer. Samples of broiler litter were collected and proximate composition was conducted to investigate the nutrient quality of broiler litter. Results obtained on dry matter (DM) and ether extract (EE) showed that there are significant (P<0.05) differences among three locations (Khartoum, Khartoum-North and Omdurman). However, there are no significant differences on other chemical compositions.*

ORIGINAL ARTICLE

Key words: *Poultry litter, survey, chemical composition.*

INTRODUCTION

Poultry litter contains a mixture of chicken manure, feathers, spilled food and bedding material. The rate of litter production and nutrient content can be affected by many factors, including the type and amount of bedding material used, number of flocks reared on the litter, feed formulation, litter management techniques, type of housing, ventilation rates and management, bird health, performance parameters, stocking density, and age of birds (Malone, 1992).

The last survey of poultry farms in Khartoum State revealed that there were about 612 farms with 8.2 million broiler chicken and 1.3 million layers. These large numbers of growing chicks implies large amount of poultry wastes. The quantity of manure excreted from chicken depends on feed intake and diet digestibility (Elemam, 2011). The treatment of broiler litter by deep stacking was effective in the destruction of pathogens as stated by (Elemam et al. 2010)

There is a powerful need to control the potentials of the numerous amounts of the litter as replacement for feed ingredients. This need has arisen mainly from the increasing demand and supply deficit of conventional feed resources. The net effect of increased unit cost of the conventional feed resources is increased accordingly the cost of the compounded rations, which increased the cost of animal products (Elemam et al. 2009a). It then becomes highly vital that other sources for rapid livestock output to meet the growing human demands for animal protein foods are secured. Such other sources should be cheap and nutritionally adequate for feeding animals with the aim of lowering the cost of animal products. One of such measures is the recycling of broiler litter as partial replacement for conventional cheap feed sources used in livestock nutrition. Broiler litter differs in composition from layer manure mainly because of the differences in diets fed and the bedding material that is mixed with broiler excreta.

The utilization of the waste through ruminant animals became a convenient option of disposing of the waste (Elemam et al. 2009b). The product is readily accepted by the cattle and sheep farmer, not because of any superior feeding qualities, but simply because it is cheaply available and is easily utilized by the digestive system of the

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ruminants. The purpose of this study was to provide some sectors with current basic information on the poultry litter produced in the State and to determine the chemical composition of the litter.

MATERIALS AND METHODS

Farms survey

A hand submitted questionnaire was designed to answer some questions by poultry farmers in Khartoum State to gather information about litter production, after that the received data was collected and analyzed.

Chemical composition

Broiler litter was collected from commercial broiler houses in Khartoum state. The litter was then spread under the sun from 8:00 am to 6:00 pm for heating and drying. Then representative samples of sun-dried broiler litter were taken and proximately analyzed was made on dried ground samples as outlined by (AOAC, 1990).

Statistical procedure

The data were subjected to the analysis of variance with the general linear model procedure of (SAS, 1994).

RESULTS

Farms survey

A total of 219 questionnaires were returned, representing a 35.78% response rate. The survey revealed that most poultry farms in Khartoum state practice the same management protocols in term of Detergent, cleaners and pesticides were usually applied to poultry houses before administer of a new batch. Litter type was sawdust shaving and application rate was not clearly known.

Poultry litter commonly collected after each production period in plastic sacks and sold as fertilizer (land application). No storage locations and handling practices. No medicinal or metabolic additives were used except for coccidiostat. The total litter produced from Khartoum state was 95097.58 ton/year based on information of poultry farm producer's.

Omdurman area secured the largest statistics of broiler, broiler growers, chicks and parents in comparison to the other two areas Table 1 and therefore there is a large quantity of litter produced about 68.42% from total litter produced in Khartoum state and this due to the existence of big companies there (Figure 1). Commonly most of poultry litter produced (87.1%) in Khartoum state was used as fertilizer and only 0.71% was used in animal feed (Figure 2).

Table 1 - Khartoum state poultry farms survey with the number of birds and annual poultry litter output.

No. / Locations	Khartoum	Khartoum-North	Omdurman	Total
Farms	89	103	27	219
Chicks	34000	18800	700000	752800
Layer growers	71241	27437	34765	133443
Broiler growers	31639	15463	32235	79337
Layers	277986	613233	21150	912369
Broilers	191950	210480	2400000	2802430
Parents	7500	2000	65000	74500
Poultry litter (ton/year)	12286.32	17748.26	65063.00	95097.58

Chemical composition

Results in Table 2 show the chemical compositions of broiler litter. The values obtained for dry matter (DM) and ether extract (EE) were significantly ($P<0.05$) different for the three locations. However, there were non-significant ($P<0.05$) difference between organic matter (OM), crude protein (CP), Crude Fibre (CF), Ash, nitrogen free extract (NFE) and metabolizable energy (ME) among the three location.

Table 2 - Chemical composition (%) of broiler litter collected from different broiler houses in Khartoum state.

Items	Khartoum-North	Khartoum	Omdurman	SEM[1]
Dry matter (DM)%	87.67[a]	86.81[ab]	87.09[b]	1.44
Organic matter % DM	76.05	70.89	68.30	2.83
Ether extract % DM	2.53[b]	0.41[c]	4.09[a]	0.44
Crude protein % DM	26.38	27.45	26.35	2.76
Crude fiber % DM	16.80	17.31	15.39	1.91
Ash % DM	17.62	20.93	19.78	2.86
NFE % DM [2]	30.35	25.74	22.48	4.15
ME (MJ/kg DM) [3]	9.04	7.89	8.35	0.41

[1]S.E.M= Standard error of mean; [a-b] means with different superscripts in the same row were significantly different (P <0.05). NFE: Nitrogen free extract. [3]ME was calculated according to the equation: ME (MJ/kg DM) = 0.012CP + 0.031EE + 0.005CF + 0.014NFE (Maff, 1975).

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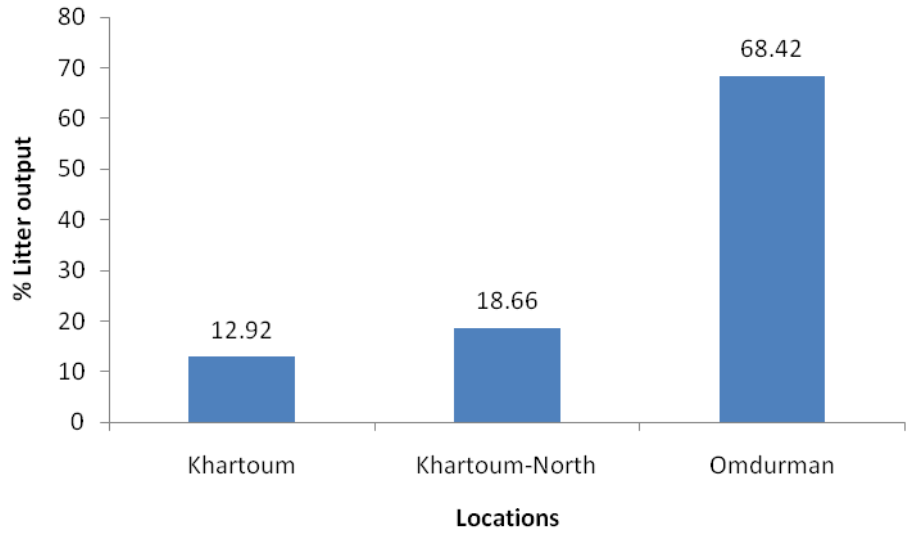

Figure 1 - Proportion of poultry litter produced from Khartoum state

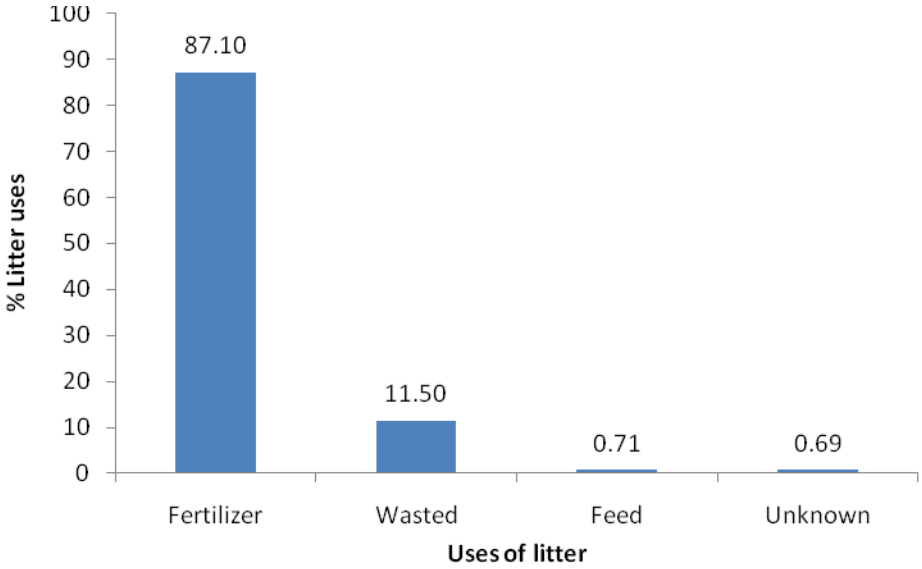

Figure 2 - The use of poultry litter in Khartoum state

DISCUSSION

The crude protein (CP) contents of broiler litter as reported in this study were 26.38, 27.45 and 26.35% for Khartoum-North, Khartoum and Omdurman respectively. Various authors have reported various values of CP for poultry litter. Adegbola et al. (1990) reported 16.5% CP for the value of layer litter. Ensimnger, (1977); Devendra and Rooghavan, (1978); Lamidi, (1995) all reported approximately 25% CP for poultry litter. However, these results were lower than the findings of Saleh et al. (2003) who compared the nutritive contents of poultry litter from three locations in Egypt and obtained crude protein scores of 19.4, 20.2 and 23%, respectively. The metaboilzable energy of the litter was lower than that obtains in most conventional feedstuffs. This is probably because of the high ash content of the litter Lowman and Knight, (1971); Ruffin and McCaskey, (1991) resulting from the use of sawdust as bedding material. The ash content provides important information about the quality of poultry litter. This is because it measures the mineral content of the litter. Ash is normally high in poultry litter because of the wood shavings or sawdust. In this study, the ash content of the litter was 17.62, 20.93 and 19.78% for Khartoum-North, Khartoum and Omdurman respectively. Ash samples between 15-25 percent are acceptable (Ruffin and McCaskey, 1991). This finding is in line with their recommendation and they further observed that high ash content (above 28 percent) will result in poor consumption in cattle and subsequent poor animal performance. With respect to the dry matter content, the study observed a DM content of 87.67, 86.81 and 87.09% for Khartoum-North, Khartoum and Omdurman respectively. From earlier reports Ruffin and McCaskey (1991); Burdine et al. (1993); Bagley et al. (1994), concluded that moisture in the litter should be between 12 and 25%.

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REGRESSION ANALYSIS OF LINEAR BODY MEASUREMENTS ON LIVE WEIGHT IN SUDANESE SHUGOR SHEEP

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ABSTRACT: *In this research, linear regression models were improved for estimation of body weight using various linear body measurements from Sudanese Shugor sheep. Simple regression models were formed when Body weight (Bwt) was dependent variable and heart girth (HG), height at withers (HTW) and height at hip (HTH) as independent variables. The best derived regression prediction equation for estimation of body weight determinated by using beta (β) as the constant based on number of variables used for the equation, mean square error (MSE) and Coefficient of determination (R^2). The model including the most appropriate measurements such as heart girth, height at wither and height at hip were the best fitted model (β = -47.54, MSE = 9.39 and R^2=0.61) for estimation of body weight in Sudanese Shugor sheep in this study.*

Key words: *Linear body measurements, Body weight, regression analysis, Shugor sheep, Sudan*

ORIGINAL ARTICLE

INTRODUCTION

Sudanese Shugor is moderately large sheep ranging in colour from light to dark brown. They have occasional patches of wool under the hair sulieman et al, (1990). They are found mainly along and to the west of the White Nile, and are the most common in the western part of Gezira, where they graze cotton residues and other agricultural byproducts.

Body weight is an important economic trait in the selection of animals. The main purposes of animal breeding practices are to improve traits of economics values (Mendes et al., 2005).

An accurate method for estimation body weight of livestock is a very important aspect of livestock breeding and production. Knowledge of Animal's live weight is of important for determining its food requirements for growth, maintenance and production, and the correct dosages in drug administration. Direct determination of live weight involves the use of weighing scales. Proper and accurate estimation of body weight is difficult under field condition production systems due to lack of weighing scales. The need to estimate live weight of animals especially sheep from simple and easily measurable morphological variables such as linear body measurements of different parts of the body become evident. Measurements of various body conformations are of value in judging quantitative characteristics of meat and are also helpful in developing suitable selection criteria. Moreover, because of the relative ease in measuring linear dimensions they can be used as an indirect way to estimate live weight (Getachew, 2008).

Apart from the conventional use of scale in determining the weight of sheep, weight determination by estimating some linear parameters could be employed (Winrock International, 1992).

This study was carried out to establish the relationship between live weight and some linear body measurements in Sudanese Shugor sheep as step towards using predictive models to estimate live weight of sheep.

MATERIALS AND METHODS

Source of data

The data used for this study were collected on a random sample of 81 male (8 months of age) shugor sheep kept at Extension and Rural Development Center, Faculty of Animal Production, University of Gezira, Sudan. The animals were managed under semi-intensive system. The flock was offered feed comprising groundnut cake, wheat bran, Dura, salt, oyster shell and green fodders. The sheep were watered regularly. Live weight was determined by small ruminants weighing scale. After determining the live weight, each animal was placed on all four legs on an even surface, and the following linear body measurements were taken with the measuring tape.

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Heart Girth (HG): Heart girth is a circumferential taken around the chest just behind the front legs and withers. The measurement should be taken to the nearest 0.5 cm.

Height at withers (HTW): This measure the distance from the surface of platform on which the animal stands to the withers. The measurement is best made by using a special measuring stick made with two arms one which held vertical and the other at right angles it sliding firmly up and down to record height.

Height at Hip (HTH): Height at hip is the distance from the surface of a platform to the hip using a measuring stick as described for height at withers.

Body length (BL): Body length refers to the distance from the base of tail to the base of neck.

All measurements were taken in the morning before the animals were fed. Each linear body measurement was recorded in centimeters and each live weight in kilograms.

Statistical Analysis

A simple regression analysis was carried out to describe the relationship between the independent variables consisting of asset of linear body measurements of Shugor sheep on the one hand, and the live weight as the dependent variable on the other hand. In selecting the appropriate variables for the predictive equation, the all possible selection procedure was adopted. This involved computing all possible and the best subset regression equation. Each equation was ten assessed by its coefficient of determination (R^2) and the constant based on the number of variable that used for the prediction.

Statistical Packages for Social Sciences (SPSS) release 15.0 (2006) was used as a tool for fitting the Prediction equation.

RESULTS AND DISCUSSION

Knowing the live weight of sheep is very useful to make appropriate management decisions. However, because of lack of accurate scales in most farms, linear body measurements of animals can be used to estimate live weight Equations correlating live weight and linear body measurements have been developed for some breeds (Gizaw, 1995).

It is important to know the different parts of the sheep body to understand the different linear measurements described in this present study. Table 1 presents the studied linear body measurements of Sudanese Shugor sheep, least-squares mean were mentioned.

Table 1 - Least square (means ± SE) of physical linear trait in Sudanese male Shugor sheep at eight months of age

Physical traits	N	Means ± SE
Body weight(kg)	81	29.60 ± 0.54
Body length(cm)	81	60.06 ± 0.55
Heart girth(cm)	81	73.23 ± 0.44
Height at withers(cm)	81	69.46 ± 0.52
Height at hip(cm)	81	72.98 ± 0.47

Determination of the accurate degree of correlation between live weight and linear body measurements in sheep may help to obtained methods for estimation of traits they are not easily measured under field condition. In present study, estimations were made by regressing the live weight on measurements of heart girth, Height at withers and height at hip of the animals. The regression coefficients of live weight on those linear measurements are shown in Table 2. There were relatively high level of significant ($P<0.05$) regression coefficients between live weight and linear body measurements. The finding of this study were consistent with those reported by Heinrichs et al.(1992), Adeyinka and Mohammed (2006b), Ojedapo et al. (2007), Samuel anf Salako (2008), and Sownade and Sobola (2008), that live body was highly correlated with linear body measurements.

Table 2 - Coefficients associated with regression of live weight(kg) on linear body measurements(cm) of Sudanese Shugor sheep breed

Model	Beta	SE	t value	sig.
1 (constant)	-47.54	7.00	-6.79	0.000
Heart girth (cm)	0.42	0.09	4.67	0.000
Height at withers (cm)	0.30	0.09	3.34	0.001
Height at hip (cm)	0.35	0.10	3.46	0,001
Derived Equation: Y = -47.54 +0.42(HG) + 0.30(HTW) + 0.35(HTH)				

These relationships were further classified by using the significance of the regression coefficients, as illustrated by t values (Table 2). Heart girth showed the best relationship at this age followed by height at hip and height at withers. Heart girth is the most variable live body measurement since it reflects condition in the animal, the results in the present study is similar to that reported for the same breed by sulieman et al. (1990).

Increasing the genetic potential for meat production of a sheep breed requires selection for increased size and live weight. Proper size and weight measurement are often difficult in field due to lack of weighing scales.

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Linear measures like heart girth are useful under these situations (Gizaw, 1995). The relatively high accuracy and significance of predictors of the prediction equation developed for this sheep breed at certain age (eight months) in the present study proposed that simple linear regression equation was sufficient to be used in the estimation of live weight from linear body measurements in sheep breeds. However, more investigation is needed in this field of research so as to confirm this statement. This is advantages for those concerns with sheep breeding and production especially in Sudan.

CONCLUSION

The strong relationship and very highly significant P values of regression between live body weight and linear body measurements of Sudanese Shugor sheep indicated that the independent variables or their combination could be used to estimate live body weight of those sheep. Heart girth had the highest correlation to live body weight according to t value. A simple regression model using linear body measurements that had relatively high coefficient of determination ($R^2 = 0.61$) could be utilized.

Finding of present study suggested that the derived equation could be used to estimate live body weight of Sudanese Shugor sheep breed.

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APPARENT DIGESTIBILTY COEFFICIENT OF PELLETED FISH FEED INCORPORATED WITH WATER HYACINTH (*Echhornia crassipes)*

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ABSTRACT: The objective of this study to determine the apparent digestibility coefficients (ADCs) of dry matter, protein, gross energy and fiber of five pelleted fish feed incorporated with different levels of water hyacinth (*Echhornia crassipes*, 0%, 10%, 15%, 20% and 25%) on performance of red Tilapia fingerlings, using chromium dioxide as an inert bio- marker. Feeds were prepared to be iso-nitrogenous (35.00%±0.20) and iso-caloric (kcal/kg 4700.00±0.52). Proximate compositions of test feeds, fecal matter and chromium contents also were determined. Results revealed the maximum value of ADCs for dry matter (DM) was found in reference feed (68.09%), while the minimum value was found in (test diet 4) 4 (50.36%). Similarly, the maximum ADCs values for crude protein content, gross energy, ether extract and crude fiber were found in control feed, while the minimum values were found in the feed 4. The survival rate was found to be significantly low among studied fish fed with feed 4. The study has shown that red tilapia efficient maximum digestion to nutrients is only up to 20% inclusion of water hyacinth in the feed.

ORIGINAL ARTICLE

Key words: Apparent digestibility, pelleted, water hyacinth

INTRODUCTION

Intensification of tilapia production global wide has made it essential to develop nutritionally efficient and cost effective complete and supplemental feeds to be used for different tilapia culture systems (intensive, extensive, race way, pond and cage culture systems). In Malaysia; red Tilapia culture is the common tilapia practice (Hambal et al., 2000). Malaysian farmers, in 2000, produced 16,383 mt of the red hybrid Tilapia in cages, tanks, pens and ponds. Feed production is the major problem face aquaculture practice in Malaysia Malaysian Industrial Development Authority report in 2009 showed that, animal feed is one of the major food imported item in Malaysia. At present, it is highly needed to search for low cost and better nutrient component ingredients to replace partially or completely the costly ingredients, such as fish meal, as protein or energy source.

Much critical analysis has been conducted in recent years on the requirement of fish for dietary protein (Cho et al., 1982; Abdel-Fattah and Mamdouh, 2008 Falaye and Jauncey, 1999; Maina et al., 2002; Perla et al., 2004; and Iluyemi et al., 2010) including tilapia. The nutritive value of mixed rations depends on the nutrient composition of the individual feed components and the ability of the animal to digest and absorb the nutrients (Smith, 1979; Kirchgessner et al., 1986). Relatively cheap energy yielding nutrients, such as fats or carbohydrates, have been found to reduce dietary requirement of protein. However, replacing fish meal which is being used globally as dietary protein in formulated fish feeds, by alternative, plant sources in aqua-feeds is rather challenging task. The major problems in using fish meal in formulation of fish feed are its rising cost, uncertain availability and variation in quality. Plant feedstuffs present high fiber content; their amino acids and fatty acids profiles do not match fish dietary requirements (Steffens, 1989; Wilson, 1989) and presence of anti-nutritional factors. Much work was done regarding the performance of fish carnivore, in the evolutionary scale, have rather simple and little developed digestive system, and as consequence, reduced ability to utilize carbohydrates as energy sources when compared with herbivore and omnivore fish such tilapia. However, few studies were done on evaluating water hyacinth utilization. Digestibility is one of the most important methods in evaluating the efficiency of feedstuffs no much

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studies so far done on it. Such information is of paramount importance in the assessment of the economical use of this macrophyte plant in aquaculture.

This study was aimed to determine the apparent digestibility of dry matter, crude protein, ether extract, gross energy and crude fiber of pelleted feed incorporated with different percentage of water hyacinth *(Echhornia crassipes*) level on performance of red Tilapia fingerlings.

MATERIALS AND METHODS

Five iso-nitrogenous (35% CP) and iso-caloric feeds incorporated with different levels of water hyacinth (*Echhornia crassippes*) were formulated in (Table 1) as described by Elsyaed (1990). Fish meal, chicken by-product were used as animal protein source while, soya meal was used as plant protein. Wheat bran was replaced gradually by water hyacinth. Chromic oxide was used.

Ingredients used and diets preparation

Water hyacinth was collected from water canal inside University Malaysia Terengganu (UMT), roots was removed and washed gently, cut into small pieces and oven dried (45℃/72hrs) powdered (2 microns) using motor grinder (FRITSCH, Puluersette 14, Germany) and store in room temperature for further use. Fish meal, soya meal and wheat bran were purchased from mill factory nearby UMT. Chicken by-product was prepared in powder form inside fresh water hatchery UMT after collection of chicken remains from chicken slaughter shop and supplied diets with an iso-nitrogenous and iso-energic. Control and experimental diets were formulated to satisfy requirement of Tilapia (Thomas et al. 1995). Chromic oxide (Cr_2O_3, 1%) was used as an inert marker and incorporated into the control feed and experimental feed. Proximate composition was carried out for used ingredients prior to formulation of experimental diets (Table 1). Diet formulation was carried out in the diet formulation chamber attached to fresh water hatchery, FASM, UMT Water and palm oil were added to premixed ingredients and thoroughly mixed until homogenous in Bio Mixer, Sakura, China. 2.5mm diameter pellet were made using meat grinder (ORIMAS, model: TBS200, China), subjected to an open air for (15 minute), oven dried (50 ℃/24hrs) and stored frozen (-20℃), as described by Qi-Cun and Rong (2010).

Table 1 - Ingredients and proximate composition of experimental diets (on %dry matter basis)

Feeds / Ingredient	Control	Feed1	Feed2	Feed3	Feed4
Fish meal	10	10	10	10	10
Chicken by-product meal	20	20	20	20	20
Soya meal	40	40	40	40	40
Water hyacinth	0	10	15	20	25
Wheat bran	25	20	15	10	0
Palm oil	2	2	2	2	2
Ascorbic acid	0.6	0.6	0.6	0.6	0.6
Choline chloride	0.5	0.5	0.5	0.5	0.5
Calcium diphosphate	0.6	0.6	0.6	0.6	0.6
Chromium dioxide	1	1	1	1	1
Vitamin pre-mix(commercial)	0.1	0.1	0.1	0.1	0.1
Mineral pre-mix (commercial)	0.1	0.1	0.1	0.1	0.1
Binder	0.1	0.1	0.1	0.1	0.1
Proximate composition (on dry matter basis) %					
Moisture	4.8	4.6	4.2	4.4	4.9
Crude protein	35.3	35	35.4	35	35.2
Ether extract	5.3	5	5.1	5	5.4
Ash	8.2	10	9.7	10.6	11.3
Fiber	7.5	7.7	8.3	8.6	8.7
NFE	38.9	37.7	37.3	36.4	28.8
Growth Energy (kcal/kg	4580	4550	4730	4500	4470

Experiment fish

A number of 400 red Tilapia fingerlings (6.2±0.3 g/fish) were brought from Jabatan Perikanan Malaysia, Penang, Malaysia.

Feeding trials, feces collection and analysis

Prior to the start of the study, fish were acclimatized to the control diet in concrete tank for 3 weeks. Fish were randomly distributed into 25-L plastic transparent aquaria (15 fish per aquarium). Fishes were fed to the

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visual satiety twice daily and the feces were collected by siphoning method two hours after the feeding using a modified method of Qi-Cun and Rong (2010). The collected feces were pooled in a glass vials and store at -20℃ (Nazura et al., 2003) for chromium detection and proximate composition analysis (Food science laboratory). Feces were freeze dried after enough feces were gathered.

Chemical analysis

Crude protein, moisture, gross energy, ether extract and fiber content in experimental diets and feces were determined following standard method of (AOAC, 1995). Chromic oxide content of feeds and feces were measured according to the method of Furukawa and Tsukahara (1966).

Digestibility determination

Apparent digestibility coefficients of dry matter (ADC_{DM}), protein (ADC_P), energy ($ADC_{e)}$, ether extract (ADC_{EE}) and fiber (ADC_{CF}) were performed by indirect method, using the chromic oxide as inert marker method as described by Cho *et al* (1982). The apparent digestibility coefficients (ADC) for the nutrients and energy of the test and reference diets were calculated as follows: ADC=1− (F/D×Di/Fi) (Cho *et al* (1982). Please write reference)

Where, D=% nutrient (or kJ/g gross energy) of diet; F=% nutrient (or kJ/g gross energy) of feces; Di=% digestion indicator acid insoluble Ash (AIA) of diet; Fi=% digestion indicator (AIA) of feces.

Statistical analysis

The obtained data were subjected to statistical analysis including analysis of variance (one way ANOVA) and significance of differences between means was tested according to Duncan (1995), using Genstat5 Software Program.

RESULTS AND DISCUSSION

The acceptance of diet by all groups of fish was observed as fish were actively fed when offered feed at each feeding time. All ADCs values for dry matter and nutrients were significantly different ($P<0.05$) among studied diets with different level of water hyacinth (WH) content (Table 1). The control diet with 0% WH was found to be efficiently utilized by fish and of highest digestibility values, while the experimental diet with 25% WH showed the minimum value of digestibility among experimental groups. The diet 4 (25%) had the least values of digestibility for dry matter and nutrients among all feeds. However, the digestibility for protein was recorded to be the highest, while the fiber digestibility was the lowest among nutrients. The survival rate decreased against the increase of WH level in diets, and it was at its lowest percentage for the test 4th experiment diet (Table 1).

Table 2 - Apparent digestibility coefficients of dry matter and nutrients, for experimental groups with different level of water hyacinth

Contents	Control diet (0%WH)	Test diet 1 (10%WH)	Test diet 2 (15%WH)	Test diet 3 (20%WH)	Test diet 4 (25%WH)
$Digestibility_{dm}$	68.09a	65.16b	62.29c	60.47d	50.36e
$Digestibility_{cp}$	92.07a	89.13b	84.83c	81.17d	60.47e
$Digestibility_{ge}$	79.30a	78.27b	71.97c	67.33d	65.52e
$Digestibility_{ee}$	82.07a	76.20b	70.27c	66.83d	59.23e
$Digestibility_{cf}$	34.34a	32.73b	29.96c	28.27d	18.53e
Survival rate%	96	91	88	81	46
P value	(not calculated)				
SEM	(not calculated)				

Figures in the same row followed by the same letters are not significantly different ($P > 0.05$)$_{dm}$= dry matter, $_{cp}$ = crude protein, $_{ge}$ = gross energy, $_{ee}$ =ether extract and $_{cf}$ = crude fiber

The present study demonstrated that WH is a potential partial substitute for wheat bran meal and could be incorporated up to 20% (on dry weight basis) in feed of red Tilapia without negatively affecting growth performance and digestion process. The feeds acceptability and palatability was observed as all groups of fish consumed the offered feeds and no rejection of any of the feeds was recorded. Digestibility of the feeds and survival rate were significantly high with the increase in WH amount in the studied feed up 20%, but decline when the inclusion rate of WH reached 25% (replacement) in test feed, and that could be referred to the fiber content. The fine grinding of WH and the other ingredients and formulation method may also play role in improving the digestibility of the feeds. However, the inclusion of 25% WH or more might be possible only to be utilized as supplementary feed in fish farming system. The results are in agreement with the finding of many authors despite the fact that different methodologies and tilapia species are used. For example, with respect to the form of WH used, how incorporated in the fish diets and tilapia species was used, Abdel-Fattah (2008) has observed that at 20% of WH inclusion level in fish feed, fish performance was reduced, and there no report regarding the digestibility of the tested feeds at all

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tested levels. However, Iluyemi et al. (2010) reported that, the inclusion of bacterial fermented (*Trichderma longibrchiatum*) palm kernel cake reduced the dietary protein digestibility and growth of red tilapia fingerlings.

CONCLUSION

The study finding indicates that fresh water hyacinth can be used with accepted level of nutrients digestibility is only up to 20% in the diet of red Tilapia at closed recirculating system with minimizing fish meal content in diet to 10%.

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EFFECT OF FROZEN *Daphnia magna* DIET MIXED WITH PROBIOTIC PROTEXIN ON GROWTH AND SURVIVAL OF RAINBOW TROUT (*Onchorhynchus mykiss*) FRY REARED UNDER CONTROLLED CONDITIONS

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ABSTRACT: *Effect of probiotic Protexin was experimentally tested on growth and survival of rainbow trout fry reared under controlled conditions. Experiments to determine the effect of different levels of probiotic (2×10^4 (T_1), 2×10^5 (T_2) and 2×10^6 (T_3) CFU/g^{-1}) on growth and survival rates of rainbow trout in comparing with those of control diet containing no probiotic were carried out under laboratory conditions. In this trail, frozen Daphnia magna was considered as a basal diet for fry feeding. Rainbow trout offered the control diet exhibited the same growth and feed utilization with all experimental treatments, and no significant differences ($P>0.05$) in growth were observed among fish groups fed various levels of the probiotic. There was no effect of probiotic inclusion level on water quality. There was no effect of probiotic supplementation on survival at the end of experiment in T_1 and T_3, but survival rate in T_2 was higher than other groups, significantly ($P<0.05$). Viability against high temperature stress was affected by dietary probiotic inclusion, as supplemented diets by probiotic revealed the better and more efficient results in fish survival. Viability of T_2, T_3 and control in challenging with high salinity was homogenous, while T_1 showed the significant difference ($P<0.05$) with others, properly.*

ORIGINAL ARTICLE

Key words: *Probiotic, growth, survival, rainbow trout (Oncorhynchus mykiss)*

INTRODUCTION

Probiotics are usually live microorganisms which when administered in adequate amounts confer a health benefits on host. Nowadays, probiotics are also becoming an integral part of the aquaculture practices to procure high production. The common probiotics that are used for aquaculture practices include *Lactobacillus*, *Lactococcus*, *Leuconostoc*, *Enterococcus*, *Carnobacterium*, *Shewanella*, *Bacillus*, *Aeromonas, Vibrio*, *Enterobacter*, *Pseudomonas*, *Clostridium*, and *Saccharomyces* species. The involvement of probiotics in nutrition, disease resistance and other instrumental activities in fish has proven beyond any doubt (Nayak, 2010).

In aquaculture programs, probiotics are used for a quite long time but in last few years probiotics became an integral part of the culture practices for promoting growth and disease resistance. This strategy offers innumerable advantages to overcome the limitations and side effects of antibiotics and other drugs and also leads to high production through enhanced growth and disease prevention (Das et al. 2008; Sahu et al. 2008). In aquaculture, the range of probiotics evaluated for use is considerably wider than in terrestrial agriculture. Several probiotics either as monospecies or multispecies supplements are commercially available for aquaculture practices (Decamp and Moriarty, 2006; Ghosh et al. 2007). Apart from the nutritional and other health benefits (Austin et al. 1995; Gram et al. 1999; Carnevali et al. 2006), certain probiotics as water additives can also play a significant role in decomposition of organic matter, reduction of nitrogen and phosphorus level as well as control of ammonia, nitrite, and hydrogen sulfide (Boyd and Massaut, 1999).

Numerous microbes have been identified as probiotics for aquaculture programs, many of which differ markedly in their mode of action. There are, however, some common mechanisms of action that have been

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reported for the majority of probiotic strains. Probiotics help in feed conversion efficiency and live weight gain (Al-Dohail et al. 2009; Saenz de Rodriguez et al. 2009) and confer protection against pathogens by competitive exclusion for adhesion sites (Vine et al. 2004; Chabrillon et al. 2005), production of organic acids (formic acid, acetic acid, lactic acid), hydrogen peroxide and several other compounds such as antibiotics, bacteriocins, siderophores, lysozyme (Yan et al. 2002; El-Dakar et al. 2007) and also modulate physiological and immunological responses in fish (Khattab et al. 2004; Balcazar et al. 2006).

This study was conducted on investigation the effect of probiotic Protexin on growth and survival of rainbow trout fry and their resistance against environmental stressors.

MATERIALS AND METHODS

Probiotic preparation

The probiotic was prepared from Protexin Co (Iran-Nikotak). The five species of probiotic bacillus as bacterial blend under the commercial title of Protexin aquatic were used for bioencapsulation of *A. urmiana*. The blends of probiotic (mixture of *Lactobacillus plantarum, Lactobacillus delbrueckii bulgaricus, Lactobacillus acidophilus, Lactobacillus rhamnosus, Bifidobacterium bifidum, Streptococcus Salivarius, Enterococcus faecium, Aspergillus oryzae and Candida pintolopesill*) from suspension of spores with special media were provided. Three concentrations of bacterial suspension, 2×10^4 (T_1), 2×10^5 (T_2) and 2×10^6 (T_3) bacteries per milliliter (CFU ml^{-1}) were provided by Protexin Co and the colony forming unit (CFU) of probiotic were tested by microbial culture in Tryptic Soy Agar (TSA) (Rengpipat et al., 1998).

Daphnia magna provision

The *Daphnia magna* is an important live feed that were used as a vector to carry probiotics (Faramarzi et al. 2011). *D. magna* was harvested from intensive production ground ponds of sturgeon in Marjani center (Iran), and maintained at −30 ◦C prior to use.

Experimental design

Four trials were carried out with rainbow trout (*Onchorhynchus mykiss*). Sixteen plastic tanks (30 l) with four replicates for treatment and control were used. Trails 1, 2 and 3 were fed by *D. magna* which was treated by probiotic. The other three aquaria served as the control and treated with only basal diets, which were absent probiotic.

Healthy fry of the rainbow trout (*Onchorhynchus mykiss*) provided by the Fish Hatchery of Fazelabad, Iran were acclimatized in two fiberglass tanks (200 l), and were fed Biomar feed six times daily for 2 weeks. Then healthy rainbow trout was distributed into 16 tanks (with water circulation) with initial stocking density of 30 fish per tanks in the Laboratory of Aquaculture Department, Gonbad University for 60 days culture. All rainbow trout had similar initial weights (470 mg). The experiment was conducted as a completely randomized design with four treatments (trials 1–3 and control). Each treatment had four replicates of 30 rainbow trout each.

Fishes were fed six times daily with each feed. Daily feeding rate was about 50-70% of total body weight and properly regulated according to actually intake of rainbow trouts. Every day the diet remains of each aquarium were collected by siphoning before the second daily feeding to further analysis and minimize leaching. A daily record was kept of feed offered and remains.

Temperature range of water was 16–18 ◦C. For water quality control, temperature and dissolved oxygen (DO) were measured daily, and weekly analyses were done of total dissolved solid (TDS), NO_3, SO_4, PO_4, salinity, electrical conductivity and pH levels. Dissolved oxygen level was maintained above 7.8 mg l^{-1} by setting the air pump.

Thermal and salinity challenges

At the end of experiment, for evaluation of the fish quality 20 fry of each replicate (10 fry for thermal challenge and 10 fry for salinity challenge) were tested by high temperature and salinity. In this propose, fishes were transferred to other tanks and temperature and salinity were increased to 32 ◦C and 20 g l^{-1}, respectively. Then, survival duration was calculated.

Sampling and analytical methods

Weights of all collected fishes from each tank were determined at initial and the end during the 60 days experiment, which treated as initial weight and final weight, respectively. At the same time, rainbow trout survival was also determined by counting the individuals in each tank. The weight and length gain (WG and LG) (g d^{-1} and cm d^{-1}) were calculated as (Yanbo and Zirong, 2006): WG = final weight (g) − initial weight (g); LG = final length (cm) − initial length (cm)

The feed conversion ratio (FCR) was expressed as (Yanbo and Zirong, 2006): FCR = total feed consumption (total feed casting − total feed residue) (g)/ total final weight (g) − total initial weight (g) + total morality weight (g); Specific growth rate (SGR) and condition factor (CF) were determined using the following equations (Zargham et al., 2011): $SGR = (\ln w_t - \ln w_0) \times 100/t$; $CF = W/L^3 \times 100$.

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Gastro Somatic Index (GSI) and Thermal Growth Coefficient (TGC) were calculated as (De Silva and Anderson, 1995): Gastro Somatic Index (GSI) = [Digestive system (g)/ body weight (g)] ×100; Thermal Growth Coefficient (TGC %) = [final weight $^{0.333}$ – initial weight $^{0.333}$ / °c (day – degrees)] × 100.

Statistical analysis using one-way ANOVA was performed to find significant difference on various parameters between treated and control trials. Differences among means were determined and compared by Duncan's multiple range tests (SPSS software). A significance level of $P<0.05$ was used. Data are reported as means ± standard deviations (Ziaei-Nejad et al. 2006).

RESULTS

Water quality parameters

There was no obvious effect of probiotic on the water quality in treatments. Total salinity (4.73 g l^{-1}), SO_4 (1216 mg l^{-1}), NO_3 (150.84 mg l^{-1}), PO_4 (150.84 mg l^{-1}), TDS (4180 mg l^{-1}), electrical conductivity (7989.84 μ mos/cm^2) and pH (7.2–7.61) were stable and within acceptable ranges (Boyd and Tucker, 1998).

Survival rate

According to figure 1, the rainbow trout survival rate of T1, T3 and control was the same after 60 days culture ,approximately, but there was a significant difference ($P<0.05$) between these trails and T_2 which was treated by 2×10^5 CFU ml^{-1}.

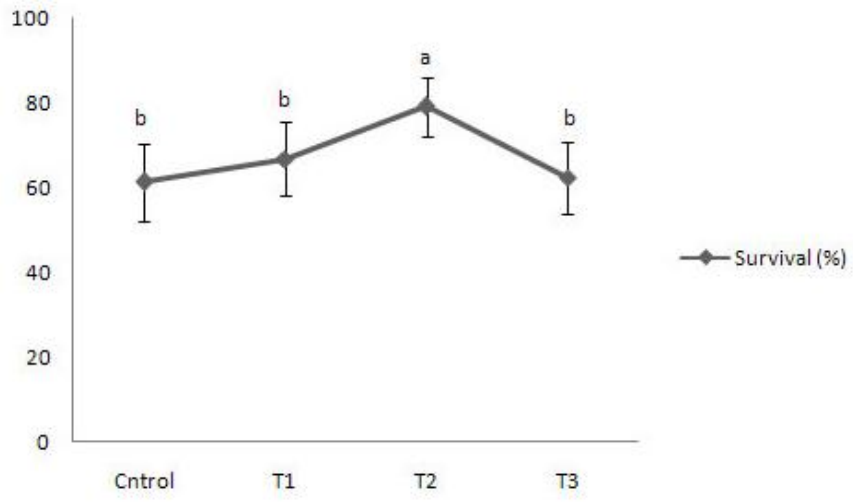

Figure 1. Survival rate (mean ± standard error) of trails at the end of experiment

Growth performance

Data on growth performance including initial weight, weight gain (WG), length gain (LG), Specific growth rate (SGR), condition factor (CF), Gastro Somatic Index (GSI) and Thermal Growth Coefficient (TGC) were reported in Table 1. At the beginning, no significant difference was observed in the initial weight between trials 1–3 and control ($P>0.05$). Comparably, weight gain of the control did not show a significant difference ($P>0.05$) with those of the trials 1–3. The values of condition factor (CF) in trials 1-3 treated with the probiotic were significantly lower than the control ($P<0.05$). Means of the FCR, SGR, TGC and GSI were not significant ($P>0.05$) in trials 1-3 treated with probiotic compared with control.

Table 1 - Performance of rainbow trout offered diets with various inclusion levels of probiotic

Parameters	Control	T_1	T_2	T_3
W_0 (g)	348±3.5	350±1.5	346±3.8	349±1.5
WG (g)	748.4±118	751.02±132	689.8±120	758.68±145
LG (cm)	4.15±0.15	4.25±0.05	4.15±0.10	4.24±0.10
FCR	1.18±1.27	1.22±1.49	1.24±1.08	1.15±1.25
SGR	2.47±0.05	2.47±0.09	2.20±0.01	2.50±0.08
CF	1.02±0.12^a	0.97±0.19^b	0.96±0.14^b	0.97±0.12^b
GSI	17.77±1.57	15.70±1.22	15.80±1.87	15.49±2.14
TGC	2.46±0.51^{ab}	2.48±0.48^a	2.30±0.53^b	2.49±0.48^a

Values in the same row with multiple superscripts are significantly different

Thermal and salinity challenges

As can be seen in Figure 2, remarkable difference ($P<0.05$) in fry tolerance against high temperature stress (32 °C) was observed between probiotic treatments and control. Indeed, survival rate of fry was soared by probiotic supplementation.

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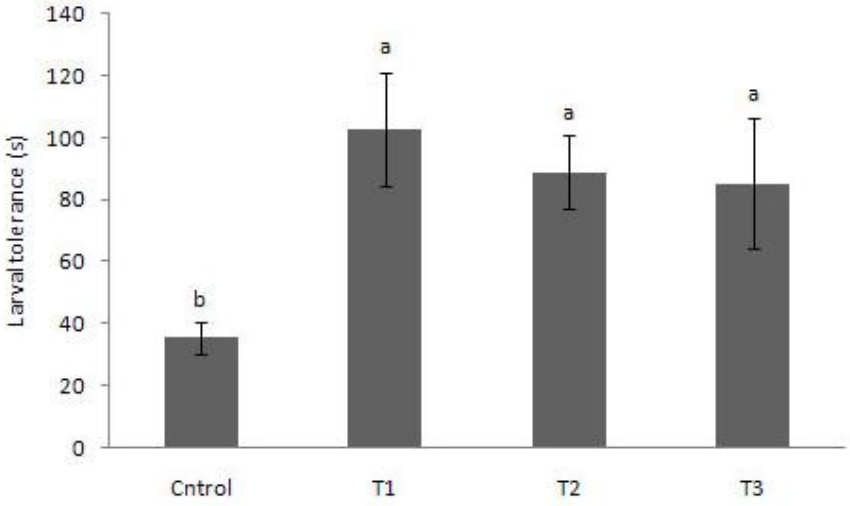

Figure 2. Fry viability (mean ± standard error) against high temperature stress. Scale bars with the same letter in each parameter are not significantly different (P>0.05)

As far as figure 3 is concerned, significant promotion in fry tolerance was obtained in T_1 with regards to high salinity stress (20 g l^{-1}), however, there were any differences among other trails (P>0.05).

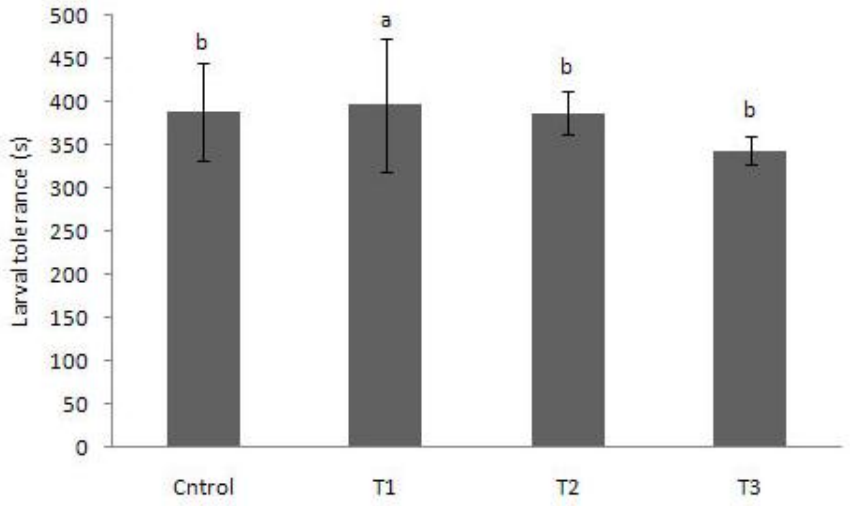

Figure 3. Fry viability (mean ± standard error) against challenge of salinity. Scale bars with the same letter in each parameter are not significantly different (P>0.05)

DISCUSSION

The exact mode of probiotic action has not been fully elucidated and there is continuous argue about its effect on the water quality (Mohamed et al. 2010). It has been reported that use of *Bacillus* sp. improved water quality and increased the health status of juvenile *Penaeus monodon* and reduced the pathogenic vibrios (Dalmin et al. 2001). In the present study, there was no obvious effect of the probiotics added to feeds on water quality. These results agree with the findings of Yanbo and Zirong (2006) and Mohamed et al. (2010).

Moriarty (1998) noted an increase of prawn survival in ponds where probiotics including some strains of *Bacillus* sp. were introduced. Rengpipat et al. (1998) also showed the effects of a probiotic bacterium on black tiger shrimp (*Penaeus monodon*) survival and had the similar results. Currently, the use of the probiotic in trails 1, 3 (2×10^4 and 2×10^6 CFU ml^{-1}) and control had shown inconsistent results. In contrast, the use of the probiotics mixture in the trails 1 and 3 at determinate density caused no significant survival increases when compared to the control. Inversely, survival rate in trail 2 (2×10^5 CFU ml^{-1}) had significant improvement and higher proportion.

All the probiotic supplemented diets and control basal diet revealed the same results in growth parameters. Similar results were observed by Abdelhamid et al. (2002) and Diab et al. (2002), who were reported probiotic addition to fish diets have not affected on growth parameters, in tilapia. Nevertheless, various study proved the positive effects of commercial probiotics lead to growth performance in some species (Noh et al. 1994; Bogut et al. 1998; Ghosh et al. 2003, Yanbo and Zirong, 2006; Farahi et al. 2011).

The equivalent FCR, SGR and GSI values observed with probiotic-supplemented diets and control suggested that addition of probiotics could not improve feed utilization of rainbow trout. Compatibly, Mohammadi Azarm et al. (2004) achieved the same result about FCR in rainbow trout larvae. In practical terms, this meant that probiotic use could not decrease the amount of feed necessary for fish growth which could not result in production cost reductions. Also, having higher and marked amount of CF in the control group, it could be concluded that probiotic-supplemented diets were not efficient related to growth performance.

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Being exposed a variety of conditions and environmental stressors in rainbow trout larvae and fry cultivation, it is crucial to exhibit new techniques for obviating of these issues. Farahi et al. (2011) evaluated the effect of dietary supplementation of probiotic *Bacillus* sp. on maternal performance and larval quality of the angelfish (*Pterophyllum scalare*). They tested the tolerance of angelfish larvae to high temperature exposure. Their results shown larval survival significantly increased in probiotic treatments. Accordingly, in our study the rainbow trout fry which received the perobiotic in their diet exhibited the best survival rate than the control, clearly. Pooramini et al. (2008) reported that challenging with different levels of salinity after 24 hours showed treatments contained yeast as a probiotic had 100% survival and showed significant differences with cod oil treatment (without yeast) and control ($p<0.05$). Moreover, Jafarian et al. (2007) revealed that supplemented diets by probiotic *Bacillus* sp. enhanced the survival rate of Persian Sturgeon (*Acipencer persicus*) Larvae. In the present research, the most significant promotion was observed in trails 1 (2×10^4 CFU ml^{-1}), but other treatments did not show any differences, obviously.

To sum up, though probiotic administration was not efficient for growth parameters in the current experiment, we cannot deny the positive effects of probiotic in improving the fry resistance against environmental stressors. In fact, the larval and fry forms of most fish and shellfish are released in the external environment at an early stage of development. These larvae and fry are highly exposed to gastrointestinal microbiota-associated disorders, because they start feeding even though the digestive tract is not yet fully developed (Timmermans, 1987) and the immune system is still incomplete (Vadstein, 1997). So, it will be effective to add the probiotic for achieving the most survival rate and reduce the financial detriments. On the other side, lucrative usage of frozen *Daphnia magna* as a feed for rainbow trout fry is a great consequence for reducing expenditures and obtaining favorite results in fish farming.

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RELATIONSHIPS BETWEEN HAEMOGLOBIN (Hb) TYPE AND PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF RAHMANI EWES AND LAMBS

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ABSTRACT: *Two hundred Rahmani ewes and seventy-one lambs used to study the relationship between the type of haemoglobin and some productive and reproductive traits. Distribution of Hb types and allelic frequencies were higher for type AA of ewes, while for lamb's type BB was higher than type AA. Fertility rate was higher in ewes with the type of haemoglobin AA than ewes with type AB or BB. Hemoglobin type, year of mating and breed of sire were not significant effects on fertility, while, age of dam and season of mating had a significant (P<0.01 or P<0.05) effect on fertility. Autumn season was the best season in fertility (84%) compared to (60%) in summer and (64%) in winter season. Ewes sired by Rahmani rams had the highest fertility (73%) compared to those sired by Chios rams (66%). All factors (Haemoglobin type, age of dam, year of lambing, season of mating, and breed of sire) had no significant effect on litter size at birth. However, ewes with Hb BB produced more lambs than either ewes with HB AB or ewes with Hb AA. Also, ewes aged 4 years had the highest litter size at birth. Ewes mating during autumn season produced more lambs than those mating during summer. Haemoglobin type was not significant effect on body weights of Rahmani lambs and F1 cross ½ C ½ R at all ages studied. Rahmani lambs with Hb AA had the lowest value of birth weight (4.05 kg vs. 4.14; 4.3 kg) compared lambs with Hb AB or BB, while lambs with Hb BB had highest weight at weaning , 6, 9 and 12 months of ages. F1 (½ C ½ R) lambs with Hb AA had the highest weight at birth, 6, 9 and 12 months of age, while lambs with Hb BB had the highest weight at weaning age. Haemoglobin type was not significant effect on daily gain at all periods studied for both Rahmani and F1 (½ C ½ R) lambs. Generally, Rahmani and (½ C ½ R) lambs with Hb AB had the lowest value of daily gain at all periods studied than lambs with Hb AA or Hb BB.*

Key words: *haemoglobin type, Rahmani ewes, reproductive performance*

ORIGINAL ARTICLE

INTRODUCTION

Haemoglobin (Hb) are group of proteins whose chief functions are to transport oxygen from the lungs to the tissues and carbon dioxide in the reverse direction, they are composed of polypeptide chains called globin and iron protoporphyrin heme groups. In the normal sheep, two types of Haemoglobin (Hb A and Hb B) can be found and these are controlled by two autosomal co-dominant genes, designated Hb A and Hb B, three phenotypes therefore are recognizable (AA, AB and BB) and can be readily identified. Harris and warren (1955) first demonstrated the existence of variable Haemoglobin (Hb) types in sheep, also. Evans and Turner (1965) designated the two (Hb) alleles as A and B, by electophoretic studies the fast-moving fraction is designated as A and the slow-moving fraction as B, thus, the three electrophoretic phenotypes are AA, AB and BB. Huisman et al. (1958) reported that Hb AA had higher Oxygen affinity than Hb BB since that time much interest has been shown in the relationship of Hb type to production and health-related traits. Such research and the frequencies of Hb alleles in various breeds have been reviewed by Agar et al. (1972). Gene frequency of polymorphic phenotypes seems to be related to performance of small ruminants. According to Agar et al. (1972) reported that the distribution of Haemoglobin variants is related to geographic environments (Wang et al. 1991), Also Vanderhelm et al. (1958) studying the Haemoglobin of different geniuses of animals it was found that abnormal Haemoglobins which are genetically controlled, may be present the results of a study of two different abnormal Haemoglobins in the sheep are given. It was found that these two Haemoglobin types show a genetical pattern, which is similar to that of some abnormal Hb in human beings. The objective of this study was to evaluate the relationship between haemoglobin types of the ewes or lambs and some productive and reproductive traits.

MATERIALS AND METHODS

The present study was carried out at the experimental farm of Animal Production Department, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt.

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Haemoglobin types

In February of 2004, a blood samples were collected from the jugular vein in heparinised tubes using (10 ml) glass tubes from 71 lambs (41 Rahmani and 30 ½ C ½ R) from first and second lambing season. Also, a 200 blood samples were collected from Rahmani ewes. Then blood samples were transported under ice–cold conditions to the laboratory (Zoology Department Faculty of Science, Assiut University) without loss of much time. A small sample of Haemolystes were prepared from each blood samples and applied to Titan III Cellulose Acetate plate. The haemoglobin types (Hb) in the samples are separated by electrophoresis using alkaline buffer (pH 8.2–8.6) and are stained with ponceau's Stain. The evaluations of the haemoglobin bands were determined by Gel– Pro Analyzer 3.1 (Program in computer) according to the procedure mentioned in Helena Laboratories publications (1985).

Haemoglobin types were determined by the location of the band or bands. Figure 1 shows an electrophoretic separation bands using alkaline buffer and are stained with Ponceau-S stain and evaluations by Gel–Pro Analyzer 3.1. Haemoglobin A has the fastest electrophoretic mobility followed in decreasing mobility by Hb-AB and HB-BB, respectively.

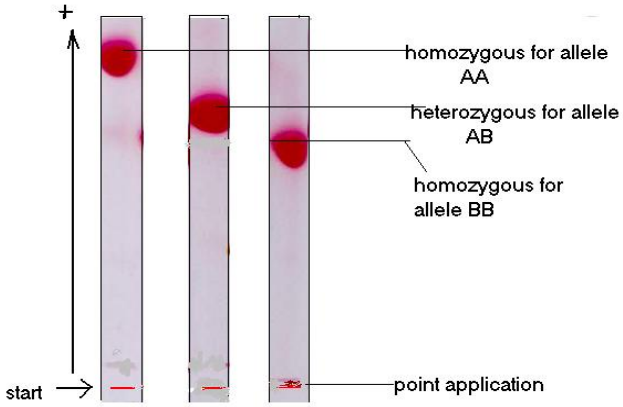

Figure 1 - Relative position of sheep haemoglobin types

Satistically analysis

Data were statistically analyzed using the GLM procedure of the SAS package, 8.1 version (SAS, 1996). Analysis was performed according to the following linear model: $Yij = \mu + Hi + eij$ Where: Yij = the trait of study, μ = the overall mean, Hi = the effect of j^{th} haemoglobin types (j = 1, 2 and 3) where 1 = AA; 2 = AB and 3 = BB, eij = Random error particular to ij^{th} observation.

RESULTS AND DISCUSSION

Haemoglobin types (Hb types) in ewes and lambs

a- Distribution and Allelic frequencies: Distribution of Hb types and allelic frequencies for Rahmani ewes and offspring (Rahmani and ½ C ½ R lambs are shown in Table 1. The number of Hb AB ewes was low in all groups. Allelic frequencies were 0.53 for type AA and 0.47 for type BB. Frequency of the B allele was higher than that of the A allele in both (R) lambs and (½ C ½ R) lambs, while A allele was the more frequent in Rahmani ewes (0.53) compared to (0.47) for B allele. In a large number of studies reviewed by Agar et al. (1972), within different breeds of sheep populations, the B allelic frequency was generally much higher than that of A allele. Stormont et al., (1968) reported that in Horned Dorset, gene frequencies were 0.41 and 0.59 for A and B, respectively. While Colombia sheep they were 0.08 for A and 0.92 for B.

Singh et al., (1976) in some indigenous, exotic and cross – breed sheep found that gene frequency of B type haemoglobin (Hb B) in all the flock of indigenous, exotic and crossbreeds was very high and varied significantly from breed to breed, he added that Hb types in sheep are genetically controlled by one pair of allelic genes with Co–dominance and are inherited in a simple Mendelion manner. Dally et al., (1980) reported that the allelic frequencies were 0.35 for A allele and 0.65 for B allele and B allele were most frequent in Dorest crosses. Wang et al., (1991) reported that the distribution of haemoglobin polymorphism was investigated in 11 breeds of domesticated and three genetic groups of wild sheep in the U.S.A, Hb B was more frequent than Hb A in most of the domesticated breeds with a pooled frequency of 0.71. The Hb B gene frequencies were (0.95 for Barbados), (0.45 for Booroola), (0.77 for Columbia), (0.40 for Finn sheep), (0.87 for Hamshire), (0.88 for Karakul), (0.98 for Rambouillet flock 1), (0.93 for Rambouillet flock 2), (0.12 for Romanov), (0.50 for St-Croix flock 1), (0.63 for St-Croix flock 2), (1.0 for Suffolck flock 1), (0.86 for Suffolck flock 2) and (0.86 for Targhee) all the wild sheep tested (Argali x European Mouflon cross, Asiatic Mouflon X European Mouflon cross and desert Bighorn) were monomorphic for Hb B the monomerphism of Hb B of wild sheep and the higher frequency of Hb B than Hb A in domesticated sheep indicates that Hb A probably occurred after sheep were domesticated. The variation in haemoglobin polymorphism within and between breeds may have resulted from a combination of genetic drift and selection. Morsy (2002) reported that distribution of Hb types and allelic frequencies were 45% for type A and 55% for type B, frequency of the B allele was higher than that of the A allele in both Chios and Ossimi ewes. While A allele was the more frequent in ½ C ½ O crossbred ewes 53% compared to 47% for B allele the number of Hb AB ewes was low in all groups.

Table 1 - Distribution of haemoglobin types (Hb) and allelic frequencies of ewes and lambs

Items	No. of Animals			Allelic frequency	
	AA	AB	BB	A	B
Ewes:					
Rahmani	83	46	71	0.53	0.47
Lambs:					
Rahmani	12	11	18	0.43	0.57
½ C ½ R	6	8	17	0.32	0.68

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b- Relationship between Haemoglobin types and reproductive performance

Reproductive performance is one of the most important criteria to be considered in planning for sheep improvement. The main measurements of reproductive performance were included in the present study being fertility and litter size at birth (prolificacy).

Fertility

Least Squares Means (LSM ± SE), analysis of variance and the significant levels for some factors affecting fertility are illustrated in Table 2.

Haemoglobin type (Hb) had no significant effect on fertility in this study. However, fertility was highest for Hb AA ewes 71%; Hb AB ewes were intermediate 70 % and Hb BB ewes had the lowest value 66%. The present results are consistent with those reported by King et al. (1958), Meyer et al. (1967), Mayo et al (1970) and Guney and Darcan (2000). King et al. (1958) reported that in Scottish Blackface breed, Hb AA ewes were more fertile than either Hb BB or Hb AB ewes, also Meyer et al (1967) reported that among Black headed Mutton sheep in Germany; Hb AA ewes were more fertile than Hb BB ewes. Work done on Australian Merinos by Mayo et al (1970) indicated no differences in fertility attributable to Hb types. Guney and Darcan (2000) working on Fawn x Hair crossbred does, reported that does with Hb AA had higher fertility (80%) than does with Hb BB (70%) and the differences statistically were not significant.

Age of dam had a significant (P<0.05) effect on fertility in the present study Table (2). Ewes aged ≤ 4 year – old or more tended to be the most fertile, while ewes aging ≤ 3 year – old or less had the least fertility values (Table 2). Similar results were reported by Vesely and Peters (1981), Long et al. (1989), Sallam et al. (1987), Marzouk (1997), Bourfia and Touchberry (1993), Marzouk and Mousa (1998) and Thieme et al. (1999). The effects of years of mating on fertility of ewes were not significant (Table 2).

Significant effect (P<0.01) of mating season on fertility was observed, autumn season (Sept– Oct) was the best season in fertility (84%) compared to (60%) in summer (May – Jon) and (64%) in winter season (Jun – Feb.). This finding is in agreement with those reported by Fahmy (1990), Marzouk (1997), Marzouk and Mousa (1998) and Tosh et al., (2002). Marzouk (1997) reported that fertility value in autumn season was (79%) compared to summer (66%) and winter (54%) seasons. Breed of sire had no significant effect on fertility in this study. Ewes sired by Rahmani rams had the highest fertility (73%) compared to sired by Chios (C) rams (66%). The present results are in agreement with the findings of, Bunge et al., (1993 a, 1993 b) and Bunge et al., (1995).

Table 2 - LSM ± SE of factors affecting fertility and litter size in Rahmani sheep

Items	No of ewes mating	Fertility	No of ewes	Litter size at birth
		LSM ± SE		LSM ± SE
Overall mean	200	0.69 ± 0.045	137	1.05 ± 0.24
Haemoglobin type		NS		NS
Hb " AA "	83	0.71 ± 0.05 a	58	1.01 ± 0.03 b
Hb " AB "	46	0.70± 0.06 a	34	1.02 ± 0.04 ab
Hb " BB "	71	0.66± 0.05 a	45	1.12 ± 0.03 a
Age of dam		*		NS
≤ 2 yr – old	32	0.44 ± 0.08 a	15	1.00 ± 0.06 b
≤ 3 yr – old	70	0.66± 0.05 a	44	1.07 ± 0.03 b
≤ 4 yr – old	46	0.80 ± 0.07 a	36	1.09 ± 0.04 a
≤ 5 yr – old	20	0.78 ± 0.10 a	17	1.05 ± 0.06 b
> 5 yr – old	32	0.77 ± 0.08 a	25	1.03 ± 0.05 b
Year of mating/Lambing.		NS		NS
2002	70	0.82 ± 0.05 a	54	1.05 ± 0.03 a
2003	67	0.65 ± 0.06 a	46	1.06 ± 0.05 a
2004	63	0.61 ± 0.06 a	37	1.04 ± 0.02 a
Season of mating		**		NS
Autumn (Sept–Oct)	64	0.84 ± 0.06a	51	1.10 ± 0.03 a
Summer (May–Jon)	66	0.60± 0.05 b	48	1.00± 0.04 b
Winter (Jun–Feb)	70	0.64 ± 0.05 b	38	1.04± 0.03 ab
Breed of sire		NS		NS
Rahmani rams	104	0.73 ± 0.04 a	74	1.06 ± 0.03 a
Chios rams	96	0.66 ± 0.04 b	63	1.04 ± 0.03a

a, b,: Means within the same classification followed by different letters significantly (P < 0.05). ** = P < 0.01; * = P<0.05; NS=P > 0.05.

Litter size at birth (prolificacy)

The effect of haemoglobin type on litter size at birth was not significant. However, prolificacy was highest for Hb BB ewes (1.12), with Hb AB ewes the average was intermediate (1.02) and Hb AA had the lowest value (1.01). The present results are in agreement with the findings of Evans and Turner (1965) reported that Hb BB Merino ewes had significantly higher lambing rates than did Hb AA ewes, also. Agar et al. (1972) reviewed a number of studied of various breeds in diverse environments in which the same conclusion was reached, also similar results reported by Bugne et al. (1990), Guney and Darcan (2000) and Morsy (2002).

Age of ewes was not significant effect on litter size at birth. Ewes aged ≤3 yr-old and ≤4 yr-old had the highest values (1.07 and 1.09) followed by ewes aging ≤ 5 and >5 yr-old (1.05 and 1.03), ewes aged 2 year – old or less had the lowest value (1.0). These results can be explained in the light of the fact that older ewes (4 years old)

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had a mature body size and better conformation. These provide higher ovulation rate and convenient uterus cavity that help percentage of twins. The nursing ability as well as the milk production merit is stronger in the older ewes than young ones. These results follow the same trend as reported by Sidwell and Miller (1971), Dickerson and Glimp (1975), Hohenboken et al. (1976), Paul et al. (1978). Fogarty et al. (1984), Hassan and Sallam (1988), However, Thieme et al., (1999) reported that age of ewe were highly significant for prolificacy, also, Cloete et al., (2000) working on Dorper sheep found that litter size of Dorper ewes was affected by dam age multiple birth rate increasing to an age of 4 – 6 years followed by a tendency towards a decline.

Effects of lambing year on litter size at birth were not significant, while the effect of season of lambing on litter size at birth was not significant. Litter size at birth of ewes mating in autumn season was higher than that mating in winter season (1.10 vs. 1.04), ewes mating in summer season had the lowest value (1.0). The significant effect of season of lambing may be due to variations in environmental factors such as availability of feeds. Similar results were reported by Othman et al. (1994), Younis et al. (1996), Hassan (1988). Breed of sire had insignificant effect on litter size at birth for (Table 2). A ewe mating with Rahmani rams was higher prolificacy than ewes mating with Chios ram (1.06 vs. 1.04). These results follow the same trend as reported in the literature by Bunge et al. (1990) reported type of ram were not significant effect on prolificacy. Also, Bunge et al. (1993b) reported breed of ram was no significant effect on prolificacy, while Bunge et al. (1995) noticed that breed of sire had a significant effect on prolificacy.

c- Relationship between Haemoglobin type and body weight and gain of lambs:

Haemoglobin type in this study was not significant effect on body weights of Rahmani lambs or F1 crosses ½ C ½ R at all ages studied Tables (3, 4, 5 and 6). Least squares means and standard error of factors affecting body weight of Rahmani lambs at different ages according to their (Hb) type Table 3 cleared that lambs with Hb BB had the highest value of weights at all ages studied except birth weight. Also, lambs F1 crosses ½ C ½ R with Hb AA had the highest value of weights at all ages studied except weaning weight.

Differences in daily gain due to Haemoglobin type of Rahmani or F1 cross ½ C ½ R lambs were not significant effect at all periods studied (Tables 5 and 6). From least square means in Tables (5 and 6) it can be noticed that Rahmani lambs with Hb BB had the highest value of daily gain than lambs with Hb AB or Hb AA, while Rahmani lambs with Hb AA had the highest value at third period (from 6 to 9 months) than lambs with Hb AB or BB. On the other hand, lambs from F1 cross ½ C ½ R with HbBB had the highest value at birth, while lambs with HB AA had the highest value at second period (from weaning to 6 months) and four period (from birth to yearling) (Table 6). Similar results were reported by Nihat et al. (2003).

Table 3 - Least squares means ± standard errors of body weight of Rahmani lambs at different ages according to their (Hb) type

Items	No of lambs	Birth weight (kg)	No of lambs	Weaning weight (kg)	No of lambs	Weight at 6 months (kg)	No of lambs	Weight at 9 months (kg)	No of lambs	Weight at yearling (kg)
Overall mean	41	4.20 ± 0.667	40	14.7 ± 3.0569	40	21.6 ± 4.385	38	26.4 ± 4.28	38	34.5 ± 6.17
Hemoglobin Type		NS		NS		NS		NS		NS
AA	12	4.05 ± 0.19 a	12	14.6 ± 0.88 a	12	20.4 ± 1.2 a	12	25.6 ± 1.2 a	12	34.0 ± 1.7 a
AB	11	4.30 ± 0.20 a	10	14.1 ± 0.96 a	10	21.1 ± 1.3 a	9	25.9 ± 1.4 a	9	33.6 ± 2.0 a
BB	18	4.14 ± 0.15 a	18	15.4 ± 0.72 a	18	23.3 ± 1.0 a	17	27.8 ± 1.0 a	17	35.9 ± 1.4 a

Table 3- Least squares means ± standard error of body weight of Crossbred (½ C ½ R) lambs at different ages according to their (Hb) type

Items	No of lambs	Birth weight (kg)	No of lambs	Weaning weight (kg)	No of lambs	Weight at 6 months (kg)	No of lambs	Weight at 9 months (kg)	No of lambs	Weight at yearling (kg)
Overall mean	30	4.6 ± 0.70	30	18.3 ± 2.5	30	25.9 ±3.7	28	31.7± 5.1	28	40.1 ± 6.5
Hemoglobin Type		NS		NS		NS		NS		NS
AA	6	4.9 ± 0.28 a	6	18.8 ± 1.05 a	6	27.7 ± 1.5 a	6	33.7 ± 2.1 a	6	42.5 ± 2.1 a
AB	6	4.2 ± 0.28 a	6	17.1 ± 1.05 a	6	23.8 ± 1.5 a	5	29.4 ± 2.3 a	5	36.9 ± 2.9 a
BB	18	4.6 ± 0.16 a	18	19.0 ± 0.60 a	18	26.3 ± 0.8 a	17	32.0 ± 1.2 a	17	40.8 ± 1.5 a

Table 5 - Least Squares Means ± Standard errors of daily gain (kg) of Rahmani lambs at different ages according to their (Hb) type

Items	No of lambs	Daily gain from birth to weaning	No of lambs	Daily gain (kg) from weaning to 6 months	No of lambs	Daily gain from 6 to 9 months (kg)	No of lambs	Daily gain from birth to yearling (kg)
Overall mean	40	0.117 ± 0.0025	40	0.076 ± 0.008	38	0.056 ± 0.0098	38	0.084 ± 0.0122
Hemoglobin Type		NS		NS		NS		NS
AA	12	0.117 ± 0.008 a	12	0.065 ± 0.008 a	12	0.061 ± 0.005 a	12	0.084 ± 0.003 a
AB	10	0.108 ± 0.009 a	10	0.078 ± 0.009 a	9	0.053 ± 0.006 a	9	0.080 ± 0.004 a
BB	18	0.125 ± 0.007 b	18	0.084 ± 0.007 b	17	0.053 ± 0.004 a	17	0.088 ± 0.002 a

Table 6 - Least Squares Means ± Standard errors of daily gain (kg) of Crossbred (½ C ½ R) lambs at different ages according to their (Hb) type

Items	No of lambs	Daily gain from birth to weaning	No of lambs	Daily gain (kg) from weaning to 6 months	No of lambs	Daily gain from 6 to 9 months (kg)	No of lambs	Daily gain from birth to yearling (kg)
Overall mean	30	0.153 ± 0.0058	30	0.085 ± 0.0081	28	0.066 ± 0.0085	28	0.097 ± 0.0022
Hemoglobin Type		NS		NS		NS		NS
AA	6	0.155 ± 0.010 a	6	0.098 ± 0.011 b	6	0.067 ± 0.011 a	6	0.103 ± 0.009 b
AB	6	0.144 ± 0.010 b	6	0.074 ± 0.011 a	5	0.067 ± 0.012 a	5	0.089 ± 0.009 a
BB	18	0.160 ± 0.006 a	18	0.082 ± 0.006 a	17	0.064 ± 0.006 a	17	0.098 ± 0.005 a

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GROWTH PERFORMANCE OF DESERT SHEEP UNDER GRAZING CONDITIONS IN NORTH KORDOFAN STATE

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ABSTRACT: *The experiment was conducted to study the effect of changing the nomadic husbandry practices during summer with feed supplementation and water restriction on the performance, carcass characteristics of desert sheep (Hamari sub type). Thirty desert sheep of about 8 month age were randomly allocated to three groups (ten animals each, 5 males and 5 females), group (A) watered daily and supplemented with concentrates, (B) watered daily only and (C) watered every 2- 3 days and was considered as control (the normal nomadic husbandry). The results included that average final live weights were significantly (P<0.05) different among the groups and were not significantly affected by sex but males in group A were heavier than the other two groups. The tail length, height at withers, heart girth, chest depth and body length were significant (P<0.05) different between the three groups. The average daily live weight gain was significantly (P<0.05) different among the groups, and the highest rate of gain was in A followed by B and C, respectively. The average daily live weight gains obtained were significantly (P<0.05) different between females and males of groups A, B and C. The males gave higher daily live weight gains than females. These results concluded that management strategy which involves shorter watering intervals and feed supplementation will probably reflect positively on the performance of Hamari sheep under range conditions.*

ORIGINAL ARTICLE

Keywords: *Dessert sheep, growth performance, Body linear measurements, concentrate ration, Sudan*

INTRODUCTION

Sudan is one of the largest countries in Africa characterized by a great numbers of livestock, vast areas of range and cultivated land. Sheep are multiple purpose animals, providing meat, milk and skin. They are raised under nomadic condition with traditional methods of management and natural grazing (Mcleroy, 1961). Thus improving sheep productive performance reflected economically to improve the nomadic life and relief poverty and hence stop people migration and support Sudanese animal export. Sheep in Sudan is about 50.39 million representing 32.51% of the total livestock population which is approximately 155 million head (MARF, 2007).The share of livestock in the national income is about 22.3%, about 18.2% of total exports and about 38% of agricultural exports. The composition of sheep exported as slaughtered animals was 700,276 sheep (M.A.R.F, 2007).

Meat is a very valuable food as it contributes to tissue building in addition to the provision of energy, vitamin, protein and minerals. It plays an important nutritional and economical role in the lives of human beings. In spite of the importance of sheep they are still raised under nomadic conditions using traditional methods of management depending on natural grazing. The specific problem regarding sheep nutrition under range land conditions is feed shortage and nutrient deficiencies. This situation becomes very critical during the dry season which extends from November through to June. This is reflected in seasonality of reproduction, high mortality rate among both young and adult animals and poor reproductive performance (EL Hag et al., 1998). Reproduction is synchronized in such a way that lambs are dropped during wet summer when fodder and water are available. The direct effects of poor nutrition are reflected in reduced conception, embryonic losses, reduced lambing rate and high ewe mortality. Rarely farmers provide their animals with different supplements during the critical period of feed shortage. Supplements used are mainly oilseed cakes and cereal grains. However, Kordofan, where most of the sheep wealth is located has a high density of trees and shrubs from which pods and foliage could be used as feeds (Fadul, 2007). There is scarcity of data on how to improve the nomadic management systems under range conditions to enhance the reproductive and productive performance of hamari sheep. The present experiment was designed to study the

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effect of changing the nomadic husbandry practices during summer with feed supplementation and water restriction and sex on the performance of desert sheep (Hamari sub type).

MATERIALS AND METHODS

The study was conducted in Mhagor-Area about 30 km south of El-Nuhood (lies within latitudes 11.5-13.75 N° and longitudes 27-29.5 E°) about 900 km west to Khartoum. Average annual rainfall is 300 and 400 mm in the north and southern parts respectively. Average maximum temperature is 24-39°C during most of the year, with peaks above 36°C during April, May and June. The soil types varied from sandy (Goze) dissected by batches of loamy sands (Gardud or gurraba) in the southern part. The main cash crop grown in the locality is mainly millets, sorghum, watermelon, rosella (*Hibiscus sabdariffa*) and groundnut.

Experimental animal's management

T Thirty desert sheep (15 males +15 females) of the same age (about 8 months) were used in this study. The animals were ear tagged and randomly divided into three groups according to age and body weight and designed as A,B and C respectively each group consist of 10 animals (5 male and 5 female). The first group (Group A) was allowed to drink water every day and was supplemented with additional concentrates, consisting of 40% durra grains, 30% groundnut cake, 29% groundnut hulls and 1% salts. Every head from this group was given 750g concentrates daily. The second group (group B) was allowed to drink water every day without supplementation. The third group (group C) was allowed water at 2-3 days intervals without supplementation. This group was considered as control. All the groups were allowed to graze at night on natural grasses available on pasture and kept in shade during the day from 7:00 am to 6:00 pm. All the parameters related to performance such as weight, body length, and fertility was recorded regularly. The sheep were allowed to mate with the rams in throughout the year.

The animals were given the experimental diet for adaptation period of two weeks. During this period the sheep were treated with Ivomec subcutaneously against external and internal parasites. Albendazole drenches for deworming were given orally. At the end of the adaptation period, the animals were individually weighed after an overnight fast, to give the initial live weight. Live animal body weights were recorded every week while the liner body measurements were done by means of a tap every two weeks (Owen et al., 1977). Body linear measurements included:

- Height at withers from the highest point on the dorsum of the animal to the ground surface at the level of the front feet.
- Body length from the tip of the scapular to the pin bone.
- Heart girth around the circumference of the chest just behind the forelegs and along the xiphoid depression.
- The length of the head from the tip of the nose to the atlas joint along the curvature of the head.
- Ear length from the base of the ear at the skull along the dorsal surface to tip of the ear.
- The length of the neck from the atlas joint to first thoracic spinal process.
- The length of the tail from the bas to the tip.

Statistical analysis:

Data were analyzed by using SPSS version 13 analysis of a completely randomized design (CRD), in factorial arrangement using LSD test for mean separation by use a computer program.

RESULTS

Growth performance of desert sheep (Hamari sub type)

The importance of supplementation during the dry season was confirmed in this study. The average initial body weights for the three groups were 32.56, 33.60 and 31.60 and were not significantly (P>0.05) (Table 1). The average final body weights were significantly (P<0.05) different among the treatment groups, sheep in treatment A (48.10 kg) had greater final body weight than treatments B (44.40 kg) and C (42 kg) (Table 1).

Table 1 - Growth performance of desert sheep (Hamari sub type)

Parameters	Animal Groups			S.E	L.S
	A	B	C		
Experimental period (days)	120	120	120	-	-
Initial body wt (kg)	32.56	33.60	31.60	1.39	N.S
Final body wt (kg)	48.10^{a}	44.40^{b}	42.00^{c}	1.39	*
Daily live weight gain (gm)	129.5^{a}	90^{b}	86.67^{c}	0.6	*

Values in the same column followed by different letters are significantly different at P<0.05 or 0.001. For this and preceding tables the superscript letters determine the significant differences: NS = Not significantly different; * = Significantly different at 0.05; ** = Significantly different at 0.01; *** = Significantly different at 0.001; S.E = Standard error; L.S = Level of significant.

The initial body weight is very indicative of how animal can response to the supplemented diets. Result obtained here is similar to the results of Ahmed (1993) for the same breed. The values of final weights were 36.8,

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32.8 and 28.3 kg for groups A, B and C, respectively. This result agrees with Beshir (1996) who reported that, the average final body weight were not significantly different among the treatment groups, their values were 37.71, 36.69 and 36.04 kg in treatments A, B and C, respectively.

The average daily weight gain was significantly (P<0.05) different among the treatment groups, and the highest rate was in treatment A (129.5 gm) followed by B (90 gm) and finally C (86.67 gm). The average daily weight gain reported here agrees with that reported by El-Khider (1989) who reported an average daily gain of 121 and 117 gm per day for desert sheep fed molasses-urea blocks plus oil seed cake and concentrates. Ahmed and Suliman (1988) and Mansour (1987) found similar results for Sudan desert sheep fed 10% and 15 % blood meal. Suleiman and El-Amin (1980) and Allama (1987) reported that daily gain of Sudan desert sheep was 237 and 215 gm per day which is superior to the values reported in the present study. These values are superior to the values reported in this study for the Desert sheep subtypes. The most likely reason for this discrepancy might be due to the fact that animals used in this study were more mature than those in the other studies reported and also may be due to different management practice.

Effect of sex on body weight growth

The sex in this study seem to be have no significant (P>0.05) effect on growth performance of the dessert sheep. In all groups there were no significant differences in initial body weight. In groups B and C the average final body weight of males (47.60, 47.60 kg, respectively) was significantly (P<0.05) greater than that of females (41.20, 42.40 kg, respectively). The differences in final weight between males and females in treatments B and C may be attributed to the anabolic effect of male sex hormones and may be to genetic factors. This results are similar to those of Mohamed (2004) who reported that, the final live weight was significantly (P<0.05) higher for ram than ewe lambs. And in line with Musa et al (2005) who reported body weights of rams and ewes were 45.59 and 39.50 kg, respectively.

The average body weights of females were significantly (P<0.05) different among the three groups. The average live weight was higher in females of group A than those of B and C respectively. This result is in harmony with the results of Lutfi (1985) and Fadul (2007) who found that there were significant differences between ewes fed on pasture and those supplemented.

The average live weights of males in the three treatments were significantly (P<0.05) different. The males in group A had higher average live weights than those of males in the other groups. This result disagrees with the results of Amani et al. (2009) and Suliman (1999) who reported that animals fed on groundnut cake had the highest final body weight average (31.69 kg), while animals fed on sesame cake had the lowest final body weight average (29.98 kg). These differences may be attributed to differences between rations.

Table 2 - Effect of sex and management system of desert sheep (Hamari sub type)

Parameters	Animal groups					
	A		B		C	
	Female	Male	Female	Male	Female	Male
Initial body wt(kg)	33.26 ±1.97	31.85±1.97	32.60±1.97	34.60±1.97	32.46±0.73	33.70±0.73
Final body wt(kg)	48.28±1.97	48.00±1.97	41.20±1.97 ^{b}	47.60± 1.97^{a}	42.40±0.73^{b}	47.60±0.73
Daily live weight gain (gm)	125.52±1.97	134.58±1.97	71.67±1.97b	108.33±1.97a	82.83±0.73b	115.83±0.73a
Females	38.74 ±0.48 a		35.21 ±0.48 a		34.21 ±0.48 b	
Males	38.73 ±0.48 a		37.07 ±0.48 b		36.08±0.48 c	

Values in the same column followed by different letters are significantly different at P<0.05 and P<0.01.

Body measurement

The determination of correlations between body measurements in sheep may help to provide tools for predicting characters which are not usually easily measured in the field. In the current study seven basic physical measurements were taken with the purpose of providing a comparative description of the three groups of animals under investigation.

Effect of sex in linear body measurements there were no significant differences between females and males in the length of head, ear, neck and tail (Table 3). However, the height at withers, heart girth, chest depth and body length, were significantly (P<0.05) different in the two sexes. The males had higher measurements than females; their values were 84.54, 84.04, 42.01 and 64.11 cm, respectively. The corresponding measurements for females were 82.60, 82.22, 41.58 and 60.71 cm, for height at withers, heart girth, and chest depth and body length, respectively. These results are agreement with Mohamed (2004) and Musa et al (2005) who indicated that the average body length, heart girth, height at withers and chest depth of ram were 64.17, 86.59, 82.65 and 43.43 cm and for ewe were 61.87, 83.10, 76.97 and 41.12 cm, respectively.

Wither height and body length were significantly (P<0.01) greater in rams than in ewes and this may partly be due to differences in the degree of development as a consequence of the effects of sex hormones. These results were in line with Maglad et al. (1986) and supported by Mehta et al. (1995) who stated that sex of the animal had a significant effect on body weight, height at weathers, body length and chest girth. In addition, the results are also in agreement with the findings of Suliman (1999) who reported that Shugor and Dobasi have the best chest depth in

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relation to age, followed by heart girth, body length and withers height. these results showed that among live measurements of body condition score heart girth, body length and withers height, have the highest correlation with body length and withers height. These differences in results may be due to genetic factors and confirm the belief that males have higher body measurements than females.

Table 3 - Effect of management systems and sex on body measurements of desert sheep (Hamari sub type)

Parameters (cm)	Animal Groups					Sex			
	A	B	C	S.E	L.S	Females	Males	S.E	L.S
Head length	29.4	30.24	29.18	0.10	NS	29.19	30.40	0.08	NS
Ear length	19.80	19.39	19.30	0.09	NS	19.49	19.50	0.07	NS
Neck length	30.11	30.88	30.86	0.09	NS	30.84	30.06	0.08	NS
Tail length	64.13	62.27	63.61	0.44	NS	64.65	63.69	0.36	NS
Height	82.42	84.65	83.14	0.42	NS	82.60	84.54[a]	0.34	*
Heart girth	82.35	84.56	83.98	0.35	NS	82.22	84.04[a]	0.28	*
Chest depth	41.15	42.77	41.47	0.17	NS	41.58	42.01[a]	0.14	*
Body length	64.81	64.46	62.96	0.29	NS	60.7	64.11[a]	0.24	*

The different measurements of females and males of the three treatments in the study were showed no significant (P>0.05) differences among females in head, ear, neck, tail, height, chest depth and body length in treatments A, B and C, respectively (Table 4). Also males of the three treatments were not significantly (P>0.05) different with regard to those parameters (Table 5). This result is in harmony with the results of Mohamed (2002) who found that, there were no significant differences in these measurements between Hamari and Kabashi lambs. However, Kabashi had higher values for height at withers, heart girth and head length.

Table 4 - Effect of female and management systems on linear body measurements (cm)

Parameters (cm)	Animal Groups			S.E	L.S
	A	B	C		
Head length	29.55	30.39	28.96	0.14	NS
Ear length	19.16	19.54	18.41	0.12	NS
Neck length	29.99	29.76	29.76	0.13	NS
Tail length	63.45	62.69	64.44	0.62	NS
Height	82.42[b]	79.51[b]	82.87[b]	0.59	*
Heart girth	82.40[b]	82.76[b]	81.50[b]	0.48	*
Chest depth	41.65[b]	41.37[b]	41.73[b]	0.24	*
Body length	60.95[b]	59.66[b]	60.51[b]	0.41	*

Table 5 - Effect of male and management systems on linear body measurements (cm)

Parameters (cm)	Animal Groups			S.E	L.S
	A	B	C		
Head length	30.39	30.43	30.40	0.14	NS
Ear length	19.77	19.24	19.54	0.12	NS
Neck length	30.23	30.00	29.96	0.13	NS
Tail length	61.44	60.86	63.62	0.62	NS
Height	84.41[a]	83.79[a]	84.41[a]	0.59	*
Heart girth	84.30[a]	84.36[a]	81.50[a]	0.48	*
Chest depth	42.15[a]	42.18[a]	41.73[a]	0.24	*
Body length	64.67[a]	63.26[a]	60.51[a]	0.41	*

CONCLUSIONS

It may be concluded that the final body weights of Hamari sheep supplemented with concentrates were greater than those grazed on natural pasture. Hamari sheep grazing on natural pasture gave male with higher body weights than female. Finally the body measurements of Hamari sheep were significantly higher with regard to height at withers, heart girth, chest depth and body length in males compared to females.

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SYNERGISTIC EFFECTS OF DIETARY GLUCOSAMINE AND PLANT/ANIMAL PROTEINS ON THE GROWTH PERFORMANCE OF ASIAN CATFISH (*Clarias Batrachus*) JUVENILES

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ABSTRACT: *A 84-days feeding trials was conducted to evaluate the use of animal and plant protein, in combination with glucosamine source for Asian Catfish, Clarias batrachus (av. wt. 0.22±0.01 to 0.24±0.07g). Six (31.18 to 43.51% crude protein, 369 to 399 kcal/100g, and crude lipid 0.0 to 6.69%) practical feeds were formulated. The animal and plant protein component of the feeds was progressively added with glucosamine 0.0, 0.5, 5.0 and 10.0% with fish meal, silkworm pupae, soybean meal and casein (F-1, PAG 0:100:0.5; F-2, PAG 0:100:5.0; F-3, PAG 0:100:10.0; F-4, PAG 100:0:0.5; F-5, PAG 100:0:5.0; F-6, PAG 100:0:10.0; The experimental feeds were fed to triplicate groups of fingerlings at 10% body weight per day and results were compared with control feed. Growth performance and feed utilization efficiency of catfish, fed with animal proteins are better than those of plant protein. The best growth among the animal protein group (F-1 to F-3) was recorded in F-2 followed by F-3 and F1 containing glucosamine @5.0, 10.0 and 0.05%. Amongst the plant protein fed fishes showed best in F6 followed by F5 and F4. The survival was improved in glucosamine supplemented feeds ranging from 49±3.2 to 85±1.7 whereas the control showed 41±1.8%. Results indicate that animal protein rich feeds were much acceptable than alternative plant protein sources for the Asian catfish, Clarias batrachus and the potential for replacing animal protein with soybean meal in the feeds of fish need more evaluation along with synergistic effects of growth promoter like glucosamine.*

ORIGINAL ARTICLE

Key words: *Clarias batrachus, glucosamine, animal protein, plant protein, growth*

INTRODUCTION

Fishmeal as raw material is the first choice in aquaculture production due to high quality protein with balanced amino acid profile (Gatlin III et al., 2007). Since last twenty years the production of fishmeal is relatively stable and the increasing requirement could not be matched in present scenario due to increased aquaculture requirement (Goitortua-bores et al., 2006). Moreover the cost of fishmeal is increasing day by day therefore there is an urgent need to evaluate the other ingredients as well find alternative protein source to make up for the shortage of fish meal and fulfill the requirement and secure the supply for commercial feed (Hardy, 2006). In this context soybean meal (SBM) regarded as an economical and nutritionally rich food ingredient which contain higher protein content in comparison to other plant ingredient (Gatlin III et al., 2007). The nutritional evaluation of Soybean meal to replace fishmeal has been a long standing priority in fish nutritional research (Hardy, 1999). Due to evermore research data a considerable success has achieved in supplement of FM with SBM plant proteins in aquatic animals (Dersjant-Li, 2002; Kaushik et al., 1995). However, at higher rate of replacement of the fishmeal with SBM encouraged growth retardation may be due to imbalance nutrition in carnivorous fishes (Kaushik et al., 1995; Toma's et al., 2005; Wang et al., 2006; Martinez-Llorens et al., 2009; Ye et al., 2011) and/or higher ammonia excretion (Ballestrazzi et al., 1994; Tantikitti et al., 2005). The reduced growth may be due to anti-nutritional factors (Francis et al., 2001; Leenhonwers et al., 2006; Ye et al., 2011). The histological changes in intestine can also

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reduce growth performance on feeding plant proteins (Boonyaratpalin et al., 1998; Krogdahl et al., 2003; Heikkinen et al., 2006; Wang et al., 2006).

Air- breeding Catfish, *Clarias batrachus* (Family: Clariidae), locally known as Magur, is a fish of great demand and attracts the attention of farmers for its high market value. Feed management determines the viability of aquaculture as it accounts for at least 40-60% of the cost of fish production (Jamu and Ayinla, 2003). Reducing the feeding costs could be key factor for successful development of aquaculture. Protein is the most expensive component in fish feeds hence it is known to require in relatively large amount by several fishes (Delong et al., 1958; Ogino and Saito, 1970; Nose and Arai, 1972; Anderson et al., 1981; Mazid et al., 1979; Wee and Tacon, 1982), the exact level of its requirement for formulation of well-balanced feed and also the most important factor affecting growth performances of fish and feed cost (Lovell, 1989). So it is important to accurately determine the protein requirements for each species and size of cultured fish. Level of dietary protein is of fundamental important because it is significantly influences growth, survival and yield of fish as well as economics of a farming industry by determining the feed cost which is typically the largest operational cost. Glucosamine a amino sugar and a prominent precursor in the biochemical synthesis of glycosylated proteins and lipids synthesize chitin, is one of the most abundant monosaccharide (Horton and Wander 1980, Roseman 2001, Muzzarelli 1977) which composes the exoskeletons of crustaceans and other arthropods. It has been well established that animal protein performs better than plant protein in the growth and nutritive value of cultivable fish (Rao and Kumar 2006). Silkworm pupa is one of the unconventional top class animal proteins (65-67%). Recycling of these wastes into an acceptable source of animal protein in the feed of fish is a big challenge in the pursuit of sustained procedure of inexpensive catfish, *Clarias batrachus* feed. Silkworm pupae (*Bombyx mori*) is a low cost animal protein source, rich in both protein and lipid (Bhuiyan et al., 1989). This study was taken up as huge mortality is recorded at fry stage of this fish in natural condition. Therefore, this experiment was carried out to study the synergistic effects of dietary glucosamine in combinations with Plant/animal proteins on the survival and growth performance of *Clarias batrachus* fry.

MATERIALS AND METHODS

Fish and feeding trial

Newly hatched larvae of catfish, *Clarias batrachus* obtained from a single batch of hatchery bred spawned broodstock were used in the experiment after acclimation for one week. In the wet laboratory the experimental fish, *Clarias batrachus* fry (av. wt. 0.22±0.01 to 0.24±0.07g) were subsequently segregated and stocked in separate specially designed plastic pool (capacity 300 l, containing 50 l of tap water with continuous aeration), in a groups of 100 fry in each pool. The experiment consisted of two replicates for each feed and continued for 84 days. The experimental feeds were hand-fed @ 10% of the total body weight. Each scheduled daily ration per batch of fish was divided into two equal proportions and distributed to the fish at 11:00 hr and 17:00 hr respectively. Initial and subsequent fortnightly weight gains (g) were recorded on electronic balance (make: Sartorius). At the end of the experiment 6-8 fish from each treatment were sacrificed and analyzed for proximate composition of the muscles. The water quality parameters were recorded for water temp, pH, dissolved oxygen and total alkalinity.

Analytical methods and analysis of data

Proximate compositions of feeds and fish carcasses were analyzed following AOAC (1990) methods. All samples were analysed in triplicate. Dry matter was estimated after drying in oven at 105°C for 24 hours; crude protein (N x 6.25) by the Kjeldahl method after acid digestion; Crude lipid by di-ethyl ether extraction method using Soxhlet apparatus. The performance of the feeds, in terms of the weight gain (%), Specific growth rate (SGR), feed conversion ratio (FCR), Protein efficiency ratio (PER). The growth in length and weight and the survival data were analysed using One-way ANOVA. Duncan's multiple Range test was used to determine which treatment means differed significantly ($P<0.05$) using SPSS version 16.0.

Weight Gain (%) = {(Final body weight) – (Initial body weight)/(Initial body weight)}x 100

Specific Growth Rate (SGR; % day $^{-1}$) = {(Final body weight) - (Initial body weight)/(experimental days)}x 100

Survival (%) = 100 x(No. of total fish - No. of dead fish)/Number of total fish

Biomass = Final average weight x Total no. of fish

Experimental feeds and feed preparation

Six feeds were prepared by using plant and animal protein in combination with glucosamine source for Asian catfish, *Clarias batrachus*. Ingredients and proximate composition of the experimental feeds are given in Table 1. The natural live feed serves as control. In the experiment six (31.18 to 43.51 % crude protein, 369 to 399 kcal/100g, and crude lipid 0.0 to 6.69%) practical feeds were formulated and their composition is given in Table 2. The animal and plant protein component of the feeds was progressively added with glucosamine 0.0, 0.5, 5.0 and 10.0 % with basic ingredients like fish meal, silkworm pupae, soybean meal and casein (F-1, PAG 0:100:0.5; F-2, PAG 0:100:5.0; F-3, PAG 0:100:10.0; F-4, PAG 100:0:0.5; F-5, PAG 100:0:5.0; F-6, PAG 100:0:10.0. Fishmeal was freshly prepared from in lab from dried trash fishes mainly *Mystus vittatus*, *Puntius sophore*, etc. Live silkworm pupae were procured from Department of Applied Animal Science, Babasaheb Bhimrao Ambedkar University, Raebareilly Road, Lucknow, cultured upto VIth Instar larvae and then de-oiled in the lab by di-ethyl-ether (Merck).

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The de-oiled pupae was dried in oven at 60°C for an hour and powdered and used for feed preparation. The feeds were prepared by thoroughly mixing of the dry ingredients in a mixer and water was added to make stiff dough. Each feed was cooked in a pressure cooker for 15minutes for the proper gelatinization of the ingredients. Finally cooked moist feeds were stored in plastic zipped polybags in a freezer (-20°C) until used.

Table - 1 Ingredients composition (w/w) of feeds for *Clarias batrachus* Fry

Feeds / Ingredients	F1 PAG 0:100:0.5	F2 PAG 0:100:5.0	F3 PAG 0:100:10.0	F4 PAG 100:0:0.5	F5 PAG 100:0:5.0	F6 PAG 100:0:10.0	Control NATFO
Soybean meal[1]	0.0	0.0	0.0	60.8	60.8	60.8	-
Silkworm Pupae	20.3	20.3	20.3	0.0	0.0	0.0	-
Fish Meal	20.3	20.3	20.3	0.0	0.0	0.0	-
Casein[2]	20.2	20.2	20.2	0.0	0.0	0.0	-
Glucosamine (Chitosamine –HCl)[3]	0.5	5.0	10.0	0.5	5.0	10.0	-
Starch[4]	32.0	27.5	22.5	32.0	27.5	22.5	-
CMC[5]	2.2	2.2	2.2	2.2	2.2	2.2	-
Papain[6]	2.0	2.0	2.0	2.0	2.0	2.0	-
VM + MM[7]	2.5	2.5	2.5	2.5	2.5	2.5	-
Natural -Live food	-	-	-	-	-		100.0
Total	100	100	100	100	100	100	100

P:A:G= Plant Protein : Animal protein : Glucosamine; CMC=Carboxy–methyl–cellulose. [1]HiMedia, Mumbai Lot No: 0000013648; [2] HiMedia, Mumbai Lot No: 0000016171; [3]HiMedia, Mumbai, Lot No: 0000028805; [4]HiMedia, Mumbai, Lot No: 0000028340; [5]HiMedia, Mumbai, Lot No. 0000014218; [6]HiMedia, Mumbai, Lot No. 0000003862; Each kg of Vitamin and mineral mixture named 'Agrimin Forte' contains Vit. A 700000 IU, Vit. D_3 70000 IU, Vit. E 250mg, Nicotinamide 1000mg, Co 150mg, Cu 1200mg, I 325mg, Fe 1500mg, Mg 6000mg, Mn 1500mg, K 100mg, Se 10mg, Na 5.9mg, S 0.72%, Zn 9600mg, Ca 25.5%, P 12.75% Manufacturer Brindavan Phosphates Pvt. Ltd, 48N, doddaballpur Ind. Area, Doddaballapur – 561 203, India Batch No. BFA-61.

Table 2 - Calculated values of Protein, carbohydrate, fat and energy composition of feeds

Total Protein	43.52	43.52	43.52	31.18	31.18	31.18
Carbohydrate	34.70	34.70	34.70	55.98	55.98	55.98
Total Fat	6.70	6.70	6.70	0.00	0.00	0.00
GE/ kg	3990.48	3990.48	3990.48	3698.46	3698.46	3698.46
$KJ.g^{-1}$	16.76	16.76	16.76	15.53	15.53	15.53

RESULTS AND DISCUSSION

Various water quality parameters: water temperature, pH and dissolved oxygen (DO), total alkalinity were observed and found to be least affected by different treatment feeds. The values of all the parameters of ambient water, i.e. temperature, pH, DO and alkalinity were almost similar for all the feeding treatments during the experimental period and were well within the optimal range. The water quality recorded for water temp, pH, dissolved oxygen and total alkalinity as 20 - 24 °C, 6.8 - 7.5, 6.9 - 7.4 ppm and 130 – 138 ppm, respectively.

Table 3 - Survival Percentage of *Clarias batrachus* fry reared for 12 weeks

Feed	Stocking Nos. (N=100 X 2 replicates)	4th Week	8th Week	12th Week
F-1	200	87 ± 2.5^a	84 ± 2.4^a	78 ± 1.9^b
F-2	200	90 ± 2.8^a	84 ± 3.3^b	80 ± 1.6^c
F-3	200	92 ± 1.4^a	90 ± 2.2^a	85 ± 1.7^b
F-4	200	65 ± 3.1^a	52 ± 2.2^b	49 ± 3.2^b
F-5	200	68 ± 2.5^a	62 ± 3.7^b	59 ± 3.2^c
F-6	200	69 ± 1.4^a	66 ± 1.7^a	63 ± 5.3^b
F-7 (control)	200	52 ± 1.9^a	46 ± 2.4^b	41 ± 1.8^c

Same alphabet in superscript in a row represents no significant difference in weight gain *= $p < 0.05$. The results are of duplicate sets of feeding trial.

The survival and average fish weight gain shown graphically in Tables 3 and 4 respectively. The best growth was recorded in fish fed F3 among the animal protein group feeding regime (F1 to F3) as 85±1.7% in F3 followed by F2, 80±1.7% and F1, 78±1.9%. The results are showing dose-dependent effects of glucosamine on the survival. The plant protein based feeds with graded level of glucosamine @ 0.5, 5.0 and 10.0 resulted in an overall poor survival for the *Clarias batrachus* fry and recorded as 49±3.2%, 59±3.2% and 63±5.3% in F4, F5 and F6 respectively. The control feed showing 41±1.8% survival. The growth of the fry was recorded better in animal

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protein fed fishes but there is no sign of dose-dependent effects on growth performance. The best growth recorded in F2 which contains 5.0% glucosamine with 100% animal protein. The plant protein diets showed poor growth in comparison to animal protein diets. The control showed poor growth after 12th week. The results are shown in Table 4. The results of FCR, SGR, PER, Feed intake and Protein intake are shown in Table 5. The FCR, SGR, PER, feed intake, protein intake ranged between 1.6±0.2 to 2.4±0.2; 36.64 to 170.5%; 0.94±0.1 to 1.75±0.03; 129±11.0 to 600.0±31; 87±6 to 187.6±11. The synergistic growth on supplementing protein and glucosamine showed significant variation ($p<0.05$) in case of weight gain, FCR, SGR, PER, However there is no change ($p>0.05$) in feed intake and protein intake in all the treatments.

Table 4 - Growth of *Clarias batrachus* fry reared for 12 weeks

Feeds	In	4th week	8th week	12th week
F1	0.24 ± 0.01^{a}	0.28 ± 0.04^{b}	0.29 ± 0.04^{b}	0.38 ± 0.02^{c}
F2	0.23 ± 0.02^{a}	0.21 ± 0.03^{a}	0.37 ± 0.02^{b}	0.56 ± 0.04^{c}
F3	0.23 ± 0.01^{a}	0.31 ± 0.02^{b}	0.37 ± 0.01^{c}	0.46 ± 0.02^{d}
F4	0.22 ± 0.02^{a}	0.29 ± 0.01^{b}	0.33 ± 0.02^{c}	0.29 ± 0.01^{b}
F5	0.28 ± 0.03^{a}	0.20 ± 0.04^{b}	0.26 ± 0.02^{a}	0.31 ± 0.03^{c}
F6	0.24 ± 0.02^{a}	0.26 ± 0.02^{b}	0.30 ± 0.01^{c}	0.36 ± 0.01^{d}
F7 (control)	0.22 ± 0.01^{a}	0.29 ± 0.02^{b}	0.33 ± 0.02^{c}	0.30 ± 0.01^{b}

Same alphabet in superscript in a row represents no significant difference in weight gain; *= $p< 0.05$. The results are of duplicate sets (n =2) of feeding trial.

In the present study, the experimental feeds were formulations with different protein are based on previous reports (Kikuchi, 1999; Kim et al., 2002, 2006; Cho et al., 2006 and Ye et al., 2011). In the study, the differences observed in the performance of the dietary animal and plant protein feeds in combination with graded level of glucosamine (0.5, 5.0, 10.0). The experimental feeds F1, F2 and F3 with animal protein along with glucosamine (0.5, 5.0, 10.0), performed better than the plant proteins based feeds F4, F5 and F6. Dietary proteins dietary protein plays a dominant role in fish growth (Cowey et al., 1972; Satia, 1974; Cho et al., 1976).On the basis of average specific growth rate and % live weight gain, an improvement in growth response was noticed with increase in dietary protein level up to maximum of 35% animal protein (casein) content and thereafter a decrease with further increase in dietary protein concentration (Das and Ray, 1991). The present study showed that different protein types (plant or animal) significantly affected the growth and feed utilization of Asian catfish, Clarias batrachus. The negative effects of weight gain, FCR, PER in response to dietary plant protein suggesting that dietary plant protein type is poorly suitable than animal protein. Similar reports are made by Ye et al. (2011) in Japanese Flounder using soybean meal more than 16% and Kikuchi (1999), who found that 43% of fishmeal protein could be replaced by soybean meal (25%) in combination with bloodmeal (10%) or corn gluten meal (10%) and blue murrels meat (5%). The data in present study on *Clarias batrachus* indicated that tolerance to animal protein substitution by plant protein in combination with glucosamine was somewhat low. According to Rao and Kumar (2006), experiment conducted to know the effect of animal protein incorporated formulated feeds on the growth and nutritive value of Rohu fingerlings, the test feeds containing 35% dietary protein level, showed better performance in growth and fertilization than the control feed having only plant protein and also the test feeds having higher protein levels. This infers that the plant protein (GOC) can be replaced by squillameal (an animal protein), which is very much similar to our results. Fish meal has superior nutritive values over other animal proteins (Seeenappa and Devraj, 1995) and plant proteins (Eyo, 1991), because of its well balanced amino acid compositions and their bioavailability (Moon and Gatlin, 1994), which influenced the performance of animal (Gaylord and Gatlin, 1996). 0.5 glucosamine with animal protein gives better results than 5.0 or 10.0 % glucosamine with animal protein which shows that 0.5% levels of glucosamine good for the health of fish. Similar results have been reported by Mollah and Alam (1990), who obtained value of 15% carbohydrate (glucosamine 5.0, 10.0) in the feed showed retardation of growth. Further, the foregoing results agree and extend the findings of Chakraborty et al. (1973) by showing that silkworm pupae (animal protein), groundnut and wheat bran was better utilized by fry *Labeo rohita* and *Cirrhinus mrigala* than that of mustard oilcake and rice bran. Prawn shell waste protein is rich in essential amino acids (Forster 1975; Penaflorida, 1989). Dietary glucosamine was found to be a growth promoting factor in shrimp (Kitabayanshi et al., 1971) and the shell (chitin) in shrimp waste growth promoting agents for the prawn *Penaeus indicus* (Vaitheswaran et al., 1986). The effect of dietary chitin on the growth and survival of juvenile *P. monodon* was studied by various workers (Lan and Pan 1993; Sudaryono et al., 1996). In the present experiment, conducted to know the effect of animal and/or plant protein incorporated with glucosamine (at graded levels of 0.5, 5.0, 10.0), the test feed F1 (100% animal protein with 0.5 % glucosamine) showed better performance in survival and growth than the other feeds containing plant proteins. Growth performance and feed utilization efficiency of this catfish, fed feeds with animal protein are better than those of plant protein. Results indicate that animal protein rich feeds were much acceptable than alternative plant protein sources for the Asian catfish, *Clarias batrachus* and the potential for replacing animal protein with soybean meal in the feeds of fish need more evaluation along with synergistic effects of growth promoter like glucosamine. Results indicate that animal protein rich feeds with glucosamine were much acceptable than natural feeds for Asian catfish, *Clarias batrachus*.

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Table 5 - Growth performance, nutrient utilization in *Clarias batrachus* fry reared for 12 weeks

Items / Feed	Dietary Glucosa-mine	Animal : Plant Protein Ratio	In wt (g)	4th week wt. gain % (up to 4 wk)	8th week wt. gain % (up to 8 wk)	12th week wt. gain % (up to12 wk)	FCR%	SGR%	PER %	Feed Intake (mg)	Protein Intake (mg)
F1	0.5	100:0	0.24±0.07^{a}	16.6±1.2^{a}	20.8±1.3^{a}	58.3± 4.7^{a}	2.4±2.0^{a}	69.11	1.31±0.04^{a}	342±20^{a}	106±4^{a}
F2	5.0	100:0	0.23±0.02^{a}	-8.7±0.9^{b}	60.8±4.5^{b}	143.5± 8.3^{b}	1.9±0.1^{b}	170.5	1.75±0.03^{b}	600±31^{b}	187.6±11^{b}
F3	10.0	100:0	0.23±0.01^{a}	34.78±3.1^{c}	60.6±3.1^{b}	100.1±7.6^{c}	1.9±0.2^{b}	118.8	1.74±0.05^{b}	420±18^{c}	130.9±8^{c}
F4	0.5	0:100	0.22±0.02^{a}	31.8± 2.1^{c}	50.0±4.1^{c}	31.0±2.7^{d}	2.4±0.03^{a}	36.64	0.94±0.01^{d}	170±10^{d}	73.9±5^{d}
F5	5.0	0:100	0.22±0.03^{a}	-9.1±1.3^{b}	18.1±2.0^{a}	40.8±3.2^{e}	2.1±0.1^{c}	48.30	1.03±0.04^{d}	201±20^{e}	87.0±6^{e}
F6	10.0	0:100	0.24±0.02^{a}	8.33±0.41^{d}	25.0±3.3^{d}	50.1±4.8^{f}	2.0±0.3^{c}	59.6	1.20±0.02^{a}	230±28^{f}	100.0±8^{a}
F7	-	-	0.22±0.01^{a}	31.7±1.8^{c}	50.6±2.7^{c}	36.4±2.8^{d}	1.6±0.2^{d}	43.07	-	129±11^{g}	-
	0.5	-	0.23±0.01^{a}	24.2±1.8^{d}	35.4±2.8^{e}		2.4±0.1^{a}	52.82	1.13±0.07^{d}	254±22.7^{d}	90.4±6.1^{e}
	5.0	-	0.22±0.03^{a}	-8.9±0.8^{b}	39.5±3.7^{e}	44.6±3.6^{e}	2.0±0.2^{c}	52.83	1.41±0.10^{a}	401±30.2^{d}	137.3±8.7^{c}
	10.0	-	0.24±0.02^{a}	21.5±2.5^{d}	42.8±2.9^{f}		1.95±0.3^{c}	52.80	1.48±0.11^{e}	325±21.6^{d}	115.4±8.2^{c}
Animal Protein 100 %	-	100:0	0.23±0.04^{a}	14.3±1.1^{a}	47.4±5.1^{c}	92.1±6.3^{c}	2.06±0.2^{c}	109.36	1.61±0.14^{d}	454±28.4^{d}	141.7±10.1^{c}
Plant protein %100	-	0:100	0.23 ± 0.03^{a}	10.3±0.9^{d}	31.0±2.2^{g}	75.2±4.1^{g}	2.2±0.1^{d}	89.25	1.06±0.08^{d}	203±13.1^{e}	86.9±6.7^{e}

Mean Values in same column with different superscript letters are significantly different (P <0.05). Values are mean ± SE of duplicate determinations (n=2); In = Initial weight of fish before feeding; SGR=Specific Growth Ratio; FCR = Feed Conversion Ratio; PER = Protein Efficiency Ratio. FI = Feed Intake; PI = Protein Intake

Table 6 - Whole body proximate composition (g.kg^{-1} DM) of *Clarias batrachus* fry fed feeds containing different proteins (animal or plant protein origin) for 12th week

Parameters (g.kg^{-1})	In W_t	F1	F2	F3	F4	F5	F6	F7(Control)
Moisture	72.2 ± 2.1^{a}	70.3 ± 2.0^{b}	70.8 ± 2.8^{b}	71.2 ± 2.2^{b}	70.8 ± 1.8^{b}	70.7 ± 2.7^{b}	73.1 ± 2.5^{a}	70.3 ± 1.9^{b}
Crude Fat	6.8 ± 0.3^{a}	8.7 ± 0.4^{b}	8.5 ± 0.3^{b}	8.3 ± 0.2^{b}	7.0 ± 0.5^{a}	6.9 ± 0.3^{a}	6.5 ± 0.2^{a}	7.2 ± 0.3^{c}
Crude Protein	56.3 ± 2.1^{a}	57.6 ± 2.9^{b}	59.7 ± 1.8^{c}	58.1 ± 2.6^{b}	56.2 ± 1.8^{a}	56.9 ± 2.9^{a}	56.0 ± 3.2^{a}	57.5 ± 2.4^{b}
Dry Matter	24.2 ± 1.5^{a}	26.1 ± 1.3^{b}	25.6 ± 1.2^{b}	25.8 ± 1.2^{b}	28.1 ± 1.7^{c}	27.5 ± 1.6^{c}	23.2 ± 1.1^{a}	26.9 ± 1.4^{b}

Mean Values in same column with different superscript letters are significantly different (P <0.05)

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The results suggest that the feeding habit of the fish with small crustaceans is met by the addition of glucosamine therefore, it is confirmed that glucosamine has impact on growth promotion in this fish. And the potential for replacing animal protein with soybean meal in the feeds of fish need more evaluation along with synergistic approach of incorporating glucosamine. Inclusion of plant protein blend affected growth performance and reduced growth performances and even not compensated by increased feed intake.

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INDUCED SPAWNING OF SILVER CARP, *Hypophthalmichthys molitrix* USING HORMONES/HORMONAL ANALOGUE WITH DOPAMINE ANTAGONISTS

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ABSTRACT: *A study was made to investigate the effects of using carp pituitary extract, human chorionic gonadotropin, luteinizing hormone releasing hormone analogues (Receptal), with or without dopamine antagonists on the spawning performance parameters of silver carp. Results of the current study indicted successful induction of spawning silver carp using different spawning agents. The breeding response and fecundity were comparable among all treatment groups. Moreover, the current experiment clearly indicated that the use of hCG, or mammalian LHRH together with dopamine antagonists was more effective in induction of ovulation and increasing fecundity and hatching rate compared to the other spawning stimulators used in the current study. The results also demonstrated that using dopamine inhibitors potentiate the effect of the hormones used for spawning induction together with reduction of its dose (i.e. dose of carp pituitary extract, human chorionic gonadotropin). Meanwhile, it is well established that domperidone is preferred than metoclopramide as a dopamine antagonists for spawning induction of fish. In view of these results it is clear that not only carp pituitary extract and human chorionic gonadotropin but also the mammalian LHRH analogue (i.e. Receptal) was effective to induce spawning in silver carp. This is important in the view of the fact that mammalian LHRH analogues are available more widely and their price is much more attractive. This would result in cost reduction of induced breeding by using mammalian LHRH analogues in combination with a dopamine antagonist or alone.*

Key words: *Silver carp, induced spawning, human chorionic gonadotropin, luteinizing hormone releasing hormone analogues, dopamine antagonists.*

ORIGINAL ARTICLE

INTRODUCTION

Aquaculture has been known in Egypt since the beginning of written history; tomb friezes date back to 2500 B.C. and illustrate the harvest of tilapia from ponds (Bardach et al, 1972). Modern aquaculture began in the mid-1930s

hormone releasing hormone (LHRH) analogues with dopamine antagonists (e.g., Ovopel, Ovaprim,Dagin, or following the introduction of the common carp at two research farms, from then until the early 1960s; the carp was kept purely for research purposes. With the introduction of modern commercial aquaculture in the late 1970s and early 1980s, Egypt built four carp hatcheries and imported brood stock fish from ex Germany Democratic Republic and Hungary.

Hypophthalmichthys molitrix (Valenciennes, 1844) matures within three years and spawns preferably during mid May to June (Naeem et al., 2005). It is fresh water, omnivorous fish (Williamson and Garvey, 2005). Induced breeding of captive fish may be approached in two ways, hormonal and environmental (Marte, 1989). Artificial reproduction has been one of the bottlenecks because it has not been possible to reproduce wild cyprinids in hatchery conditions without hormonal stimulation (Krejszeff et al., 2008; Kucharczyk et al., 2008; Targońska et al., 2008; Żarski et al., 2009). For this reason, many hormonal treatments such as carp pituitary homogenate (CPE), human chorionic gonadotropin (hCG) or different luteinizing Kabarelin) have been used for stimulation of gamete maturation in commercial cyprinid culture (Kucharczyk et al., 2005, 2008; Brzuska, 2005, 2006; Krejszeff et al., 2008, 2009).

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Hypophysation (use of Carp Pituitary Extract (CPE) to induce ovulation) for spawning induction in fish have been employed in aquaculture since 1930 (Yaron et al., 1999). However, failures have been frequently encountered. This led to the development of new approaches in inducing spawning in cyprinid fishes. Human chorionic gonadotropin (hCG) received some attention as a substitute for pituitary, but has met with little success, excepting in the breeding of silver carp (Chondar, 1985; Chondar, 1990). However, the use of fish pituitaries or human chorionic gonadotropin (hCG) is now limited, owing to inconsistent results, as within 2-3 years, these fish fail to ovulate in response to hCG or carp pituitary extract, making it necessary for fish farmers to continually grow large numbers of female silver carp as brooders (Lin, personal observations, 1986 citted in Kraak et al., 1989).

Accordingly, number of studies conducted in breeding various species of cultured fish in China with LH-RH analogues led to the development of "Linpe method" (Peter et al., 1988). In this approach of induced spawning different LH-RH form and their analogues stimulating endogenous GtH release from the pituitary are used with dopamine receptor antagonist that potentiates the response to the peptide (Zohar and Mylonas, 2001). Currently, emphasis is laid on standardization and reduction of cost of induced breeding by using gonadotropin-releasing hormone (GnRH or LHRH) and their analogues in combination with a dopamine antagonist or alone.

In Egypt the governmental hatcheries are the main source of carp larvae. However the production of these hatcheries become inefficient for meeting the increased demand of silver carp seeds needed for cage and pond culture in the last five years. This, in turn had forced the private sector to make investment in commercial hatcheries for artificial propagation of silver carp.

Therefore, the aim of this study is to investigate the effects of using CPE, hCG and GnRH or LH-RH analogues with or without dopamine antagonists on the spawning performance parameters of silver carp. The possible reduction of carp pituitary dose or other hormone preparations through using dopamine antagonists was also investigated.

MATERIALS AND METHODS

Experimental fish and location

The experiment was conducted on female silver carp *(Hypophthalmichthys molitrix val)* collected from brood stock ponds in carp hatchery complex located at Fowa City, Kafr El-Shaikh governorate, Egypt prior to the breeding season (May, 2007). The brood fish were reared following routine brood husbandry as reported by Jhingran and Pullin (1985).

Experiment protocol

When the temperature reached 20:24°C, fully matured silver carp females (average body weight: 3 to 6kg) and males were selected based on the external secondary sexual characters (Jhingran and Pullin, 1985). Brood fish were randomly divided into eight groups (G_1:G_8) each comprising of four ripe female broods except for groups (G_3,G_7 and G_8) that consisted of 3 fish due to limited number of appropriate ripe fish. The selected males and females were transferred in fiber glass tank filled with water to the hatchery where they were kept undisturbed 3hrs in cycloid steel tanks. The brooders were weighed to estimate the number of pituitary glands needed and amount of hormone and other drugs required for injection.

Preparation of the pituitary gland extracts PCE

The CPE used in this study was prepared from the pituitary glands of adult carps (1-3kg) collected in the pre-spawning season before the beginning of the experiments. Pituitaries were conserved in acetone and were stored as a powder at 4°C. Dry pituitary glands were weighed then grinded in a mortar into powder form. To each g powdered pituitary 10 ml of normal saline (0.7 %) was added. The suspension was centrifuged at 3000 r.p.m then the supernatant was used for fish injection.

Hormone and drugs preparation

Human chorionic gonadotropin hCG (5000 I.U/ml) (Organon Company).

Receptal: each 1 ml contains 0.004 mg Buserelin (Luteinizing Hormone-Releasing Hormone Analogue) Intervet Egypt (S.A.E).

Domperidone (DOM): each 1 ml contains 1mg Domperidone, Glaxo Smithkline Company (GSK).

Metoclopramide: each 1 ml contains 5mg Metoclopramide, SEDICO Company.

Hormone injection

Brood fish were sedated using MS 222 at a dilution of 1:10000 (1g/100 liter water). All brood fish females received two injections of different combinations of CPE, hCG, LHRH analogues and dopamine antagonists (DA) (Table 1). On the other hand brood fish males received one injection of CPE 2h before the time of the second injection of females at a rate of 2 glands/male. Injection was made intramusculary (IM) into the dorsolateral region under the base of the dorsal fin by using hypodermic syringe after cleaning the area with cotton swab soaked in alcohol.

Stripping

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Six hours after final injection the bottom of the fish tanks was checked regularly for the presence of released eggs, which indicated the approximate spawning time. Once eggs were identified in the tank (Drori et al., 1994; Brzuska, 2004), fish were examined every 30 minutes and ovulated fish were anesthetized and stripped by slight pressure on abdominal region. The males were caught from the cycloid steel fish tank and milt was squeezed-out of the males into fertilizing solution. Ovulated eggs were manually stripped from the female and collected in dry plastic vessels. All eggs were immediately weighed and samples were taken to determine the number of eggs per gram and the total number of eggs per female. The eggs of each fish were weighed and fertilized by a mixture of sperm collected from two hormonally induced males. Continuous stirring was performed while adding fertilizing solution every 3 minutes until complete fertilization occur within 15 minute.

Table 1 - Hormonal doses used in different brood fish silver carp groups for spawning induction

Treatment	Dose	Number of fish
G_1: (CPE)[1]	• 1st dose (females) 3mg CPE /female. • 2nd dose 8hrs later 3.5mg CPE/female	4
G_2 : (CPE)[1] + (DOM)[2]	• 1st dose 3mg CPE /female + 1mg DOM. • 2nd dose 8hrs later 1.5 mg CPE /kg +0.5mg DOM	4
G_3: (CPE)[1] + (MET)[3]	• 1st dose 3mg CPE /female + 5mg MET • 2nd dose 8 hrs later 1.5mg CPE /kg + 2.5mg MET	3
G_4: (hCG)[4]	• 1st dose 250:300 IU/Kg. • 2nd dose 12 hr later 1500:1800 IU/Kg.	4
G_5: (hCG)[4]+ (DOM)[2]	• 1st dose 250:300 IU hCG/kg + 1mg DOM • 2nd dose 750:800 IU /kg hCG+ 0.5mg DOM	4
G_6: (hCG)[4]+ (MET)[3]	• 1st dose 250:300 IU/Kg + 5mg MET • 2nd dose 750:800 IU/hCG+ 2.5mg MET	4
G_7:Buserelin (LHRHa)[5]	• 1st dose 1ml (0.004mg) Buserelin /kg • 2nd dose 12h later 1ml Buserelin/kg	3
G_8:Buserelin (LHRHa)[5] + (DOM)[2]	• 1st dose 1ml Buserelin /kg + 1mg DOM • 2nd dose 12h later 1ml Buserelin/Kg +0.5mg DOM	3

1. Carp pituitary extract; 2. Domperidone; 3. Metoclopramide; 4. Human chorionic gonadotropin; 5. Luteinizing hormone releasing hormone analogue.

Incubation of fertilized eggs

In Fowa Governmental Artificial Hatchery the German System is used (System of Glass Aquaria). At first glass aquaria (150 X 50 X 50 cm^3) were treated with formalin diluted at the rate of 1: 10000 before incubation of eggs. Thereafter, the aquaria were supplied with water. Eggs were incubated in aquaria at the rate of 2 kg/aquarium. The water volume in each aquarium was about 235.5 liter with a water flow rate maintained at 1 liter /minute. There was an air pump tube under the surface of water in order to help in stirring of eggs. Water temperature during egg incubation was 20 - 24°C. Eggs for each aquarium were treated with formalin diluted at the rate of 1: 10000 every four hours

The fertilization and hatching successes were determined according to Rothbard (1981). Spawning success (the number of ovulated fish/total number of treated fish), the latency period (the time between treatment and ovulation) and practical fecundity (number of stripped egg kg^{-1} body weight before stripping) were calculated according to Drori et al. (1994) and Szabó et al. (2000).

Statistical analysis

One-way analysis of variance (ANOVA) was applied ~~used~~ using (Statistical analysis System (SAS) software (SAS Institute Cary, North Carolina, USA, 2004) to fulfill the requirement of the following statistical model:

$X_{ijk} = \mu + T_i + R_j + e_{ijk}$

X_{ijk} = observed value

μ = population mean

T_i = Effect of treatment i,

R_j = Effect of replicate j

e_{ijk} = random error

RESULTS

The results of the different trials on the induced spawning of silver carp with CPE, CPE+DOM, CPE+MET, hCG, hCG+DOM, hCG+MET, buserelin and buserelin+DOM are presented in Table 2.

The brood fish females of different treatment groups spawned completely, as indicated by the breeding response. However, no significant differences ($P > 0.05$) observed in the female fecundity among all of the treated

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brood fish groups. On the contrary, the female quantity of spawn/kg of female differed significantly ($P < 0.05$) among different treatment groups. Brood fish of G_6 and G_5 showed the highest level of fecundity however they were not significantly differed ($P > 0.05$) from G_1 G_2, G_3, G_4 and G_7. On the other hand, the fecundity of G_8 brood fish was significantly ($P < 0.05$) lower than the other treated brood fish groups. Similarly, G_5 and G_6 brood fish had the highest significant ($P < 0.05$) fertilization rate and hatching rate, whereas, G_1 brood fish was the lowest. Meanwhile the recorded fertilization rate of G_5, G_6 brood fish and hatching rate of G_5 brood fish was not significantly differed ($P > 0.05$) from those recorded for G_8 brood fish. Additionally, G_7 brood fish and G_8 brood fish had significantly higher latency period ($P < 0.05$) which was not significantly differed among the other brood fish groups.

Table 2 - (Means±SD) for the effect of different treatments on spawning parameters studied in silver carp.

Treatment	no. of fish spawned	Broodstock weight(kg)	Quantity of spawn (kg) produced / female	Total No. of eggs/kg female B.Wt	Fertilization rate (%)	Hatching rate (%)	Latency period (hours)
G_1: (CPE)[1]	4/4	4.50±1.29[a]	0.45±0.13[ab]	36872±11254[a]	86.50±1.29[d]	83.50±1.29[d]	7.50±0.58[c]
G_2 : (CPE)[1] + (DOM)[2]	4/4	5.00±1.47[a]	0.48±0.13[ab]	35602±13058[a]	89.50±1.00[c]	86.50±1.00[c]	7.50±0.58[c]
G_3: (CPE)[1] + (MET)[3]	3/3	4.83±0.58[a]	0.41±0.05[ab]	30008±3353[a]	90.66±1.15[bc]	87.00±1.00[c]	7.67±0.58[c]
G_4: (hCG)[4]	4/4	4.63±1.38[a]	0.45±0.13[ab]	36166±11815[a]	89.50±1.00[c]	86.25±1.26[c]	7.50±0.58[c]
G_5: (hCG)[4]+ (DOM)[2]	4/4	5.00±1.83[a]	0.50±0.18[a]	31004±8261[a]	92.50±0.58[a]	88.75±0.50[ab]	7.50±0.58[c]
G_6: (hCG)[4]+ (MET)[3]	4/4	5.38±0.48[a]	0.53±0.05[a]	33892±2918[a]	92.75±0.50[a]	89.25±0.96[a]	7.25±0.50[c]
G_7:Buserelin (LHRHa)[5]	3/3	4.00±0.5[a]	0.35±0.05[ab]	30667±3834[a]	90.00±0.00[bc]	86.00±1.00[c]	11.00±1.00[a]
G_8:Buserelin (LHRHa)[5] + (DOM)[2]	3/3	3.33±1.04[a]	0.32±0.08[b]	34798±9812[a]	91.33±1.15[ab]	87.33±0.58[bc]	10.00±0.00[b]

Means within the same column carrying different letters are significantly different at ($P < 0.05$). 1. Carp pituitary extract; 2. Domperidone; 3. Metoclopramide; 4. Human chorionic gonadotropin; 5. Luteinizing hormone releasing hormone analogue.

DISCUSSION

Results of the current study indicated successful induction of spawning of silver carp using different spawning agents; carp pituitary extract (CPE), human chorionic gonadotropin (hCG) or luteinizing hormone releasing hormone (LHRH) analogues with or without dopamine antagonist. These results are in agreements with the results obtained by several studies (Kucharczyk et al., 2005, 2008; Brzuska, 2006; Basavaraja et al., 2007; Krejszeff et al., 2008, 2009; Vazirzadeh et al. 2011). The breeding response and fecundity were comparable among all treatment groups. Similarly, Brzuska, (1999) failed to detect significant difference between LHRHa plus dopamine antagonist (Pimozide) or CPE silver carp treated fish in spawning index. Additionally, Brzuska and Bialowąs (2002) showed no significant effects of Ovopel (mammalian GnRHa+dopamine antagonist, Metoclopramide) or CPE on egg weights. Nevertheless, in another study, Brzuska (2003), however, found high statistically significant values of egg weight for fish treated with three different treatments: CPE, Ovopel and CPE plus Ovopel.

On the other hand, the addition of dopamine antagonists successfully increased fertilization rate and hatching rate on hCG+MET, hCG +DOM and Buserelin (LHRH) +DOM treated brood fish groups. *Aizen et al. (2005)* indicated that, the addition of some additives to hCG or CPE as a dopamine antagonist (DOM + GnRHa) causes the stimulator was more potent in inducing ovulation and spawning as compared to GnRHa alone or dopamine antagonist alone and this attributed to Dopaminergic inhibition is a major barrier along the reproductive axis that arrests spontaneous spawning. Similarly, simultaneous injection of pimozide (10 mg/kg) plus LHRH-A (100 pg/kg) caused a high rate of ovulation and the fertility of ovulated eggs (75% > was similar to that of the hCG spawned fish (Lin et al., 1987).

The higher spawning results due to using hCG+DOM may be attributed to that, Human Choronic Gonadotropin (hCG) is the most common purified Gonadotropin hormone used for induced spawning. hCG by-pass the brain–pituitary link, acting directly on the ovaries and testes (Rottmann, et al.,1991). Meanwhile, it is well established that DOM is the preferred DA for spawning induction of fish because DOM does not cross the blood-brain barrier (Omeljaniuk et al., 1987), and DOM can cause a long-lasting, dose-dependent depletion of dopamine in the pituitary (Sloley et al., 1991), which in turn my explain the success of spawning induction in this study with reduced doses of all the hormones used in combination with dopamine antagonists.

Concerning the latency period, all silver carp brood fish began spawning 7-12h after hormones injection with or without DA injection. These results are in agreement with the results obtained by other several studies irrespective of induced spawning of many cyprinids including silver carp (Ngamvongchon et al., 1988; Peter et al., 1988; Brzuska, 2006; Basavaraja et al., 2007; Makeyeva *et al*., 1996; Kłodzińska and Kozłowski 1991; Vazirzadeh

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et al., 2011). Additionally, The fact that the silver carp females yield eggs in a short time interval (in case of both LHRH-a and other hormones used in the current study) is very important on account of the short period in which the optimum spawning occurs in herbivorous fish at temperatures between 20 °C and 26 °C (Zonnenveld 1984; and Brzuska, 1999).

However, it seems to be worth stressing that the females of silver carp began spawning more than 9 h after the LHRH-a and pimozide injection at a temperature of 20-24°C. In the Linpe method (Peter et al., 1988), an equal latency of 8–12 h was recorded for these species of herbivorous fish at the temperature of 18–30°C, irrespective of the application of mammalian or salmon analogues. On the contrary, Ngamvongchon et al. (1988) and Makeyeva et al., (1996), recorded a latency time of more than 20h upon using LHRH-a analogue as ovulation stimulator in silver carp.

Conclusion

The results of this experiment indicated that injection of silver carp with using hCG, or mammalian LHRH together with dopamine inhibitors was more effective in induction of ovulation and increasing fecundity and hatching rate compared to the other spawning stimulators used in the current study. The results also demonstrated that using dopamine inhibitors potentiate the effect of the hormones used for spawning induction together with reduction of its dose (i.e. dose of carp pituitary extract, human chorionic gonadotropin). Meanwhile, it is well established that domperidone is preferred than metoclopramide as a dopamine antagonists for spawning induction of fish. In view of these results it was clear that not only carp pituitary extract and human chorionic gonadotropin but also the mammalian LHRH analogue (i.e. Receptal) was effective to induce spawning in silver carp. This is important in the view of the fact that mammalian analogues are available more widely and their price is much more attractive. This would result in cost reduction of induced breeding by using mammalian LHRH analogues in combination with a dopamine antagonist or alone

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COMPARATIVE UTILIZATION IMPACT OF VARIOUS DIETARY LIPIDS, ON GROWTH INDICES, IN STRIPED MURREL, *CHANNA STRIATUS* (BLOCH) FINGERLINGS

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ABSTRACT: *A 84-day feeding trial was conducted to evaluate the utilization impact of dietary omega–3 HUFA as a dietary energy source by fingerlings of striped murrel, Channa striatus on the growth study and tissue composition. There were seven treatments (L3HUF, H3HUF, MUSOL, LINOL, MIXOL, SATOL and NATFO), each having two replicates, stocked with 100 fingerlings in circular plastic pools (300l capacity). The six feeds were formulated with basic ingredients (Soybean meal, 41%; soluble starch, 25%; Casein, 20%; carboxy-methyl-cellulose, 2%; papain, 0.5%; vitamin and mineral mix, 3.5%) with iso-energetic (19.3 kJ/g, F1-F6) diets and results were compared with natural food fed fishes. The isocaloric diets were formulated from semi-purified ingredients with six different types of oil supplement which were fed to replicate groups of fishes ad libitum. Based on the protein efficiency ratio (PER), specific growth rate (SGR), average per day increment (PI) and food conversion ratio (FCR), and, it was observed that C. striatus fingerlings utilized dietary lipid. The LINOL showing best growth performance followed by H3HUF, MUSOL on the basis of SGR and PER were significantly (P<0.05) influenced in striped murrel, Channa striatus. But lower SGR levels were obtained with diets containing L3HUF, MIXOL, SATOL and NATFO. This study suggests that the lipid from unsaturated origins could be effectively utilized by striped murrel fry with a better resultant growth.*

ORIGINAL ARTICLE

Key words: *Lipid, utilization, growth, Channa striatus*

INTRODUCTION

The snakehead murrel, *Channa striatus,* is a promising species for aquaculture exploitation with its carnivorous feeding habits, air-breathing characteristics, rapid growth and good market potential. In terms of value-added, processed fish products, this species should have potential in Asian markets. Therefore, it is important to estimate the optimum lipid/Energy ratios in a oil (Omega-3 HUFA) and other alternative oils from plant origin for practical diets. Suitable alternative energy nutrients such as oilseed by-products are the most promising sources of lipid and energy for aqua-feed in the future (Hardy, 2000). The snakehead which is locally known as striped murrel is commonly distributed in Asia and African countries. It is now a popular farmed fish, preferred for its faster growth performance and delicate taste. However, farmers are facing problems in its commercial culture because of the absence of complete feed. There is some information available on its life cycle (Das, 1940; Parameswaran, 1975) but there is not sufficient data available about the dietary requirements of this fish except for scanty reports on protein requirements (Samantray and Mohanty, 1997; Haniffa and Arockiaraj, 1999a). Information on nutritional requirements of major dietary components such as protein and energy is a prerequisite for the formulation of an inexpensive and balanced diet for the fish. India have huge potential for the production of cheaper plant source e.g. deoiled cakes like linseed oil cake etc. rich in Essential Fatty Acid (EFA, Omega – 3 HUFA) which can be utilized as source of lipid in carnivorous fish nutrition. Recycling of these agro-based by-products, like mustard oil cake, linseed oil cake etc. can be used in place of animal origin oils as source of lipid and EFA. Thus, the fatty acid composition of these various ingredients of plant origin have a good source of HUFA which can be utilized for carnivore fish nutrition. These can be used in place of animal lipid source, and can be studied for the deposition of nutrients in

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terms of flesh. Sarowar et al. (2010) have studied the impacts of different diets on growth and survival of *Channa striatus* fry. Influence of dietary lipid/protein ratio requirement has been studied in *Channa striatus* (Aliyu-Paiko et al., 2010). The present study was taken up to evaluate the utilization impact of dietary lipids on the optimum growth by utilizing the various dietary lipids by the striped murrel, *C. striatus.*

MATERIALS AND METHODS

Experimental design

Six semi-purified experimental diets were formulated to be iso-energetic (19.3 kJ/g, F1-F6) diets. Weighed dry ingredients and some water were poured into a mixer and the resulting dough processed in a hand pelletizer to make 2 mm diameter pellets. Compounded feed pellets were dried in an oven at 60° C, packed separately and stored at -20° C until used during the feeding trial. The seven dietary treatments were designated as L3HUF, H3HUF, MUSOL, LINOL, MIXOL, SATOL AND NATFO containing lipid source @ 0.5% omega-3 fatty acid + 7.5% saturated oil; 1.0 % omega-3 fatty acid + 7.0% saturated oil; 8.0% mustard oil; 8.0% linseed oil; 4% mustard oil + 4.0% linseed oil; 8% saturated oil and natural food respectively. Table 1 gives the summary of ingredients used in the formulation of experimental diets and proximate composition of all dietary treatments.

Table 1 - Ingredients composition (w/w) of feeds for *Channa striatus*

Ingredients	F-1	F-2	F-3	F-4	F-5	F-6	F-7
	L3HUF	H3HUF	MUSOL	LINOL	MIXOL	SATOL	NATFO
Soybean meal	41.0	41.0	41.0	41.0	41.0	41.0	-
Starch Soluble	25.0	25.0	25.0	25.0	25.0	25.0	-
Casein	20.0	20.0	20.0	20.0	20.0	20.0	-
Carboxy Methyl Cellulose	2.0	2.0	2.0	2.0	2.0	2.0	-
Papain	0.5	0.5	0.5	0.5	0.5	0.5	-
Vitamin & Mineral Mix.	3.5	3.5	3.5	3.5	3.5	3.5	-
Omega–3 HUFA	0.5	1.0	-	-	-	-	-
Saturated Oil	7.5	7.0	-	-	-	8.0	-
Mustard Oil	-	-	8.0	-	4.0	-	-
Linseed Oil	-	-	-	8.0	4.0	-	-
Live Fish/Natural Food	-	-	-	-	-	-	100.0

L3HUF = Low Omega–3 HUFA; H3HUF = High Omega–3 HUFA; MUSOL = Mustard Oil; LINOL = Linseed Oil; MIXOL = Mixed Oil (Mustard Oil: Linseed Oil :: 1 : 1 w/w) ; SATOL = Saturated Oil; NATFO = Natural Food

Fish rearing and feeding trials

Channa striatus fry were hatchery bred at NBFGR, Lucknow and shifted to the wet laboratory in air-blower aerated, 300 l capacity plastic pools with two-thirds filled with water and covered with plastic covers. Fishes were acclimated to laboratory conditions in a 1000 l capacity FRP tank, feeding on post-larval crumbled pellets containing a minimum of 450 g per kg crude protein for one week. Fry (mean initial weight 0.54 ± 0.02 to 0.54 ± 0.03g) were randomly distributed into each of 14 plastic pools containing about 200 l of water. The fishes were fed twice a day at 1000 and 1700 hours *ad libitum* per day. Fish were weighed every 4 wk to determine the weight gain ratio for each plastic pool. The weighing of fish during and on termination of the experimentation was done as determines by Hasan et al. (1989). All pools were covered with plastic perforated covers throughout the experiment, to prevent fish from jumping out. Culture pools were cleaned every week and about half the water in the system changed to reduce the nitrogenous waste accumulated. Fishes were weighed individually at the beginning and end of the experiment, whereas batch weighing per tank was carried out once every 2 weeks to monitor growth performance alongside measuring feed consumption. At the end of the experiment after 12 weeks, surviving fish were randomly grouped into three per tank and used to determine body indices, intestinal lipase activity and carcass proximate composition.

Specific growth rate {[($\log_e$ final body weight-$\log_e$ initial body weight)/time] x 100}, food conversion ratio (dry food intake/live weight gain), protein efficiency ratio (live weight gain/protein intake), average daily gain (growth/experiment duration), survival rate [(initial no. of fish/final no. fish) x 100] and weight gain (%) {[(final weight - initial weight)/initial weight] x 100}. Variations in weight gain (%), SGR, FCR, PER after feeding of the test diets were analyzed by one-way ANOVA and Tukey's multiple range test and their mean differences by least significant differences (LSD).

RESULTS

During the feeding trial, the fish readily accepted the diets, and survival rates were 65% to 95%. The growth responses under different treatments are given in Table 2. Initial body weight of the various dietary groups did not

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vary significantly, but the performances were significantly different (P<0.05) in terms of weight gain, SGR, FCR, PER, PI and survival %. The weight gain was significantly different in LINOL, MUSOL and H3HUF (P<0.05) from the NATFO, SATOL and MIXOL. The specific growth rate (SGR) ranged between 5.38 to 7.52 %/day. There was no significant interaction between FCR and lipid contents and was not significantly different (P<0.05). The Protein efficiency ratio (PER) ranged between 1.02 ± 0.03 to 1.83 ± 0.07. The PER was significantly higher in LINOL (P<0.05) followed by MUSOL and L3HUF.

Table 2 - Initial and final weights and lengths, weight gain and percent weight gain of the *C. striatus* fingerling of different treatments during 84 days experimental period

Feed	In length (cm)	Fn length (cm)	In weight (g)	Fn weight (g)	length gain (cm)	Length gain %	Weight gain (g)	Weight Gain %
F1 (L3HUF)	4.2±0.1	10.30±0.10^{b}	0.54±0.03	5.85±0.05^{c,d}	6.1	145.2	5.31	983.3^{b}
F2 (H3HUF)	4.2±0.1	11.85±0.05^{a}	0.54±0.02	6.24±0.09^{b}	7.65	182.1	5.70	1055.5^{c}
F3 (MUSOL)	4.2±0.1	10.45±0.45^{b}	0.54±0.03	5.95±0.05^{c}	6.25	148.8	5.41	1001.8^{c}
F4 (LINOL)	4.2±0.1	12.15±0.15^{a}	0.54±0.03	6.86±0.03^{a}	7.95	189.2	6.31	1170.3^{c}
F5 (MIXOL)	4.2±0.1	9.80±0.10^{b}	0.54 0.03	5.74±0.04^{d,e}	5.60	133.3	5.20	962.9^{b}
F6 (SATOL)	4.2±0.1	9.75±0.15^{b,c}	0.54±0.02	5.57±0.02^{e}	5.55	132.1	5.03	931.4^{b}
F7 (NATFO)	4.2±0.1	9.10±0.10^{c}	0.54±0.02	5.06±0.03^{f}	4.90	116.6	4.52	837.0^{a}

Means in a given column having the same letter superscript are not significantly different at (p <0.05) by ANOVA and Duncan multiple range test

Table 3 - Average initial and final weight, specific growth rate (SGR), food conversion ratio (FCR), protein efficiency ratio (PER), per day increment (PI) and survival rate (%) of *C. striatus* fingerlings fed various experimental diets for 84 days

Feed	In weight (g)	Fn weight (g)	% of SGR /day	FCR	PER	PI (mg)	Survival (%)
F1 (L3HUF)	0.54±0.03	5.85±0.05^{c,d}	6.32	2.46	1.42±0.04^{b}	63.21	48^{b}
F2 (H3HUF)	0.54±0.02	6.24±0.09^{b}	6.78	2.48	1.55±0.09^{c}	67.85	54^{c}
F3 (MUSOL)	0.54±0.03	5.95±0.05^{c}	6.44	2.56	1.83±0.07^{d}	64.40	59^{c,d}
F4 (LINOL)	0.54±0.03	6.86±0.03^{a}	7.52	2.35	1.34±0.03^{b}	75.23	62^{d}
F5 (MIXOL)	0.54±0.03	5.74±0.04^{d,e}	6.19	2.53	1.07±0.02^{a}	61.90	45^{b}
F6 (SATOL)	0.54±0.02	5.57±0.02^{e}	5.98	2.55	1.11±0.01^{a}	59.88	43^{b}
F7 (NATFO)	0.54±0.02	5.06±0.03^{f}	5.38	2.54	1.02±0.03^{a}	53.80	40^{a}

Means in a given column having the same letter superscript are not significantly different at (p <0.05) by ANOVA and Duncan multiple range test

DISCUSSION

Fish in general utilize dietary lipid poorly. For instance, Furuichi and Yone (1980) noted depressed growth and feeding efficiency in red sea bream, *Pagrus major*, and common carp, *Cyprinus carpio* fed diets with high carbohydrate and low lipid contents. The optimum level of dietary nutrients should enhanced maximum growth and feed efficiency (Shiau, 1997) and so the decrease weight gain and the specific growth rate may due to higher energy content and high carbohydrate content in the diets (Page and Andrews, 1973; Daniels and Robinson 1986). An inverse relationship between growth and dietary energy was reported by Daniels and Robinson (1986) in juvenile red drum, *Sciaenops ocellatus*. Dietary carbohydrate levels of 12% and 20% are recommended for trout (Phillips et al., 1948) and Chinook salmon (Bubler and Halver, 1961), respectively. Habib et al., (1994) demonstrated that 30% carbohydrate level and low protein levels were well suited for silver barb, *Puntius gonionotus,* and 35% carbohydrates with low protein was well suited for *Heteropneustes fossilis* (Akand et al., 1991). Mollah and Allam (1990) reported that 15%-20% carbohydrate level was well suited for *Clarias batrachus.* In terms of protein efficiency ratio (PER), the protein is responsible for large part of the cost of most prepared feeds. The expensive protein fraction should therefore be optimally utilized for protein synthesis rather than for energy by the fish. Knowledge of the optimal level of protein and protein-sparing effects of non-protein nutrients such as lipids and carbohydrate can be used effectively in reducing feed costs (Shiau, 1997). Our PER value is comparable with the values of Daniels and Robinson (1986). Lin et al. (1997) reported that better SGR may have partly resulted from better carbohydrate and lipid utilization by snakehead fingerling feeding strategy and carbohydrate source. Furthermore, snakehead fingerlings tended to be fatter indicating that they may be able to better utilize lipids for growth. The better lipid utilization by snakehead fingerlings may be related to differences of their natural diets. The snakehead is carnivorous in nature (Parameswaran, 1975) and it mainly feeds on a carnivore diet containing some carbohydrates during the fingerling stages, mainly on zooplankton (Haniffa and Arockiaraj, 1999b), which contains little digestible lipid and carbohydrates. Our SGR values are comparable with that value of De Silva et al. (1989). Although the carcass protein, carbohydrate, and lipid contents increased after feeding the test diet, there was no appreciable change in body composition of the following treatments. Deposition of high lipid contents in the fish

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fed higher amounts of lipid may be due to the availability of sufficient energy in those diets (Habib et al., 1994). Fatty carcasses of fish at higher dietary lipid and carbohydrate levels were also reported by Wee and Ng (1986). Inversely, higher amounts of dietary carbohydrate usually retard growth (Austreng et al., 1977). The requirements of dietary lipid vary among different species according to their mode and habits of feeding. The carnivorous fish, *C. striatus,* needs a low amount (12%) of dietary carbohydrate for its maximum growth, whereas Habib et al. (1994) reported a comparatively high requirement of dietary carbohydrate (30%) for maximum growth in silver barb which may be due to its herbivorous nature. Herbivorous fish can metabolize carbohydrates better than carnivorous species (Shiemeno et al., 1979; Cowey and Sargent, 1979). Lin et al. (1997) reported that the capacity to utilize different lipid sources varies among fish species. Common carp, red sea bream (Furuichi and Yone, 1982), tilapia (Anderson et al., 1984), yellow tail (Furuichi et al., 1986) and channel catfish (Wilson and Poe, 1987) grew better when fed a lipid with enriched carbohydrate diet. On the other hand, there was no significant difference in net weight gain between lipid and starch fed white sturgeon (Hung et al., 1989). According to the researchers the *Channa spp.* did not intake the purified diets (Wee and Tacon, 1982; Qin et al., 1997). The best growth performance and feed utilization was gained in LINOL H3HUF, MUSOL and L3HUF groups and the decline in growth in the NATFO and SATOL and feed utilization with increasing dietary lipid above this level was observed in present study. Similar results have been reported in turbot (Cacerez-Martinez et al., 1984; Regost et al., 2001), salmon (Silverstein et al. 1999), rainbow trout (Weatherup et al., 1997), Carp (Murai et al., 1985). However, some reports showed no effect of dietary lipid on body weight gain in juvenile turbot (Danielssen and Hjertnes, 1993) and Atlantic halibut (Berge and Storebakken, 1991). Martino et al. (2002) reported in Surubim, a carnivorous freshwater fish in Brazil, that fish weight gain increased with dietary lipid from 60 to 180 g per kg. Although many species like salmonids, sea bass or rainbow trout, where a protein sparing effect of lipids has been well demonstrated (Lee and Putnam, 1973; Watanabe, 1982; Beamish and Medland, 1986; Dias et al., 1998), an increase in dietary lipid level from 40 to 120 g per kg does not appear to improve protein utilization in grass carp with no clear protein sparing effect of dietary lipid. Peres and Oliva-Teles (1999) believed this lack of protein sparing effect by dietary lipid may be related to the high protein level of the diet and according to Dias et al. (1998), the beneficial effects of an increase of the lipid level from 100 to 180 g per kg in sea bass diets were significant only with a low protein diet, but not with a high protein diet. But in the present study, although the dietary protein content was relatively high, when lipid level was below 40 g per kg, the protein utilization increased with the lipid level. This suggests, even in high protein diets, the protein sparing effect by lipid is possible within a low upper limit. This was further proved by the lowest protein retention in the lipid-free diet group. The significant decreased lipid retention with the increased dietary lipid levels, suggest an increased proportion of lipid used for energy. This agrees with Cho and Watanabe (1985) who observed in rainbow trout, that the highest lipid diet did not promote the highest lipid retention. Peres and Oliva-Teles (1999) also reported decreasing lipid retention when dietary lipid increased from 120 to 300 g per kg). Lipid utilization demonstrated by Akand et al. (1991) for stinging catfish, *H. fossilis,* by Hasan et al. (1989) for Asian catfish, *Clarias batrachus*, by Hasan et al. (1990) for Indian major carps and by Habib et al. (1994) for *Puntius gonionotus.* The relationship of body lipid content with protein and moisture contents is a common phenomenon in fish, and our results are comparable to those of Stansby and Olcott (1976). Based on the results of the present investigation, it is estimated that types of lipid effects on the growth performance of the fingerlings of *Channa striatus.*

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POSSIBILITIES OF USING MORINGA (*Moringa oleifera*) LEAF MEAL AS A PARTIAL SUBSTITUTE FOR FISHMEAL IN BROILER CHICKENS DIETS

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ABSTRACT: *A six-week feeding trial involving 180 2-week old Cobb broiler chicks was conducted to assess the effects of partial replacement of fishmeal with Moringa (Moringa oleifera) leaf meal on broiler chickens. The birds were randomly assigned in equal numbers in a Completely Randomized Design (CRD) to four dietary treatments containing 0, 5, 10, and 15% Moringa leaf meal (MLM). Each treatment was replicated three times giving 15 birds per replicate. Feed and water were supplied ad libitum. The parameters measured were feed intake, initial weight, final weight, weight gain, feed conversion efficiency, carcass traits, hematology, serum biochemistry and meat quality. Final weight, weight gain, feed conversion efficiency significantly (p<0.05) declined with increasing level of MLM. None of the carcass traits measured was significantly affected by addition of MLM. Mean Corpuscular Hemoglobin (MCH) was the only hematological parameter that showed significance (P<0.05) difference in treatment groups. Triglycerides, Low Density Lipoprotein (LDL) and Very Low Density Lipoprotein (VLDL) differed significantly (P<0.05). Also incorporation of MLM significantly (P<0.05) affected the moisture, crude protein and crude fat of the meat of experimental birds. Cost benefit analysis showed that incorporation of MLM resulted in reduced feed cost. However, the net revenue from birds fed diets containing MLM reduced as a result of poor weight gain. Based on the data obtained in this study it is concluded that Moringa oleifera leaf meal when partially used to replace fishmeal may hamper growth rate of broiler chickens. Nonetheless, addition of MLM does not adversely affect mortality, carcass traits and blood variables.*

Key words: *Moringa, Performance, Hematology, Serum biochemistry and Meat quality.*

ORIGINAL ARTICLE

INTRODUCTION

Feed costs amount to a considerable proportion of production cost in any intensive livestock production system (Ekenyem, 2001). It has been reported that, feed cost represents up to 60-80% of the total cost of broiler production (Teguia and Beynen, 2005). Fishmeal, a conventional feed resource, has been used as the source of animal protein in diets of poultry in many countries including Ghana due to unavailability of cheaper alternative protein sources. With the present trend of rising prices of feedstuffs, considerable attention has been placed on the search for non-conventional feedstuffs (Esmail, 2002).

The protein from leaves may be fed to poultry in the form of leaf protein concentrate (Farinu et al. 1992). For instance, leaf meals made from shrubs have been useful to small-scale farmers (WAC, 2006). Various leaf meals have been used in poultry diets, including those of leucaena (Udedibie and Igwe, 1989), Amaranthus (Frages et al., 1993), centrosema (Nworgu, 2004) and cassava (Ogbnna and Oredein, 1998). One such non-conventional feedstuff, which could be of value for poultry feeding, is the leaves of moringa.

Moringa (*Moringa oleifera*) is a rapidly-growing tree which was used by the ancient Romans, Greeks and Egyptians as animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), green manure (from leaves), gum (from tree trunks), honey (flower nectar), medicine (all plant parts), pulp (wood), rope (bark) and water purification (powdered seeds) (Fuglie, 1999). It is now widely cultivated and has become naturalized in many locations in the tropics. It is a perennial softwood tree and is being grown in West, East and South Africa, tropical Asia, Latin America, the Caribbean, Florida and the Pacific Islands. All parts of the Moringa tree are edible and have long been consumed by humans. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible

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protein, Ca, Fe, and carotenoids suitable for utilization in many developing regions of the world where undernourishment is a major concern (Oduro et al., 2008). Results of analyses by Oduro et al. (2008) revealed that moringa leaf meal contains 76.53, 27.51, 19.25, 7.13, 2.23, and 43.38% of Dry matter, crude protein, crude fibre, ash, ether extract and nitrogen free extract. A large number of reports on the nutritional qualities of Moringa now exist in literature (Fuglie, 2000). Because of the high protein content of the moringa leaf meal, it can be used to partially substitute fishmeal in poultry diets.

This experiment was therefore conducted to determine the effects of moringa leaf meal as a partial replacement for fishmeal on growth performance, carcass characteristics, hematology, serum biochemical parameters and meat quality of broiler chickens.

MATERIALS AND METHODS

Experimental diets and Preparation of Moringa leaves

Moringa *(Moringa oleifera)* leaves were harvested from an orchard near the College of Agriculture, University of Education, Winneba, Mampong Campus. The cut branches were spread out on a concrete floor and allowed to dry for a period of 3-4 days under room temperature. After drying, the leaves were separated from the twigs. They were then milled in a hammer mill to obtain the leaf meal (MLM).

Chemical Analysis of Moringa leaf meal and Experimental Diets

Samples of the MLM were subjected to proximate analysis according to AOAC (1990) methods (Table 3). The proximate composition of each experimental diet was also determined as above. Four iso-nitrogenous and iso-caloric experimental broiler diets were formulated and designated as MLM 0%, MLM 5%, MLM 10% and MLM 15% (Tables 1 and 2).

Experimental Design and Statistical Analysis

One hundred and eighty (180) Cobb broiler chicks procured at day-old from Darko Farms and Company, Kumasi, were initially brooded together for two weeks. At two weeks they were divided into four treatment groups with three replicate per each treatment, giving 15 birds per replicate in a Completely Randomized Design (CRD). Feed and water were provided *ad libitum* and all required managerial practices were the same for each treatment group. Daily feed intake and individual bird weights were recorded before and at the end of the experimental period. Daily weight gains and feed conversion efficiency were calculated. The data were analyzed using Statistical Analysis System (SAS, 1999). Multiple Range test was used to separate significant treatment means. Significance was accepted at 0.5 level probability.

Table 1 - Percentage Composition of Broiler Starter Diets

Ingredients	Level of dietary MLM (%)			
	MLM_0	MLM_5	MLM_{10}	MLM_{15}
Maize	58.00	58.00	58.00	58.00
Fish Meal (64% CP)	10.00	10.00	7.00	7.00
Fish Meal (52% CP)	7.00	2.00	2.00	2.00
Moringa leaf meal	0.00	5.00	10.00	15.00
Soybean meal	10.50	10.50	10.50	5.50
Wheat bran	12.00	12.00	10.00	10.00
Oyster shell	1.00	1.00	1.00	1.00
Vit/mineral premix	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50
Di-calcium phosphate	0.50	0.50	0.50	0.50
Proximate analysis % DM				
Crude protein	20..92	20..07	20.37	20.63
Crude fibre	3.33	4.23	4.77	5.64
Ether extract	4.24	3.89	3.64	3.68
Ash	12.33	13.54	13.86	14.09
NFE	59.18	58.27	57.36	55.96
Calculated composition (%)				
Calcium	1.04	0.98	1.02	1.14
Available phosphorus	0.70	0.60	0.54	0.53
Lysine	1.38	1.19	1.02	0.86
Methionine	0.44	0.37	0.31	0.28
ME (kcal/kg)	2750.00	2722.00	2708.00	2730.00

*Composition of vitamin/mineral premix per kg: Vitamin E, 25mg; Vitamin A, 6250 IU; Vitamin D3, 1250 IU; Vitamin K3, 25mg; Vitamin B1, 25mg; Vitamin B2, 60mg; Vitamin B6, 40mg; Vitamin B12, 2mg; Elemental calcium, 25mg; Elemental phosphorus, 9mg; Elemental magnesium, 300mg; Iron, 400mg; Selenium 1.0mg, Iodine 20mg, Copper 60mg, Magnesium 100mg, cobalt 10mg, Zink, 150mg; Sodium Chloride, 1.5mg; Choline Chloride, 500mg; Live Lactobaccillus spore, 0.2 million cfu; Niacin, 40mg; Folic Acid, 10mg; d-Biotin, 5mcg.

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Table 2 - Percentage Composition of Broiler Finisher Diets

Ingredients	Level of dietary MLM (%)			
	MLM_0	MLM_5	MLM_{10}	MLM_{15}
Maize	60.00	60.00	60.00	60.00
Fish Meal (64% CP)	6.00	6.00	6.00	6.00
Fish Meal (52% CP)	6.00	4.00	4.00	4.00
Moringa leaf meal	0.00	5.00	10.00	15.00
Soybean meal	13.00	10.00	5.00	2.00
Wheat bran	12.00	12.00	10.00	10.00
Oyster shell	1.00	1.00	1.00	1.00
Vit/mineral premix	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50
Di-calcium phosphate	1.00	1.00	1.00	1.00
Proximate analysis % DM				
Crude protein	18.73	18.59	18.06	18.88
Crude fibre	3.11	4.00	4.68	5.58
Ether extract	3.89	3.78	3.73	3.80
Ash	13.24	14.38	14.54	14.97
NFE	59.03	59.25	58.99	56.77
Calculated composition (%)				
Calcium	1.02	1.08	1.18	1.30
Available phosphorus	0.64	0.59	0.55	0.55
Lysine	1.22	1.04	0.87	0.77
Methionine	0.36	0.32	0.29	0.29
ME (kcal/kg)	2749.00	2767.00	2698.00	2709.00

*Composition of vitamin/mineral premix per kg: Vitamin E, 25mg; Vitamin A, 6250 IU; Vitamin D3, 1250 IU; Vitamin K3, 25mg; Vitamin B1, 25mg; Vitamin B2, 60mg; Vitamin B6, 40mg; Vitamin B12, 2mg; Elemental calcium, 25mg; Elemental phosphorus, 9mg; Elemental magnesium, 300mg; Iron, 400mg; Selenium 1.0mg, Iodine 20mg, Copper 60mg, Magnesium 100mg, cobalt 10mg, Zink, 150mg; Sodium Chloride, 1.5mg; Choline Chloride, 500mg; Live Lactobaccillus spore, 0.2 million cfu; Niacin, 40mg; Folic Acid, 10mg; d-Biotin, 5mcg.

Hematology and Serum Biochemistry Analysis

Blood samples were obtained from two birds per replicate making a total of six per treatment at the eighth week by inserting a new sterile needle into the wing vein of the birds and extracting 2 mls of blood which was placed inside sterile test tubes containing Ethylene Diamine Tetra Acetic Acid (EDTA). The blood samples were shaken to mix with the EDTA in order to prevent coagulation. The samples were then analyzed for Red Blood Cells (RBC), Packed Cell Volume (PCV), Hemoglobin (Hb) and White Blood Cells (WBC) using the Abbott Diagnostics Cell Dyn 3500 (Abbott Diagnostics, Abbott Park, IL) automated hematology analyzer. Again, blood samples were obtained from each bird by the same procedure mentioned above and drawn into vacuumed capillary tubes to determine the blood cholesterol, triglyceride, High-density Lipoprotein (HDL), Low-density Lipoprotein (LDL) levels, coronary risk, total protein and glucose. After coagulation, blood samples were centrifuged and then serum was collected for analysis. Serum biochemistry was determined by using Cobas integral 400 plus chemistry analyzer manufactured by Roche Diagnostics Ltd., Switzerland.

Carcass Evaluation and Chemical Analysis of Meat Yield

At the end of the experiment, two birds were randomly selected from each replicate. They were weighed and killed. The birds were killed by severing the carotic arteries. The birds were bled and immersed in hot water for 5 minutes to loosen feathers. The defeathered carcass was weighed. After dressing, the following weights were taken: carcass weight, dressed weight, gizzard, liver, heart, neck, shanks, and intestine. The crude protein, crude fat and ash composition of thigh meat was also determined using the methods of AOAC (1990).

RESULTS AND DISCUSSION

Results of proximate analysis of moringa leaves are presented in Table 3. The summarized results of performance of birds are also presented in Table 4. The final body weight (FBW), mean body weight gain, feed conversion efficiency declined significantly ($P<0.05$) with the dietary inclusion of MLM. Olugbemi et al. (2010) also reported a decline in final weight and weight gain with increasing level in diet when they included moringa leaf meal in cassava based diets. Nevertheless, Du et al. (2007) observed no significant depression in growth performance of 3 weeks old broilers (Arbor Acres) that were fed on diets substituted with 0.5, 1.0, 2.0 and 3.0% levels of *M. oleifera* leaf meal. Also, Atuahene et al. (2008) reported no significant effect of diets containing moringa leaf meal at 0%, 2.5%, 5%, and 7.5% levels on feed intake of broiler chickens. But the effect of inclusion of moringa leaf meal on feed conversion efficiency (FCE) recorded in their study was different from what was observed

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in this work. In their study, FCE was highest for birds fed diets containing 750g/100kg moringa leaf meal and declined as the proportion of it in the diet decreased. Ash et al. (1992) have observed that inclusion of leaf meals in broiler diets above 5-10% resulted in depressed performance as was observed in this study. The health condition of experimental birds observed during the experimental period did not seem to have been affected by inclusion of MLM in diets. Du et al. (2007) reported that dietary supplementation of *M. oleifera* may increase immune ability of broilers. Apart from Mean Corpuscular Hemoglobin (MCH), all the other hematological indices were not significantly affected, indicating that the diets were nutritionally adequate to meet the nutrient needs of the birds. Birds fed 10 and 15% MLM-based diets rather recorded the lowest MCH whiles their counterparts on control and 5% MLM-based diets recorded the highest. Yellow coloration of body parts such as shanks and beak was observed. This could be attributed to the presence of xanthophylls and carotenoid pigments in MLM.

Table 3 - Proximate Composition of MLM (%)

Proximate fraction	%
Dry Matter	92.21
Crude protein	25.56
Crude fibre	16.45
Ash	7.41
Ether extract	3.33
Nitrogen free extract	47.25

Table 4 - Effect of MLM on Performance of Broiler Chickens (mean ± standard error)

Variable	Level of dietary MLM (%)			
	0% MLM	5% MLM	10% MLM	15% MLM
Mean Initial Body Weight (g)	260±0.00	260±0.00	260±0.00	260±0.00
Mean Final Body Weight (g)	2173± 23.76 [a]	1860± 1.00 [a]	1880± 43.00 [a]	1460± 90.00 [b]
Mean Total Body Weight Gain (g)	1913±37.12[a]	1600±1.00[a]	1620±50.33[a]	1200±94.52 [b]
Mean Daily Weight Gain	46.33±0.67[a]	39.33±2.67[b]	39.66±1.33[b]	29.27±2.27[c]
Mean Feed Intake (g)	125.43±0.97	137.53±7.72	124.50±0.76	125.70±4.43
FCE (Feed/Gain)	2.67±0.07[a]	3.53±0.12 [b]	3.17±0.07 [b]	4.33±0.18 [c]
Mortality (%)(GH₵)	0.00±0.00	2.22±2.22	0.00±0.00	2.22±2.23
Feed cost/kg diet (GH₵)	1.08	1.05	0.89	0.86
Feed cost/bird (GH₵)	5.46	5.88	5.04	5.46
Price/bird at 8 weeks (wt/kg) (GH₵)	6.00	6.00	6.00	6.00
Value/ bird (GH₵)	13.04	11.16	11.28	8.76
Net revenue/bird (GH₵)	7.04	5.16	6.24	3.30

[a,b,c,d]: Treatment means with different superscripts within the same row are significantly different at P<0.05; SEM = Standard error of mean; NOTE: US$ 1.0 = GH₵ 1.5

Table 5 - Effect of MLM Meal on Organ Weights of Broiler Chickens (mean ± standard error)

Variable	Level of dietary MLM (%)			
	0% MLM	5% MLM	10% MLM	15% MLM
Dressed Weight (g)	1444.00±23.67	1455.00±35.00	1433.00±9.00	1376.00±48.67
Dressing Percentage (%)	81.17±1.40	79.70±0.85	80.03±0.90	81.80±0.48
Carcass weight (g)	1179.33±19.67	1825.67±12.33	1791.67±29.33	1684.33±77.67
Liver	81.33±5.33	85.00±9.00	94.00±5.00	91.67±3.33
Kidney	1.00±0.00	1.00±0.00	1.00±0.00	1.00±0.00
Heart	7.67±0.67	10.00±1.00	8.67±0.67	9.33±0.33
Full crop	11.00±0.00	11.67±2.67	12.33±1.67	11.00±0.00
Empty crop	9.67±0.67	9.67±0.66	11.67±1.33	10.33±0.33
Full proventriculus	9.33±0.33	9.33±0.33	9.33±0.67	8.66±0.67
Empty proventriculus	9.33±0.33	8.67±0.67	8.67±0.33	8.33±0.33
Full gizzard	54.00±0.00	57.67±0.33	60.67±7.33	55.33±1.33
Empty gizzard	40.00±0.00	39.67±0.33	40.33±3.67	39.67±1.33
Small intestine:				
Full	126.00±6.00	137.00±10.00	137.00±13.67	120.67±13.67
Empty	69.33±1.67	68.67±1.00	68.67±1.33	70.00±1.00

[a,b,c,d]: Treatment means with different superscripts within the same row are significantly different at P<0.05; SEM = Standard error of mean

Table 6 - Effect of MLM Meal on Meat Quality (mean ± standard error)

Variable	Level of dietary MLM Meal (%)			
	0% MLM	5% MLM	10% MLM	15% MLM
Moisture	74.67±0.003[a]	30.90±0.003[b]	72.36± 0.003[c]	68.06±0.003[d]
Crude Protein	77.66±0.33[a]	70.06±0.03[b]	70.06±0.03[b]	62.13±0.03[c]
Crude Fat	22.53±0.3[a]	31.53±0.03[b]	30.50±0.003[c]	34.50±0.003[d]

[a,b,c,d]: Treatment means with different superscripts within the same row are significantly different at P<0.05; SEM = Standard error of mean

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Triglycerides, VLDL and LDL values in blood serum of broilers were significantly different in treatment groups (P<0.05), however, total cholesterol, HDL-Cholesterol, coronary risk, total protein and glucose values were not found to be significantly (P<0.05) different (Table 9). A negative relationship between cholesterol and triglyceride values was also observed. The triglycerides and VLDL values of the groups fed with 5% MLM were the lowest. The cholesterol values of the group fed the control diets were the highest. In other studies, animals fed diets rich in cholesterol or saturated fat had elevated carcass cholesterol and blood cholesterol levels (Blanch and Grashorn, 1995). On the other hand, several researchers (Oayzdog˘an et al. 1996; Bachorik et al. 1991) have shown that low HDL and high LDL are values associated with atheroschlorosis.

None of the parameters measured for carcass characteristic (Table 5) was affected significantly (P>0.05) by inclusion of MLM. Incorporation of Moringa leaf meal in the diets however affected meat quality significantly (P<0.05). The moisture, crude protein and fat of the meats analyzed were significantly (P<0.05) affected by the dietary treatments (Table 6). The fat tended to increase as the level of MLM increased in the diets. Consumption of high levels of fat has been associated with high incidence of coronary heart diseases in humans (A.D.A.M., 2005). WHO (1990) recommended a reduced dietary fat intake. As the moisture content of the meat decreased, the fat content appeared to increase. Other researches on this subject support the negative relationship between carcass moisture and fat content (Mendes et al., 1995). Protein levels in meat reduced with increasing levels of MLM. The results of economic analysis (Table 4) indicated that the cost of feed reduced with increasing levels of MLM in the diets. Onibi et al. (2008) also reported a reduction in the cost of feed consumed at higher inclusion of leaf meals. However, the net revenue from birds dropped as the level of MLM in the diets increased. This could be attributed to the depressed weight gain recorded for birds fed these diets.

Table 7 - Effect of MLM on Blood Variables (mean ± standard error)

Parameter	Level of dietary MLM (%)			
	0% MLM	5% MLM	10% MLM	15% MLM
WBC ($x10^3/\mu L$)	12.87±0.02	12.52±0.03	12.65±0.02	12.76±0.54
RBC ($x10^6/\mu L$)	3.06±1.00	3.18±0.18	3.08±0.17	3.43±0.17
HGB (g/dL)	14.16±0.43	14.60±0.80	13.73±0.97	14.83±0.97
HCT (%)	36.30±1.10	37.10±2.20	35.13±0.73	37.93±1.87
MCV (fL)	123.60±2.6	124.09±2.09	123.88±1.92	124.43±2.00
MCH (pg)	46.30±0.10[a]	45.86±0.13[a]	44.07±0.67[b]	43.17±0.73[b]
MCHC (g/dL)	39.03±0.03	39.33±0.17	38.70±0.30	39.33±0.67
LYM (%)	73.73±2.03	41.43±20.72	49.53±24.77	68.33±0.33
GRAN	5.17±0.83	2.87±2.87	3.33±1.67	7.87±0.07
MID	21.10±1.20	8.07±8.07	13.8±0.90	23.80±0.40
RDW	10.8±0.20	9.90±0.30	11.10±0.70	11.27±0.47

[a,b,c,d]: Treatment means with different superscripts within the same row are significantly different at P<0.05; SEM = Standard error of mean

Table 8 - Effect of MLM on Blood Variables (mean ± standard error)

Parameter	Level of dietary MLM (%)			
	0% MLM	5% MLM	10% MLM	15% MLM
Total cholesterol (mmol/L)	3.04±0.19	2.73±0.44	2.52±0.27	2.49±0.17
Triglyceride (mmol/L)	1.14±0.14[a]	0.51±0.02[b]	1.20±0.17[a]	1.17±0.32[a]
HDL-Cholesterol (mmol/L)	2.40±0.10	2.04±0.32	1.92±0.30	1.83±0.33
LDL	0.13±0.03[a]	0.43±0.13[b]	0.03±0.03[a]	0.13±0.03[a]
Coronary Risk	1.30±0.00	1.30±0.00	1.33±0.07	1.33±0.07
VLDL	0.53±0.03[a]	0.20±0.00[b]	0.50±0.07[a]	0.53±0.17[a]
Total protein (g/L)	33.76±1.57	30.30±3.30	30.40±1.2	32.00±1.2
Glucose (mmol/L)	13.28±1.19	12.36±0.12	11.61±0.23	11.91±2.55

[a,b,c,d]: Treatment means with different superscripts within the same row are significantly different at P<0.05; SEM = Standard error of mean

CONCLUSION

From this study it can be concluded that *Moringa oleifera* when partially used to replace fishmeal may hamper growth rate of broiler chickens. However, inclusion of MLM at the levels used in this study may not have any adverse effect on health and carcass quality. Again it was observed that inclusion of MLM in diets led to a reduction in feed cost. The net revenue recorded for birds on diets containing MLM however reduced due to depressed weight gain.

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EVALUATION OF FALSE YAM (*Icacina oliviformis*) LEAVES ON THE GROWTH PERFORMANCE OF WEANER RABBITS (*Oryctolagus cuniculus*)

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ABSTRACT: *This study was conducted to determine the effect of Icacina oliviformis leaf meal (IOLM) on the growth performance of weaner rabbits. Twenty-one (21) weaner rabbits with an average initial weight of 661g were used in a completely randomized design. The feeding trial lasted for 56 days at the livestock unit of the University for Development studies. The chemical analysis was carried out at the Spanish Laboratory of the University for Development studies. The variables measured were feed intake, apparent nutrient digestibility and body weight gain. The average daily feed intake showed a significantly (P<0.05) higher intake for T2 (129.27g) compared with T0 (125.11g). Average daily body weight gain was significantly (P<0.05) higher for T0 (17.65g) compared to T2 (10.83g). However there was no significant difference (P>0.05) between T0 (17.65g) and T1 (13.33g).There was a significantly (P<0.05) higher crude protein digestibility for T0 (84.68%) compared to T1 (80.99%) and T2 (67.08%). Apparent digestibility for CP and EE decreased with increase in the level of IOL in the diet. Based on the results of this study, IOL can be used as a feed ingredient in the diet of rabbits at 5% without any detrimental effects.*

ORIGINAL ARTICLE

Key words: *Icacina oliviformis, Rabbits, performance, apparent digestibility*

INTRODUCTION

Rabbit production in developing countries is based on low cost feeding, using locally available feedstuffs (Mailafia et al., 2010). In developed countries where commercial rabbitary is on the lead, feeds are compounded to increase growth rate and to minimize labor requirements (Walsingham, 1972). However, in developing countries more important considerations would be to formulate cheap diets based on feedstuffs that are of little direct value as human food. If the rabbits are kept on a small scale, diets such as green succulent fodders can be fed with little costs. Current feeding practices vary widely in the tropics, depending on the types of feed materials that are available locally (Aduku and Olukosi, 1990)

Rabbits may be maintained solely on green feeds together with household vegetable waste. However, careful management and balancing of diets is necessary (Aduku and Olukosi, 1990). The two most common deficiencies encountered in such diets are of energy and protein rather than minerals or vitamins. Although the rabbit is by nature herbivorous, growth rates on forage based diets containing high fiber levels will be increasingly curtailed with increasing fiber level. This is due to the animal's inability to obtain sufficient digestible material to satisfy its energy demands. The nature of the fibrous components is also important; the greater the degree of lignifications, the greater the reduction in the digestibility.

Icacina oliviformis is an under exploited savannah shrub used for its edible seeds, tuberous roots, and fruit mesocarp in many areas of Africa. The large seeds provide a relied-upon resource in Senegal, Guinea-Bissau, and the Central African Republic at the end of the dry season when food reserves in the villages are at their lowest levels. The tuber sometime weighs over 50kg; provide a rich source of starch in times of famine (Fay, 1987). Fay, (1991), reported the following proximate composition for false yam seed and tuber; Seeds contains 80.7% nitrogen-free extract (NFE), 14.0% crude protein, and 0.5%crude fat (dry weight).The average moisture content of live seeds is 18.3%. The roots contain 84.5% NFE, 4.4% crude protein and 1.6% crude fat (dry weight). The leaves of *Icacina oliviformis* has not been exploited since the plant was discovered, hence no adequate information on the utilization of the leaf as feed for rabbits is documented.

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It is against this background that the study was conducted to investigate the effect of *Icacina oliviformis* leaf on the growth of weaner rabbits.

This experiment was aimed at determining effects of *Icacina oliviformis* leaf meal on intake and growth of weaner rabbits.

MATERIALS AND METHODS

Study area

The experiment was conducted at the livestock section of the Department of Animals Science, University for Development Studies, Nyankpala campus, Tamale. This location lies on latitude 9˚25'45'N and Longitude 0˚58'42'N at altitude 183m above sea level (SARI, 2001) which is generally described as a hot dry savannah zone. Rainfall is monomodal which occurs in April to October with the dry season setting in from November to March .The temperature of the area ranges between 19˚c (minimum) and 42˚c (maximum). The experiment lasted for 56 days from 5th October to 11th December 2010.

Source and processing of *Icacina oliviformis* Leaves

False yam (*Icacina oliviformis)* leaves were harvested manually from the wild in Nyankpala, succulent leaves were harvested and sun dried for eight hours. The dried leaves were milled with hammer grounding mill to a coarse texture. A top pan scale was used to weigh the milled leaves. The processed false yam leaves were bagged and stored for use.

Experimental Diet

Three experimental diets were formulated with inclusion levels of *Icacina oliviformis* leaves at 0%, 5% and 10%.The experimental diets were labeled T0(0%), T1(5%) and T2 (10%) respectively. T0 represents control diet and thus contained no IOL, while T1 contained 5% and T2 contained 10%. See Table 1 for the inclusion levels and chemical compositions of the different treatment diets.

Table 1 - Composition of experimental diets (%)

Ingredients	Levels of *Icacina oliviformis* leaf (IOL) in diets (%)		
	T0 (0%)	T1 (5%)	T2 (10%)
IOL	-	5	10
Soyabean meal	16	16	16
Sheanut cake	15	15	10
Brewers spent grain	68	63	63
Vitamin/mineral Premix*	0.25	0.25	0.25
Dicalcium	0.25	0.25	0.25
Salt	0.5	0.5	0.5
Analysed nutrient Composition (%)			
Dry matter	93.7±1.9	93.4±0.8	93.2±2.7
Crude protein	18.6±13.5	17.2±4.5	18.2±19
Ether Extract	6.9±0.5	7.7±9.6	7.0±0.1
Ash	9.9±1.4	9.9±0.7	9.9±1.4
Organic matter	83.8±1.9	83.4±0.8	83.2±2.7

* Premix composition (per kg of diet): vitamin A, 12,500 IU; vitamin D3, 2500 IU; vitamin E, 50.00mg; vitamin K3, 2.50mg; vitamin B1, 3.00mg; vitamin B2, 6.00mg; vitamin B6, 6.00mg; niacin, 40mg; calcium pantothenate, 10mg; biotin, 0.08mg; vitamin B12, 0.25mg; folic acid, 1.00mg; chlorine chloride,300mg; manganese, 100mg; iron, 50mg; zinc, 45mg; copper, 2.00mg; iodine, 1.55mg; cobalt, 0.25mg; selenium, 0.10mg; antioxidant, 200mg

Chemical Analysis of Experimental Diet

Samples of the FYLM and fecal matter were analyzed for their composition of crude protein (CP), Ether extract (EE), DM, and Ash. The analysis was done in the Spanish laboratory of the University for Development Studies. 200g of each treatment diet and fecal matter were weighed and dried in an oven for 48 hours at 60˚c. The weight after drying was used for computing the dry matter percentage.

Crude protein, ether extract and ash were determined according to the procedure of AOAC (2002). 10g of each treatment diet was collected ground and sieved to pass through 3mm sieve for the analysis of CP, E.E and Ash.

Experimental animals

Twenty one weaner rabbits were sourced from Kwame Nkrumah University of Science and Technology .They were brought into the farm which was already prepared for their arrival. On arrival they were given glucose in water to reduce stress, they were also fed with concentrates. Water was given *ad libitum*. Experimental animal were adjusted for one week on the experimental diet. Medication was given to animals when the need arose.

Experimental Design

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A 56 day feeding trial was conducted using a complete randomized design (CRD). The design consisted of three dietary treatments each replicated seven times. Each treatment had 3males and 4 females. The mean initial weights of the weaner rabbits was 661g. Animals were randomly assigned to the cages individually.

Management of rabbits

The rabbits were housed in wire mesh cages .Each raised 1m above the ground. The height of the hutch was 60cm at the front, 50cm at the back and width was 50cm-60cm.The Length was 90-120cm.water was provided *ad libitum*. Each cage was provided with an earthen were bowl for water and feed.

Data collection

The parameters of interest included feed intake, weight gain and apparent digestibility. The animals were given 200g of feed daily between 6:30am and 4:30pm. The left over feed was collected and weighed using a top pan scale. The growth pattern of the rabbits was determined by weighing each rabbit every week, early in morning before feeding, over a period of 56 days. Fecal droppings from each animal were collected for two weeks after one week of adjustment. 100g of each animal fecal matter was sub-sampled and used for the determination of apparent DM, CP,EE and Ash digestibility.

Data analysis

Data collected was analyzed using ANOVA from Genstat discovery editions. Means were separated using LSD. Results were presented in tables.

RESULTS AND DISCUSSION

Results from the experiment can be found in table 2 below. From table 2, final weight was significantly higher for T0 (989.0g) compared with T2 but was not significantly different from T1. It was observed from table 2 that daily weight gain and final weight decreased with increase in the level of IOL (T0>T1>T2). Daily weight gain was also significantly higher for T0 (17.65g) than T2 (10.83g). However there was no significant (P>0.005) difference between T0 and T1. According to Champe and Maurice (1983), rabbits require more than 9% crude fiber in feed for normal growth. Rabbits require some level of forage in their diet to enhance digestibility hence the use of *Icacina Oliviformis.* However the results rather showed a significantly lower weight gain as *Icacina Oliviformis* level increased in the diet. The results obtained could be attributed to the presence of some anti-nutritional factors (ATF) present in most browse plant such as *Icacina Oliviformis* (Robbins 1993 and Robins et al., 1995). These ATF's include phenolics and terpens which have been reported by Robbins (1993) and Robins et al. (1995) to be responsible for reduction in dry matter digestibility. Terpens according Villalba et al. (2006) decreased the concentration of Volatile fatty acids (VFA) in the caecum. These properties could have accounted for the significantly low weight gain recorded as the level of *Icacina Oliviformis* increased in the experimental diet. Dei and Adeti, (2010) reported a favorable results when boiled false yam tuber was fed to broiler. At 30g/kg inclusion, there was no significant different between the boiled tuber and raw tuber in the final weight. This suggests that further treatment of the leaves could have reduced the effect of the ATF's present in the IOL. The relatively low weight gain in T1 and T2 compared to the control could have been due to the poor utilization of the nutrients. Since the digestibility was low for T1 and T2, lower amounts of nutrients will be available thereby affecting its utilization for growth in the animals.

Table 2 - Performance and apparent nutrient digestibility of rabbits fed increasing levels of *Icacina oliviformis* leaf (IOL)

Parameters	Level of IOL in diet (%)			
	T0 (0%)	T1 (5%)	T2 (10%)	SED
Initial weight	703.0	644.0	639.0	61.1
Weight gain, g/day	17.65^{a}	13.33^{ab}	10.83^{b}	2.32
Feed intake, g/day	125.11^{b}	128.65^{a}	129.27^{a}	0.72
Final weight gain	989.0^{a}	746.0^{ab}	606.0^{b}	129.7
Gain/Feed	0.14^{a}	0.10^{ab}	0.08^{b}	0.02
Digestibility (%)				
Crude protein	84.68^{a}	80.99^{b}	67.08^{b}	0.42
Ether extract	48.6^{a}	40.9^{b}	32.3^{c}	3.18
Ash	50.21	50.00	50.14	0.17
Organic matter	64.05^{a}	62.23^{a}	45.09^{b}	1.11

$^{a,b,c:}$ Mean values in row with uncommon letters are significantly different at P<0.05

From Table 2 above, intake was significantly lower for T0 (125.11g/day) compared to T1 (128.65g/day) and T2 (129.27g/day). There was an increase in intake with increase in IOL. The trend observed could be attributed to high crude fiber present in the IOLM diet. High crude fiber levels have been reported by Wen-Shyg Chiou et al. (1998) to increase rate of passage in the digestive tract there by leading to a higher intake. Even though intake was high for T1 and T2, it did not correspond to an increase in weight gain. This could be due to the less time the feed stayed in the ileum as a result of the faster rate of passage. Nutrient absorption was reduced as a result.

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Apparent crude protein digestibility was significantly higher for T0 (84.68%) compared to T1 (80.99%) and T2 (67.08%). The trend was the same for organic matter and ether extract. Apparent nutrient digestibility decreased with increase in the level of IOL in the diet. This result disagrees with Ajayi et al. (2007) who reported an increase in apparent CP digestibility with increase in sun flower leaf meal mixture. The difference obtained in the current study could be due the IOL. This is an indication that different shrubs are digested differently by rabbits. The presence of terpens in IOL may have accounted for the low digestibility of the crude protein. The higher passage rate that may have been caused by the high fibre in the IOL could have also contributed to the low digestibility. The low apparent nutrient digestibility could have contributed to the lower body weight recorded in T1 and T2.

CONCLUSION AND RECOMMENDATION

Based on the results of this study, it can be concluded that, feeding IOL at 5% improved feed intake, digestibility and weight gain.

It is recommended that 5% IOL be included in the diet of rabbits.

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BIOSECURITY PRACTICES IN ALGERIAN POULTRY FARMS

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ABSTRACT: *The objective of this study was to determine the level of adoption within the Algerian poultry farms (broiler chickens, laying hens) of a range of standard biosecurity practices (isolation, traffic control, decontamination, vaccination…). Quantitative and qualitative evaluation of the biosecurity in the poultry houses has been analyzed thanks using method developed by the French Food Safety Agency. Factorial analysis has permitted to determine four classes of poultry farms. Class 1 and 2 (55%) regroup poultry farms very badly maintained, with breeders which do not respect the elementary hygiene measures (precarious buildings, impure water, non respect of the sanitary vacuum, badly disinfection, presence of contamination vectors, bad elimination loose chickens…). The two classes are a score between, 0 - 100 points and UFC (faecal streptococci) > 25. Class 3 and 4 regroup 45% of poultry farms and demonstrates that the number of faecal streptococci colonies/25 cm² is the lowers (3<UFC<9) and (10<UFC<25) respectively. In these farms, the sanitary teams apply very rigorous barriers of security and decontamination. Visual score attributed for these classes represents unfortunately score between, 100-200 points. The decline of production performances (mortality, feed conversion, and laying rate) especially observed in the poultry farms, class 1and 2, because of failings sanitary barriers in production period.*

ORIGINAL ARTICLE

Key words: *Algeria, biosecurity, poultry farms, production performances*

INTRODUCTION

The poultry production knows a real development since several years. Carried by the craze of the consumers for products of poultry origin, the production of broiler chicken and laying hens increased considerably due to the important investments granted by the private and public sectors.

However, the intensification of the poultry breeding does not evolve without problems. In fact, the majority of breeders do not master the application of the fundamental hygienic rules, which consequently favor the development of an unfavorable environment for the poultry, dragging the emergence of different pathologies. These last ones strike a blow at the profitability and at the quality of products. Sanitation measures, disinfection, vaccination and diagnostic control are great importance in diseases and pathogenic microflora control.

It is important to know the hygienic status in poultry houses, to identify points of risks that explain the continuity of pathological problems as for example the salmonellosis (WHO 1993, Nespeca et al 1997, Rose et al 2000) drag consequent economic losses of a high mortality rate in the breeding flock.

The objectives of this study is: 1) Quantitative evaluation of the biosecurity in the poultry houses by the systematic measures of the hygiene status due to the method developed by the French Food Safety Agency (Drouin and Toux, 2000). 2) Estimation of the effect hygienic status on production performances in poultry breeding.

MATERIALS AND METHODS

An investigation on 40 poultry farms realized in the East of Algeria. The passage in building made before the implementation of the breeding flock. For each breeding, a technical index card distributed to collect information (population density, vaccination, body weight, feed consumption, feed conversion, and rate of laying mortality, disinfection, rodent and pest control, and the period of sanitary vacuum…).

Poultry breeding concerned with this inquiry divides as follows 25 poultry farms of broiler chickens and 15 poultry farms of laying hens.

Bird's distribution in poultry houses vary between 5000-10.000 for broiler chickens and between10.000-30.000 for laying hens.

Quantitative and qualitative evaluation of the biosecurity in the poultry houses has been analyzed thanks using method developed by the French Food Safety Agency (AFSSA) (Drouin and Toux, 2000), which consists in making two operations:

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1-hygienogramme: method based on the visual control of poultry house after decontamination (pest control, rat extermination, cleaning and disinfection). A score between 0–200 points, is attributed to the poultry houses according to the quality of the decontamination and traffic control in the various places.

2-bacteriological control: 16 contact limps of 25 cm^2 (*fecal streptococci*) are used for each poultry house (640 bacteriological samples for 40 buildings). Takings are realized after the decontamination of buildings and concern the following places: the door, cages, carpet of droppings, ventilation circuit, feeding dishes, watering places, floor and the walls.

After an incubation of 36 hours, the reading of colonies (UFC/25cm^2) and results compared with the norms established by the AFSSA - CIDEF (Cable and Fargeas, 2000). All the data gathered in tables and a factorial analysis of multiple correspondences (AFCM) realized to determine different class of biosecurity (hygienic status, traffic control, sanitary barriers) in poultry farms. The differences were tested by analysis of variance (ANOVA), they are considered significant at $P < 0.05$.

RESULTS AND DISCUSSION

Factorial analysis of multiple correspondences associated to a hierarchical ascending classification has permitted to determine four classes of poultry farms.

Visual control of decontamination and traffic control are weak for most breeding (Fig. 1). On 40 poultry farms, only two (class 4 and 3) have a satisfactory biosecurity procedures, score (150- 00) and (100-150) respectively. In the other poultry farms, biosecurity procedures are considered insufficient and the score is lower than 150 points.

The qualification of the staff in methods of decontamination plays a very big role in the success of the fight against vectors and contaminants.

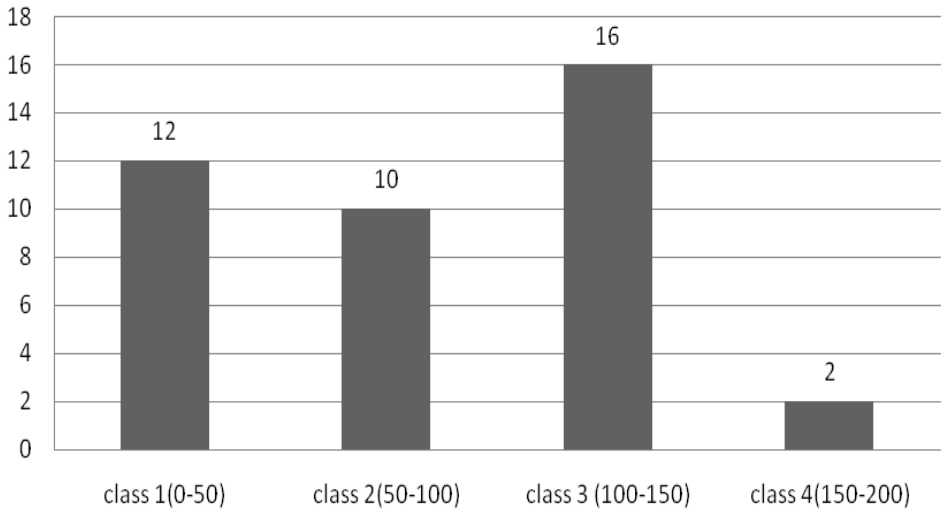

Figure 1. Visual score in poultry farms (n=40)

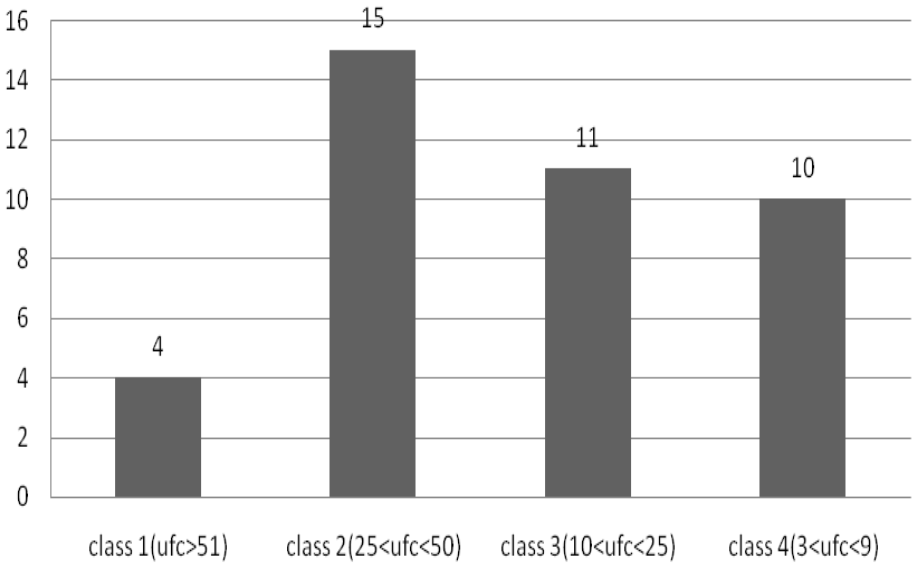

Figure 2. Bacteriological score in poultry farms (n=40)

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Bacteriological control (Fig. 2) revealed the following results in the different classes:

Class 4 regroups for the greater part poultry breeding and demonstrates that the number of *fecal streptococci* colonies is the weakest (3<UFC<9). In these farms, the sanitary teams apply very rigorous sanitary barriers. This class represents unfortunately that 25% of poultry farms.

Class 3 constituted partially by 27.5% poultry farms. Bacteriological score of the decontamination and traffic control can be considered as acceptable (10<UFC<25). In this group, breeders are much more aware by the problem of hygiene measures they strictly apply the orders of their veterinarian advice (medical prevention, rigorous decontamination, under floor space, access to the strictly regulated poultry houses).

Class 2 (25<UFC<50) and 1 (UFC>51) regroup breeding very badly maintained, with breeders which do not respect the elementary hygiene measures (absence of footbath, precarious buildings, non respect of the sanitary vacuum, auto medication, badly made disinfection, presence of contamination vectors, corpses of animals on the site..). These two classes represent 47.5 % of poultry farms.

The bad management of the cleaning, disinfection operation and the sanitary barriers failings in breeding period can be causes according to Drouin (1988) , Rokicki and Kolbuszewski (1996) and East (2007).

The breeders that respect the biosecurity measures obtain best performances in broiler farms (Table 1). Mortality rates are generally weak in breeding where hygienic status ranged in the class 3 and 4. Weight gain and feed conversion are slightly weak in badly maintained breeding. These results confirm studies made by the other authors, Drouin (1988) and Cardinal et al. (2001).

Laying hens performances (Table 2), notably the laying rate of and the egg mass are slightly more favorable in poultry farms where hygiene and traffic control are well-applied (class 4). The analysis of the variance allowed to confirm significant differences (P<0.05) especially between the classes of poultry farms for the mortality rate and the laying rate (class 2 and 4). The decline of performances especially observed in the poultry flock deprived because of the failings of the sanitary barriers in production period (Drouin et al., 2000; Valancony et al., 2001).

Table 1 - Performances in broiler farms (day 49)

Class	4	3	2	1	Total (n =25)
Feed conversion	2.46*	2.59	2.97*	2.70	2.68±0.18
weight (g)	1895*	1690	1700	1786*	1767±116
Mortality (%)	3.9	3.2	6.7*	7.9*	5.42±0.8

*Data in a row with no common superscript differ significantly P<0.05

Table 2 - Performances in laying hens farms

Class	4	3	2	1	Total (n =15)
Feed conversion	2.36	2.29	2.47*	2.60	2.43±0.02
Laying (%)	80*	78	81*	72	77.75±0.9
Egg mass (g)	63.23	60.10	62.54*	61.58	61.86±1.3
Mortality (%)	4.5*	4.92	3.96*	6.58	4.99±0.05

*Data in a row with no common superscript differ significantly P<0.05

CONCLUSION

Results of this study show that the biosecurity of poultry houses is below standards recommended by AFSSA (French Food Safety Agency). However, we note that some breeders apply the elementary hygiene measures, which allows obtaining good production performances. It is important to intensify preventive measures to limit the poultry environment microflora to a lower level, to limit his impact on the breeding production and poultry health.

The decontamination of poultry houses is a delicate operation. Is must be obligatory and regulated to avoid any contagion of the breeding flock. It must be also made by a qualified and competent team. The excellent efficacy of the decontamination of poultry houses can be mainly explained by using an HACCP team, supervision of cleanliness, a sanitation including all of buildings, equipment and approaches; moreover a biosecurity program to remove risk factors, was carried out. The sanitary responsible has to convince the breeders of the importance of hygiene measures and disease prevention in the fight against pathologies and the improvement of production performances.

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BIOCHEMICAL AND NON-SPECIFIC IMMUNE PARAMETERS OF HEALTHY NILE TILAPIA (*Oreochromis niloticus*), BLUE TILAPIA (*Oreochromis aureus*) AND THEIR INTERSPECIFIC HYBRID (*MALE O. aureus* × *FEMALE O. niloticus*) MAINTAINED IN SEMI-INTENSIVE CULTURE SYSTEM

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ABSTRACT: *Oreochromis niloticus, Oreochromis aureus and their interspecific hybrid tilapia (♂ O. aureus x ♀ O. niloticus) maintained under semi-intensive culture system were compared in a preliminary study to explore the variations in blood biochemical and non-specific immunological parameters. Comparisons were performed after one week of acclimation ("base-line" level). Serum cholesterol, albumin, SGPT and SGOT level were significantly higher (P<0.05) in the purebred O. aureus than the purebred O. niloticus and their crossbred hybrid. The tested genotypes showed insignificant difference (P>0.05) in total protein, globulin and urea. Additionally, the levels of ALP and uric acid were significantly higher (P<0.05) in both ♂O. aureus and the crossbred hybrid (♂O. aureus x ♀O. niloticus). On the other hand, the level of creatinine was significantly higher in the purebred O. niloticus followed by the crossbred hybrid and then the purebred O. aureus but still without a significant difference (P>0.05) between the latter two genotypes. The phagocytic activity and phagocytic index were significantly higher (P<0.05) in the crossbred hybrid (♂O. aureus x ♀O. niloticus) than the other purebred genotypes. The differences identified suggest that hybrid families from the two species would be used to construct a segregating population for genetic analysis of immunological traits in tilapia. But still, a larger sample size obtained from populations cultured under different managemental practices should be used and challenged to learn if the differences are large enough to produce a segregating population for genetic analysis of immunological traits and disease resistance.*

Key words: *Purebred, Oreochromis niloticus, Oreochromis aureus, inter-specific hybrid tilapia normal blood biochemical reference, phagocytic activity, phagocytic index.*

ORIGINAL ARTICLE

INTRODUCTION

Tilapia has become the shining star of aquaculture with farms starting and expanding across the globe while consumption races ahead of even the most ambitious farm building plans. In 2010, the world production of farmed tilapias reached 3.2 million metric tons (Fitzsimmons et al., 2011). .In North Africa, Egypt is the second largest producer of tilapia after China (FAO, 2009). The current trend in tilapia farming in Egypt is towards increased intensification of culture systems. Increases in stocking densities can make fish more susceptible to stress and disease which in turn cause severe losses of Tilapia stock. Unfortunately, there are few diagnostic tools available to veterinarians and fish health professionals to evaluate disease in fish. Many of the clinical tools used to evaluate mammalian health are not developed for use in fishes. As the aquaculture industry expands, there is an increasing need for improved diagnostic methods. Hematology and clinical chemistry analysis, although not used regularly in fish medicine, can provide substantial diagnostic information once reference values are established. Although tilapia are the second most frequently cultured fish in the world, there are surprisingly few reports of normal blood values. (Terao and Ogaw, 1984; Palti et al., 1999; Bittencourt et al., 2003; Cnaani et al., 2004; Chen et al., 2003; Mauel et al., 2007). Therefore; established species-specific normal reference values are necessary. Accordingly the

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present study aimed to determine some biochemical parameters and non-specific immune response in three genotypes of tilapia; *O. niloticus* and *O. aureus* and their interspecific hybrid (♀ *O. niloticus* x ♂ *O. aureus)* cultured under semi-intensive pond culture.

MATERIALS AND METHODS

Fish sampling

O. niloticus and *O. aureus* and their hybrid (♀ *O. niloticus* x ♂ *O. aureus*) fry were produced in early September 2008 from a mass spawning of brooders in earthen spawning ponds (Phelps and Popma 2000) in a private fish farm in Behara governorate. They were allowed to grow in deep nursery ponds throughout their nursery and winter period. Thereafter; the fingerlings of each genotype were allowed to grow (two growout ponds for each genotype) through the growing season (April-October 2009). During the course of their growout period sixty apparently healthy fish (170±15 g/fish) were randomly selected from the purebred species *O. niloticus* (n=20) and *O. aureus* (n=20) and 20 fish of their interspecific hybrid (♀ *O. niloticus* x ♂ *O. aureus*). The experimental fish were reared in 100L rectangular glass aquaria supplied with continuous flow of water. Fish were fed once a day at a feeding rate 3% of their body weight till the end of the experiment. Daily water temperature was recorded (23-25°C).

Blood analysis and immunological parameters

Each of the biochemical and immunological parameters recorded in this experiment was measured in blood samples taken after one week of acclimation period. Blood samples (n=20) were collected from each pure genotype and their crossbred hybrid. Fish were fasted for 24 h prior to blood sampling; blood was collected with a hypodermic syringe from the caudal vein. The withdrawn blood samples were pooled to obtain 10 samples for each genotype and divided in two sets of Eppendorf tubes. The first set (five pooled samples for each pure genotype and their hybrid) with anticoagulant (0.1 ml of 4% sodium citrate solution/1 ml blood) used for estimation of phagocytic activity and phagocytic index (Kawahara et al., 1991). The second set were left to clot at 4 °C and centrifuged at 3000 rpm for 15 minutes at room temperature. The collected serum used for determination of total protein (Doumas, 1994), albumin (Reinhold, 1988) using commercial kits produced by Pasteur Lab. Globulin was calculated by subtracting the albumin value from the total protein value of the same sample (Coles, 1998). Albumin/Globulin ratio (A/G) was calculated. Serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) were estimated according to Anderson and Chalman (1999) using commercial kits produced by Pasteur lab. Serum alkaline phosphatase (ALP) was estimated according to the modified method of Lied et al., (1989) using commercial kits produced by bioMerieux lab. Kidney function was monitored by estimation of some parameters including serum urea and serum creatinine (Crouch, 1997), serum uric acid (Fossatti and Prencipe, 1990). Serum total cholesterol was determined according to Allain (1998) using kits of Quimica Cinica Aplicada S.A. (QCA).

Statistical analysis

One-way analysis of variance (ANOVA) was used (Statistical analysis System SAS (SAS Institute Cary, North Carolina, USA, 2004) to fulfill the requirement of the statistical model:
$X_{ijk} = \mu + T_i + R_j + e_{ijkz}$; X_{ijk} = observed value; μ = population mean; T_i = Effect of treatment I; R_j = Effect of replicate j; e_{ijk} = random error

RESULTS

Measurements of serum components taken in the current study for purebred *O. niloticus, O. aureus* and their hybrid (♂*O. aureus x* ♀*O. niloticus*) at the base-line level are presented in Table 1. Serum cholesterol, albumin, SGPT and SGOT level were significantly higher ($P < 0.05$) in the purebred *O. aureus* than the purebred *O. niloticus* and their crossbred hybrid. The tested genotypes showed insignificant difference ($P > 0.05$) in total protein, globulin and urea. Additionally, the levels of ALP and uric acid were significantly higher ($P < 0.05$) in both ♂*O. aureus* and the crossbred hybrid (♂*O. aureus x* ♀*O. niloticus*). On the other hand, the level of creatinine was significantly higher in the purebred *O. niloticus* followed by the crossbred hybrid and then the purebred *O. aureus* but still without a significant difference ($P > 0.05$) between the latter two genotypes. Levels of the innate immunity parameters at base line level recorded in the current study are presented in Table 2. The phagocytic activity and the phagocytic index were significantly higher ($P < 0.05$) in the crossbred hybrid (♂*O. aureus* x ♀*O. niloticus*) than the other purebred genotypes.

DISCUSSION

Blood parameters analyses have proven to be valuable tools to analyze the health status of farmed fish as these indices provide reliable information on metabolic disorders, deficiencies and chronic stress status before clinical symptoms appear (Bahmani et al., 2001). Although tilapia are the second most frequently cultured fish in the world, there are surprisingly few reports of normal blood values. (Terao and Ogaw, 1984; Palti et al.,1999;

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Bittencourt et al., 2003; Chen et al., 2003; Mauel et al., 2007). Compared with previously reported blood biochemical values for healthy tilapia, our results were almost similar or varied for most analytes. Yavuzcan Yildiz et al., (1997) reported blood chemistry in 25 small (52 g) tilapia *O. niloticus* and showed higher total protein and albumin (4.60 and 2.96 g/dl) than those measured in our study. Hussein et al., (1996) reported another study on *O. niloticus* (average weight 38.46 g), total protein and albumin (3.40 and 0.67 g/dl), cholesterol (161.3 mg/dl). On the other hand, Chen et al. (2003) identified the blood chemistry in 120 healthy *O. niloticus* (393.2±117g) through a year and showed higher means for Cholesterol (251.9g/dl), globulin (2.67g/dl) and lower albumin (1.32 g/dl). In those studies, the sizes of fish were either smaller or larger than those in our study which in turn could explain the differences in the results.

Table 1 - Means (±SD) measurements of biochemical serum components taken from Nile tilapia (*O. niloticus*), blue tilapia (*O. aureus*) and their hybrid (♀ *O. niloticus* x ♂ *O. aureus*)

Item	*O. niloticus*	*O. aureus*	Hybrid (♂ *O. aureus* × ♀ *O. niloticus*)
Cholesterol (mg/dL)	122.5±26.45^{b}	151.4±45.70^{a}	110.0±10.93^{b}
Total protein (g/dL)	3.35±0.47^{a}	3.63±0.54^{a}	4.02±0.64^{a}
Albumin (g/dL)	1.54±0.30^{b}	1.85±0.14^{a}	1.77±0.27^{a}
Globulin (g/dL)	1.82±0.33^{a}	1.78±0.58^{a}	1.81±0.41^{a}
Albumin/Globulin ratio	0.87±0.21^{a}	1.21±0.59^{a}	1.02±0.21^{a}
^{1}SGPT (U/L)	5.60±2.07^{b}	13.2±5.79^{a}	2.75±0.78^{b}
^{2}SGOT (U/L)	64.1±18.9^{b}	175.00±66.5^{a}	73.25±14.55^{b}
Alkaline Phosphatase (U/L)	5.59±1.53^{b}	6.45±0.77^{ab}	7.10±0.76^{a}
Urea (mg/dL)	6.10±1.50^{a}	6.80±1.23^{a}	6.20±1.23^{a}
Uric acid(mg/dL)	2.96±0.33^{b}	4.27±1.42^{a}	3.39±0.16^{b}
Creatinine (mg/dL)	0.32±0.22^{a}	0.20±0.07^{b}	0.27±0.02^{ab}

Means with different letters at the same row differ significantly at ($p<0.05$); ^{1}Glutamic pyruvic transaminase; ^{2}Glutamic oxaloacetic transaminase

Table 2 - Means (±SD) measurements of phagocytic activity% and phagocytic index taken from Nile tilapia (*O. niloticus*), blue tilapia (*O. aureus*) and their hybrid (♀ *O. niloticus* x ♂ *O. aureus*)

Genotype	Phagocytic activity%	Phagocytic index
O. niloticus	15.5±1.87^{b}	7.83±2.04^{b}
O. aureus	5.5±2.1^{c}	5.5±1.38^{c}
Hybrid (♂ O. aureus x ♀ O. niloticus)	20.0±1.79^{a}	12.0±0.89^{a}

Means with different superscripts at the same column differ significantly at ($p<0.05$)

On the same manner Palti et al. (1999) reported higher means for Cholesterol (267/dl), total protein (4.5g/dl), albumin (2.2g/dl), globulin (2.2g/dl) and ALP (35U/l) in *O. aureus* than those observed in the current study. Similarly, Hrubec et al. (2000) and Mauel et al. (2007) reported higher values of blood chemistry for hybrid tilapia (*Oreochromis niloticus* x *O. mossambicus* x *O. aureus* hybrids) and (*Oreochromis niloticus* x *O. aureus* hybrids), raised in a high-density aquaculture setting. These deviations could reflect the fact that some parameters could be affected significantly by culture conditions. Ammonia, nitrite, culture density and the culture systems could influence the values obtained (Hrubec et al., 1996, 1997).

Total cholesterol level, which differed significantly among different genotype in the current study, was found to be associated with disease resistance in fish (Maita et al., 1998). Meanwhile, high levels of serum protein, albumin and globulin are thought to be associated with strong innate response in fish (Wiegertjes et al., 1996). Palti et al. (1999) identified significant differences between *O. aureus and O. mossambicus* in serum total protein, albumin and globulin. Similarly, the same pattern was observed, with higher values in *O. aureus* than in *O. mossambicus*, *O. niloticus* (wild strain) and *O. niloticus* (red strain) Cnaani et al. (2004). However, the current study identified a significant increase only in the serum albumen content of *O. aureus*. Biochemical differences were also identified in levels of SGPT, SGOT, ALP, uric acid and creatinine. The immunological significance of those differences is currently unknown.

On the other hand, the phagocytic activity and the phagocytic index were significantly higher in the crossbred hybrid (♂*O. aureus* x ♀*O. niloticus*) in compare to its tilapia parental species. These results are in agreement with the data put forward by Solis et al. (2007) who concluded that *O. niloticus* Rocky Mountain (cross of *O. niloticus* and *O. aureus*) had the best phagocytic activity and the phagocytic index than the other tilapia genotypes; *O. mossambicus*, *O. aureus, O. niloticus* Egypcia and the hybrid *O. niloticus* Stirling (cross of *O. niloticus* and *O. mossambicus*) studied. Phagocytosis is a fundamental and generally efficient mechanism within the innate immune response that provides the host with a continuous surveillance against foreign invaders and is ultimately responsible for the destruction of the phagocytized pathogens (Silva et al., 2002).

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CONCLUSION

It is known that the normal values of blood components have genetic and physiological variations. The genetic variation may due to interspecific factors between species and intraspecific within species. The physiological variations may be caused by age, sex and nutritional aspects. In this study, three tilapia genotypes were of the same age and were sampled from the same culture environment. Therefore; the observed variations of serum biochemical components may reflect the genetic variations in nature (Sifa et al., 2000). In this study we identified significant differences in two parameters of non-specific immunity between two tilapia species and their hybrid. The differences identified between *O. niloticus*, *O. aureus* and their hybrid and those identified in previous studies (Cnaani et al., 2004; Mauel et al., 2007) suggest that hybrid families from the two species may be used to construct a segregating population for genetic analysis of immunological traits and stress response. Further research is needed to determine if the immunological differences are associated with variation in disease resistance.

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PRODUCTION POTENTIALS AND THE PHYSICOCHEMICAL COMPOSITION OF SELECTED DUCK STRAINS: A MINI REVIEW

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ABSTRACT: Physicochemical composition of meat is an important factor in human nutrition and contributes to the choice of food by mankind. In recent times humans are much conscious of the health benefits of what they consume. Emphasize on the consumption of balance diets have been given much attention. The consumption of organic foods, vegetables, fruits, foods high in fibre, foods of animal origin with less fat and cholesterol are among the food stuffs being upheld. Poultry meat, eggs and products are widely consumed worldwide without much religious restrictions. The high consumption of poultry meat is partly due to it ease for preparing different dishes and the development of a wide range of processed ready-to-eat meals incorporated with chicken as a major protein source. Poultry meat (white meat) is known to be healthier than red meat probably due to its low calorie and lipid contents. Duck meat is comparable to that of chicken despite being red meat and it is a close alternative source of protein and other nutrients for humans. Duck meat is high in protein, iron, selenium and niacin; and lower in calories compared to many cuts of beef. This mini-review reports on the production potentials of ducks and the physicochemical composition of selected duck strains. It also reports on world duck population.

REVIEW ARTICLE

Key words: *Duck meat, consumption, health benefits, nutrition, physicochemical*

INTRODUCTION

Physicochemical composition of meat comprises of both the physical and chemical properties of meat. Physical components include slaughter weight, meat colour, water content and so on while the chemical (nutrient) composition protein content, lipid content and many more. Humans are becoming increasing concern about food safety issues. Such issues include how safe a particular food substance is in terms of it microbial status, the presence of certain chemicals, compounds or nutrients in foods which are indigestible and thus may leave permanent residual effects and the nutrient composition of foodstuffs. Proteins, carbohydrates, lipids, vitamins, minerals and/or water are important nutrients which when combined in the right proportion promote healthy life. Proteins can be derived from both animal and plant sources. Although animal protein is closely related to that of human protein and the fact that some plant proteins lack certain essential amino acids, animal protein has undergone some criticism due to it association with cancer, heart diseases and/or other unknown complications (Brown, 2003; Danaei et al., 2009; Jakobsen et al., 2009; Tanaka, 2012). More so, protein from white meat (poultry, rabbit) is more preferred to protein from red meat (duck, beef, chevon, mutton) sources due to it less fat and cholesterol content (Brown, 2003; Tanaka, 2012).

Poultry meat is largely consumed worldwide. It is easy to prepare and has been used for developing several ready to eat and processed food products. A close relation that can serve as an alternative to poultry meat is duck meat. The nutrient composition of duck meat and eggs are comparable to that of chicken (Tai and Tai, 2001, Adzitey et al., 2012). Duck meat is high in protein, iron, selenium and niacin; and lower in calories compared to many cuts of beef (Anonymous, 2010). Duck meat, like that of chicken can also be used for the preparation of several processed meat products. It has been used to prepare sausages, meatballs, and many more (Huda et al., 2010; Huda et al., 2011; Putra et al., 2011). Duck meat and products are relished and consumed by many, especially people from the Far East (Tai and Tai, 2001). Ducks have the advantage over chickens in that; they are hardy and have better adaptation to harsh environmental conditions (Adzitey and Adzitey, 2011; Adzitey et al.,

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2011). Ducks have also undergone breeding and selection to improve upon their performance and characteristics. The meat quality and physiochemical characteristics of duck breeds are also under intensive under research for improvement.

Despite this a review on the production potentials of ducks, the nutrient composition of duck meats, and world duck production is unavailable. Thus, this paper presents a short summary of the production potentials of ducks and the physicochemical composition of selected duck strains. It further gives a summary of world duck production.

PRODUCTION POTENTIALS AND PHYSICOCHEMICAL (NUTRITIONAL AND PHYSICAL) ATTRIBUTES OF DUCKS

Intensive breeding and selection of ducks have resulted in the production of duck breeds and strains with desirable traits and growth performance. Different genotypes of ducks including common ducks such as Pekin ducks (*Anas platyrhynchos*), Muscovy ducks (*Cairina moschata*), mule ducks (crossbreed) and hinny ducks (crossbreed) are widely used to produce meat. Zhou (2011) reported that the modern domestic White Pekin duck currently outpaces the modern broiler chicken in terms of body weight gain and feed efficiency to the same live weight due to genetic improvement. Ducks from the paternal pedigree strain A44 for example, have been selected in order to increase their musculature and decrease fatness (Wawro et al., 2004). Optimum slaughter weight for broiler ducks has been reduced to 7 or 8 weeks through selection (Adamski et al., 2005; Kokoszynski and Korytkowska, 2005). The natural ability of ducks to grow rapidly in free range, scavenge on their own and resist a number of diseases as well as control insects can be relied on in selection and breeding programs to reduce input cost while improving carcass quality. It has been noted that the more sophisticated duck strains may perform better in modern intensive production systems that provide adequate shelter, requisite nutrition to optimize growth rate and standard health programs (Zhou, 2011).

Potentially, a variety of duck breeds (Pekin, Muscovy, Khaki Campbell and mule) are available for production, feed stuffs (conventional, non-convention and by-products) are also readily available, and duck meat and products have good market especially in Asian countries. The meat has several potentials for developing processed meat products. These potentials have been described in details by Huda et al. (2011). With recommendations for the reduction of red meat intake due to its association with cardiovascular pathologies, the consumption of white meats and duck meat is gaining more attention (Pfeuffer, 2000; Witak, 2008). Anonymous (2010) reported that duckling breast without skin is lower in calories (140 cal vs165 cal), lower in fat (2.5g vs. 4g), and richer in iron (5mg vs. 1mg) compared to chicken breast without skin and of good value to individuals interested in weight loss or management. Dry-cured duck breast has low moisture and high protein content in comparison with other dry-cured meat products made from cuts of whole meat (Lorenzo et al., 2011). Lysine and leucine, followed by valine, threonine and isoleucine are the main essential acids present in dry-cured duck meat (Lorenzo et al., 2011). Aspartic and glutamic acids were the most important nonessential amino acid fraction found (Lorenzo et al., 2011). Lorenzo et al. (2011) also reported that the dry cured-duck breast also proved to be a valuable source of iron, zinc, copper and manganese.

Research has also been carried out (and are still being carried out) with specific focus on the improvement of dressing percentage (Kokoszynski and Korytkowska, 2005), chemical composition of muscles (Adamski, 2005), and physical and chemical meat characteristics (pH, water holding capacity and colour) (Adamski et al., 2005) of ducks. Important meat quality traits such as the amino acids (essential and non-essential) and fatty acids (unsaturated-mono and polyunsaturated, and saturated) composition of duck meat are also under studies and improvement (Woloszyn et al., 2006). The physiochemical characteristics, fatty acid and amino acid composition of some duck strains have been summarized in Table 1. The values are averages of both male and female ducks slaughtered at 7 weeks of age. Duck strain A4 (3.143kg) had the highest pre-slaughter weight compared to Star63 (2.997kg), PP54 (2.645kg) and CaA15 (2.488kg) but exhibited the lowest dressing percentage of 60.70%. Star63 (69.85%) had the highest dressing percentage, followed by CaA15 (69.45%) and PP54 (68.90%). The high pre-slaughter weight of A4 had a positive influence on the breast and thigh muscles by being heavier than the other strains. The pH range among all the duck strains were within acceptable limits and thus the meats were not pale soft exudative. Postmortem pH decline influences the ability of meat to retain moisture (Huff-Lonergan and Lonergan, 2005; Adzitey, 2011). The water holding capacity, crude protein and fat contents, and meat colour of A4 were also within acceptable limits.

The percentage protein of P66 (21.81%) was the highest, followed by P55 (21.37%), K2 (20.91%), P33 (20.25%) and A3 (19.53%). In humans protein is important for growth, maintenance and repair of won out tissues (Lloyd, 2011; Tanaka, 2012). It can also serve as a source of energy in the absence of carbohydrate (Lloyd, 2011). From Table 1, ducks are important source of amino acids such as leucine, lysine, threonine, tryptophan and valine. The amino acid composition was highest for P55 except tryptophan which was highest in A3. The amino acid composition of P66 was close to that of A3 and was better than the other strains. The percentage lipids were 1.32%, 1.32% 1.28%, 1.16% and 0.80% for A55, P66, A3, K2 and P33, respectively. Lipids are very important source of energy for humans but it excess have adverse effect on health. The cholesterol level was least in A55 and highest in K5. Cholesterol is important for the production of hormones, for normal functioning of the brain, nerve tissues and cell membrane, synthesis of Vitamin D and many more (Anonymous, 2011).

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Table 1 - Physiochemical characteristics, fatty acid and amino acid composition of some selected duck strains

Parameter/Strain	A4	P33	K2	A3	A55	P66	Star 63	PP54	CaA15
Preslaughter body wgt (g)	3143	-	-	-	-	-	2997	2644.5	2488
Eviscerated carcass wgt (g)	1907	-	-	-	-	-	-	-	-
Dressing % (%)	60.70	-	-	-	-	-	69.85	68.90	69.45
Breast muscle (%)	14.40	-	-	-	-	-	14.00	13.40	13.50
Leg muscle content (%)	15.20	-	-	-	-	-	13.55	11.65	13.70
pH_{15}	6.23	-	-	-	-	-	5.85	6.015	5.865
pH_{24}	5.76	-	-	-	-	-	5.43	5.44	5.485
Water holding capacity (%)	17.50	-	-	-	-	-	-	-	-
Meat colour (L)	33.20	-	-	-	-	-	-	-	-
Water content	77.10	-	-	-	-	-	-	-	-
Crude protein content	19.4	-	-	-	-	-	-	-	-
Crude fat content	3.60	-	-	-	-	-	-	-	-
Protein (%)	-	20.25	20.91	19.53	21.37	21.81	-	-	-
Lipids (%)	-	0.80	1.16	1.28	1.32	1.32	-	-	-
Moisture (%)	-	77.70	76.67	77.53	75.86	76.10	-	-	-
Cholesterol (mg/100g)	-	95.17	111.82	106.05	71.21	82.23	-	-	-
Leucine (%)	-	7.67	7.88	7.78	8.45	8.13	-	-	-
Lysine (%)	-	8.87	8.68	8.60	9.57	8.90	-	-	-
Threonine (%)	-	4.11	4.15	4.45	4.13	5.22	-	-	-
Tryptophan (%)	-	1.14	1.15	1.25	0.78	0.70	-	-	-
Valine (%)	-	3.68	3.74	3.67	7.01	6.90	-	-	-
SFA (%)	-	42.04	38.84	38.16	34.17	34.53	-	-	-
MUFA (%)	34.88	23.46	24.01	27.15	29.96	31.97	-	-	-
PUFA (%)	14.84	26.66	30.44	27.62	28.92	28.67	-	-	-
n-6/n-3 (%)	10.07	5.09	5.85	3.85	3.27	3.59	-	-	-

Key - = data unavailable for that study; References: Woloszyn et al. (2006); Bernacki et al. (2008); Witak (2008)

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Table 2 - World duck meat production by Continents as at 2008		
Continent	**Duck meat production (Kg)**	**% Production**
Africa	57,100	1.51
North and Central America	112,000	2.96
South America	17,600	0.47
Asia	3,121,900	82.61
Europe	459,000	12.15
Australia	11,400	0.30

Source : FAO (2010)

Table 3 - World duck meat production (kg) by individual country within the past three years beginning from 2006			
Country	**2006**	**2007**	**2008**
China	2,175,300	2,328,200	2,518,200
France	233,400	246,800	248,600
Malaysia	108,000	111,000	111,000
Thailand	84,900	84,900	84,900
USA	85,600	83,400	84,000
Vietnam	86,000	84,000	84,000
Myanmar	67,900	74,200	74,200
India	70,200	72,800	72,800
Germany	38,500	55,800	60,800

Reference: FAO (2010)

However, high cholesterol level (especially low density lipoprotein (LDL) type) has been associated with cardiovascular diseases (Danaei et al., 2009). Duck meat also contain appreciable amount of saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acid (Table 1). Saturated fatty acid (42.04%), MUFA (34.88%) and PUFA (30.44%) was highest in P33, A4 and K2, respectively. The consumption of high SFA is a risk factor to develop heart related diseases due to increase concentration of LDL cholesterol in plasma (Danaei et al., 2009; Mozaffarian et al., 2009). A study suggested that to prevent chronic heart diseases, SFA intake should be replaced with PUFA intake rather than MUFA or carbohydrate (Jakobsen et al., 2009). The moisture content in duck meat ranged from 75.86% to 77.70%. Acceptable moisture content in needed to prevent excessive drip which will affect the acceptability of duck meat by consumers (Huff-Lonergan and Lonergan, 2005; Adzitey, 2011; Adzitey and Huda, 2011). Water helps regulate body temperature, protect body organs/tissues, carries oxygen, dissolves minerals and nutrients, lubricates joints, and moistens eyes, nose and mouths in the humans (Anonymous, 2012).

WORLD DUCK PRODUCTION

World duck meat has seen an increase in the past decade. There has been an increase of 0.28 million ton in 2000 to 0.37 million ton in 2008 with an average rise of 31% (FAO, 2010). Table 2 shows the current percentage of duck meat production by continents. From Table 2, Asia dominates in global duck meat production and accounted for 82% of the total duck meat produced worldwide. This was followed by Europe (12%), North and Central America (3%) and Africa (1.51%) and South America (0.47). The least producing continent was Australia (0.30%). By country, China is the leading producer of duck meat and produces about 67% of the total duck meat consumed globally, followed by France and Malaysia. Table 3 depicts the major duck producing countries from 2006 to 2008. In China duck production rose from 2006 to 2008 by 16%. Increased production indicates the high demand for duck meat in Chinese communities and a rise in income levels. There is also a switch over from traditional backyard or smallholder flock to large-scale commercial systems (FAO, 2010). The duck industry has grown significantly in Germany (58%) within the past three years although total output was still less than France (248.6 ton), the leading producer of duck meat in Europe. Thailand experienced no growth while outputs from countries such as USA and Vietnam experienced a decline of 2%. No country from Africa and South America is among the first nine main producer of duck meat.

CONCLUSION

Ducks like chickens are also important sources of proteins and lipids. Advancement in duck breeding programmes, selections, feed formulations and others have pave the way for improvement in duck performances, and their carcass and meat quality. According to this survey, the duck strain P55 could be the breed of choice due to it better protein percentage, water, cholesterol level and amino acid composition. This survey also revealed that duck production is of much greater importance in Asian and China compared to other continents and countries,

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respectively. The popularity of duck production in Germany should also be noted. Africa, Australia and South America countries produce duck meats in very small quantities.

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EFFECT OF DATE PITS ON THE PERFORMANCE OF SUDANESE DESERT LAMBS

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ORIGINAL ARTICLE

ABSTRACT: *Twelve Sudanese desert lambs with an average live weight of 20.9 kg were divided into three groups of equal number to study the effect of date pits level on the performance of Sudanese desert lambs. The study was conducted at small ruminant research unit in the Faculty of Agricultural Technology and Fish Sciences, Al-Neelain University Khartoum, Sudan. Three iso-nitrogenous and iso-caloric diets containing graded levels of date pits (0%, 5%, and 10%) were randomly assigned to the lambs groups. Feeding was on ad libitum for 45 days. Performance of experimental lambs did not significantly influenced with introduction of date pits.*

Key words: Lambs, date pits, chemical composition, performance.

INTRODUCTION

The increasing pressure on the aquaculture to reduce or eliminate feed antibiotics as growth enhancers has initiated new research to find safe and efficient natural alternatives. This new generation of feed additives includes herbs and their essential oils and extracts (Brenes and Roura, 2010). Herbal additives contain substances which increase also appetite and digestion (Barreto et al., 2008). There has been published many studies have confirmed that the addition of plants or their extracts in the diets has a beneficial effect to improve growth parameters and protect from diseases in aquaculture (Shalaby, 2004; Sasmal et al., 2005; Johnson and Banerji, 2007, Farahi et al. 2010, Sudagar et al., 2010; Kasiri et al., 2011).

Dates are considered as one of the most important food crops in many countries around the world, especially in tropical and subtropical regions. However a substantial amount of this production is inedible due to its low quality. This portion is used mainly as fertilizer or animal feed.

Date pits (known also as date stones, kernels, or seeds) represent about 13-15% of the total weight date fruits (Hussein et al. 1998). Date pits contains about 10-20% fiber and 55-70% nitrogen free extract (NFE) depending on date species and varieties (FAO 1999). About 55-73% of NFE in the date pits is mainly starch (Yousif et al. 1996; Hussein et al. 1998; Ali et al. 1999).

A number of studies have been conducted on the use of date by-products for sheep (Tag El- Din and Nour 1993; El Hag et al. 1996), poultry (Hussein et al. 1998) and Calves (El Hag and El Khanjari 2000).

The high content of NFE in date pits has attracted the attention of a number of researchers to evaluate its potential use in animal feed, with promising results. Dietary inclusion of date pits significantly improved the growth and feed utilization of sheep (Elgasim et al. 1995), rats (Ali et al. 1999) and poultry (Vandepopuliere et al. 1995; Hussein et al. 1998).

So the study here was carried out to see the effect of the date pits on the performance of Sudanese desert lambs.

MATERIALS AND METHODS

Date pits were collected, washed, soaked in water for 7 days and dried in the shade then grounded. Proximate analysis of date pits were carried out according to methods of AOAC (1980).

Three iso-nitrogenous and iso-caloric diets A, B and C were formulated which contains date pits meal with percentages 0%, 5%and 10% respectively (Table 2).

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Twelve Sudanese desert lambs with an average live weight of 20.9 kg were used in this study. Lambs were kept for an adaptation period of two weeks during which they were sprayed with an acricide and drenched for endoparasites. A mixture containing equal proportions of experimental diets was fed to the lambs. At the end of the adaptation period lambs were individually weighed and divided into three groups of equal number and weight. Each group was separately kept in a pen provided with watering and feeding facilities.

The diets were randomly assigned to the lambs groups and offered *ad libitum* in one morning meal throughout the feeding period. Green fodder (*Medicago Sativa*) was also offered at a rate of 1kg/ head/week as a source of vitamin A. Clean water and salt lick were available throughout the feeding period which lasted for 45 days. Feed intake, live weight and feed conversion ratio were determined.

Data was statistically analyzed according to the analysis of variance applicable to complete randomized design as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

The proximate analysis of date pits and the ingredients proportion of three experimental rations were shown in Table 1 and Table 2 respectively. Performance characteristics of Sudanese desert lambs were presented in Table 3. Graded percentages of date pits meal induced no significant effect on the final body weight, weight gain and feed conversion efficiency.

Table 1 - Approximate composition (g/Kg DM) of date pits

Items	g/kg DM
CP	214
EE	50
CF	158
Ash	53
ME (Mj/kg DM) *	8.8

* ME was calculated according to the equation: ME (MJ/kg DM) = 0.012CP + 0.031EE + 0.005CF + 0.014NFE (Maff, 1975).

Table 2 - Ingredients proportion and chemical composition of experimental diets

Ingredients	Ration A	Ration B	Ration C
Sorghum grain	30	22	22
Wheat bran	18	22	20
Groundnut meal	19	18	17
Groundnut hulls	24	21	20
Datepits	0	5	10
Molasses	7	10	9
Lime stone	1	1	1
Common salt	1	1	1
ME (Mj/kgDM)	10.26	10.00	9.97
CP %	16.7	17.05	17.1

Table 3 - Performance characteristics of Sudanese desert Lambs fed

Item	A	B	C	S.E
No. of animals	4	4	4	-
Experimental period (days)	45	45	45	-
Initial weight (Kg)	20.2	20.6	20.3	0.26
Final weight (Kg)	25.51	25.02	25.17	0.43
Average daily gain (g/)	118	98	108	1.05
Feed intake (Kg/day)	1.20	1.09	1.12	0.90
Feed conversion*	10.21	11.08	10.38	1.56

S.E. Standard error; *Feed intake (g) /average daily gain (g)

Table 4 - Financial Study of the research

Feeds	Feed Intake	Kilogram's Price*	Whole Price
A	202.32	0.84	169.95
B	182.88	0.82	149.96
C	188.64	0.78	147.14

* Price in Sudanese pounds

These results were not in line with a number of previous studies (Shawket, 1999; Ahmed et al., 2001; Shawket et al., 2001; Abouheif et al., 2000) this may be due to the low percentages of the date pits that were used in this study. On the other hand feed intake, average daily gain and feed conversion were lower with diet containing date pits than that of diet containing no date pits. These results were not in agreement with that of Al-Owaimer et al. (2008), who reported that feed intake was higher with the lambs fed on diet containing date pits. As seen from

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Table 4 inclusion of date pits minimize the cost of the diet to 0.84, 0.82 and 0.78 Sudanese pounds for kilogram in case of 0, 5 and 10% inclusion of date pits.

CONCLUSION

The current study recommended that using date pits by 10% give a good animal performance among trail diets as well as it had a lower cost.

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ESTIMATION OF LIVE BODY WEIGHT FROM LINEAR BODY MEASUREMENTS FOR FARTA SHEEP

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ABSTRACT: *A study, to develop regression models for prediction of body weight from other linear body measurements, was conducted in Esite, Farta and Lai-Gaint districts of South Gondar, Amhara region. Records on body weight (BW) and other linear body measurements (Body Length (BL), Wither Height (WH), Chest Girth (CH), Pelvic Width (PW) and Ear Length (EL)) were taken from 941 sheep. Non-linear, simple linear and multiple linear regression models were developed using Statistical Package for Social Sciences (SPSS version 12.0). For the multiple linear regressions, step-wise regression procedures were used. Predicting models were developed for different age, sex and for the pool. Positive and significant (P<0.01) correlations were observed between body weight and linear body measurements for all sex and age groups. Among the four linear body measurements, heart girth had the highest correlation coefficient (except ear length) in all age and sex groups which is followed by body length, height at wither and pelvic width. Heart girth was the first variable to explain more variation than other variables in both sex and age groups. The models developed had a coefficient of determination of 0.26 to 0.89; the highest coefficient of determination was depicted for male while the lowest was for dentition groups having two permanent incisors. Regression models in general were poor in explaining weight for the dentition groups above one pair of permanent incisors. Heart girth alone was able to estimate weight with a coefficient of determination of 0.77, for both sexes and the pool. The coefficient of determination of the fitted equations (in general) decreased as the age of sheep advances indicating that the fitted equations can predict weight for younger sheep with better accuracy than for older ones. In general, much of the variation in weight was explained when many traits were included in the model. However, for ease of use and to avoid complexity at field condition, it is possible to use heart girth alone as a predicting tool. As a method to estimate weight using linear body measurements, it is possible to use these linear body measurements for selection in an effort to improve body weight of Farta sheep. In addition, the difference in the correlation coefficients between weight and other linear measurements for different age groups indicates the possibility of using different body measurements at different ages to predict weight and use for selection as well.*

Key words: *Farta sheep, body weight, linear body measurements, regression model*

ORIGINAL ARTICLE

INTRODUCTION

Farta breed of sheep is one of the sheep breeds found distributed in the south Gonder zone of the Amhara national regional state, Ethiopia. These sheep are kept mainly for meat production (sale and slaughter) under the traditional management systems (Shigdaf et al., Unpublished). There is no any specialized breed improvement program designed for this sheep. Genetic improvement of its live weight is required to increase meat yield from this breed.

Body measurements are simple and easily measured variables for estimating live weight with relatively lower costs with a high relative accuracy and consistency (Sowande and Sobola, 2007; Stephen et al., 2010). In addition, body measurements have been used to evaluate performance and characterize breed of animals, assess growth rate, feed utilization and carcass characteristics in farm animals (Anye et al., 2010; Stephen et al., 2010).

Estimation of the relationship between body measurements in sheep may help to provide means for predicting traits which are not normally and easily measured under field conditions. In a breeding programme where improved live weight is the overall breeding objective other body measurements having strong correlation to

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live weight could be considered (Sowande and Sobola, 2007). There is paucity of information on the relationship between live weight and body measurements of Farta sheep. This study was undertaken to investigate the relationship between linear body measurements and obtain prediction equations for estimating live weight of Farta sheep from five body measurements for the purpose of breed characterization.

MATERIALS AND METHODS

Study Area

The study was conducted in Estie, Farta and Lai-Gaint districts of south Gondar zone, Amhara region where Farta sheep is distributed. Farta district is located about 100 km north-east of Bahir Dar, capital of the Amhara National Regional State. Farta lies within an altitude range of 1920-4135 m a.s.l. The district receives an average annual rain fall of 900-1099 mm and a mean-range temperature of 9-25 C^o (Farta District OoARD, annual report). The second district, Lai-Gaint district, is located 175 km from Bahir Dar and lies between an altitude ranges 1300-3500 m.a.s.l. Lai-Gaint receives an annual average rain fall of 600-1100 mm and mean minimum and mean maximum temperature of 9 and 19 C^o, respectively. The third district, Estie district, is located 157 km North West of Bahir Dar city having an altitude range of 1500-4000 m.a.s.l. The minimum and maximum mean annual rainfall perception of the area is 1307-1500 mm and the mean annual minimum and maximum temperature is 8.3 ^{0}C - 25^{0}C (ENMA, unpublished).

Study Animals and Management

Study animals considered were Farta sheep. They are short fat tail; wooly under coat; medium sized; commonly white (37.5%), brown (27.5%) and black with brown belly (15%), white/brown with brown/white patches (Solomon, 2008). Sheep were managed under traditional systems; the main feed resources were natural pasture (communal and private grazing land), crop residue, improved forage, and crop aftermath.

Data Collection

Data on Weight and other linear body measurements were collected from 941 sheep, with different age/dentition and sex groups. Age was estimated based on dentition groups, Pair of Permanent Incisors (PPI) (0PPI - sheep with milk teeth; 1PPI - sheep with 1 PPI; 2PPI - sheep with 2 PPI; 3PPI - sheep with 3 PPI; 4PPI - sheep with 4 PPI and above). For dentition group 0PPI, sheep approaching to one year of age, based on information from the owner and physical estimation, were used.

Weight measurement, the live weight of an animal, was taken using the Salter scale (50 kg capacity with 200 gram precision). Linear body measurements (heart girth, wither height, body length, pelvic width and ear length) were taken using flexible metal tape (3 meter length) to the nearest 0.5 cm after restraining and holding the animals in an unforced position. The reference points taken were: heart girth - the circumference of the chest posterior to the forelegs at right angles to the body axis; wither height - the highest point measured as the vertical distance from the top of the shoulder to the ground (bottom of forelegs); body length - horizontal length from the point of shoulder to the pin bone; pelvic width - horizontal distance between the extreme lateral points of the hook bone (*tuber coxae*) of the pelvis; and ear length - length of the external ear from its root to the tip.

Statistical Analyses

Statistical analyses were carried out using SPSS Software version 12.0 (SPSS 2003) General Linear Model (GLM) procedures, and linear and nonlinear regression procedures. Sex and dentition were considered as fixed effects. Live weight was regressed on other body measurements for sexes, dentition groups and for the pool. In the multiple regression equation, prediction equations were developed using a stepwise elimination procedure.

The following models were used for data analysis.

$Y_{ij} = \mu + S_i + T_j + (ST)_{ij} + e_{ij}$	(GLM)	Model 1
$W = a + bG$	(Simple linear)	Model 2
$W = a + b1G + b2G^2$	(Quadratic)	Model 3
$W = a + b1G1 + b2G2 + ...+ bnGn$	(Multiple linear)	Model 4

Where Y_{ijk} = The observation on body weight and other linear body measurements; W = The observation on live weight of the animal; μ = Overall mean; S_i = Fixed effect of sex (i = Female, Male); T_k = Fixed effect of dentition (k = 0, 1, 2, 3, 4); $(ST)_{jk}$ = the interaction effect of sex with dentition; a = Intercept; b= Regression coefficient of weight on body measurements; G = Body measurements; n = n^{th} number of body measurement; e_{ijk} = effect of random error

RESULT AND DISCUSSIONS

Body Weight and Linear Body Measurements

The mean body weight and linear body measurements of Farta sheep are presented in Table 1. The overall mean body weight, wither height, body length, chest girth, pelvic width and ear length obtained in the present study was 26.2±0.32 kg, 64.3±0.34 cm, 55.6±0.35 cm, 70.9±0.44 cm, 12.8±0.11 and 9.35+0.12 cm, respectively.

There was significant difference ($p<0.05$) in body measurements (except ear length) between sexes and dentition groups. Males were superior over females in all the measurements except pelvic width where they were

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similar (P>0.05). As can be expected, sheep with 0PPI were lower in all the measurements followed by sheep with 1PPI. This might be because they are still growing. Sheep with 2PPI and above were similar almost in all the measurements, may be because Farta sheep attains maturity when it erupts the first 2PPI.

Table 1 - Least squares means and standard errors (LSM±SE) of body weight and linear measurements of Farta sheep as affected by sex and dentition

Variables	N	BW (kg)	WH (cm)	BL (cm)	CG (cm)	PW (cm)	EL (cm)
		LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	941	26.20±0.32	64.31±0.34	55.59±0.35	70.86±0.44	12.79±0.11	9.35±0.12
Sex		***	***	***	*	NS	NS
Female	800	23.82±0.19	62.16±0.20	54.30±0.20	69.76±0.26	12.83±0.06	9.67±0.07
Male	141	28.58±0.62	66.46±0.65	56.89±0.67	71.96±0.84	12.76±0.22	9.03±0.24
Dent		***	***	***	***	***	NS
0PPI	315	15.82±0.23^{a}	56.54±0.24^{a}	48.45±0.25^{a}	58.91±0.31^{a}	10.66±0.08^{a}	9.23±0.09
1PPI	64	26.02±0.70^{b}	65.12±0.74^{b}	55.36±0.76^{b}	72.25±0.95^{b}	13.00±0.25^{b}	9.40±0.27
2PPI	61	28.33±0.65^{c}	65.39±0.68^{c}	56.33±0.71^{b}	73.30±0.88^{bc}	12.78±0.23^{b}	9.44±0.25
3PPI	74	29.75±0.83^{cd}	66.83±0.87^{cd}	59.01±0.90^{c}	73.67±1.13^{bc}	13.69±0.29^{c}	8.93±0.32
4PPI	427	31.09±0.98^{d}	67.67±1.03^{d}	58.82±1.07^{c}	76.15±1.33^{c}	13.84±0.35^{c}	9.75±0.38
Sex*Dent		***	**	NS	NS	NS	NS

NS: Not significant (P>0.05), *P<0.05, **P<0.01, ***P<0.001; BW - Body Weight; CG - Chest Girth; BL - Body Length; PW - Pelvic Width; WH - Wither Height; EL - Ear length; 0PPI - sheep with milk teeth (>about 9 months); 1PPI - sheep with 1 pair of permanent incisor (PPI); 2PPI - sheep with 2 PPI; 3PPI - sheep with 3 PPI; 4PPI - sheep with 4 PPI and above

Correlation between Weight and Linear Body Measurements

The Pearson's correlation of linear body measurements with weight and with each other is presented in Table 2. There were significant and positive relationships between body weight and other linear body measurements and with each other irrespective of age and sex, except ear length to which there was inconsistent relationships.

Chest girth had the highest correlation coefficient (r=0.43-0.87; p<0.01) with body weight in both sexes and all dentition groups which is followed by wither height and body length. Ear length has almost no correlation with body weight (inconsistent relationship). Good correlation coefficients between body weight and chest girth was also reported for Menz and Washera sheep (Tibbo et al., 2004; Mengistie et al., 2010). Strong and positive correlation between body weight and other linear body measurements have also been reported by different scholars (Sowande and Sobola, 2007; Khan et al., 2006).

The relationship between linear body measurements and weight was different for different age groups. The highest correlation coefficient was depicted with chest girth followed by wither height at age group 0PPI. The correlation coefficient, in general, decreases as the age advances. This is in agreement with other findings (Mengistie et al., 2010) and disagrees with the findings of Khan et al. (2006).

With regard to sex, males had better correlation coefficient and agree with literature (Alade et al., 2008; Khan et al., 2006; Stephen et al., 2010). The highest coefficient was found with chest girth (87% for males and 86% for females) followed by wither hight (86%) for males and body length (76%) for females.

The high and significant correlation coefficients between body weight and linear body measurements for all age groups suggest that either of these variables or their combination could provide a good estimate for predicting live weight of Farta sheep.

Prediction of Weight Using Body Measurements

Regression models developed are presented in Figures 1, 2, 3, 4 and Table 3. Different regression models were developed for different sexes, dentition groups and for the pool.

The regression equations developed had different coefficient of determination and the body measurements used to predict weight were different for different age groups; might be because of the difference in growth and proportion of conformational traits at different ages. This tends to infer that at different ages different conformational traits may be better to predict weight and can be more successful for selection (Thiruvenkadan, 2010). The coefficient of determination of the fitted equations (in general) decreased as the age of sheep advances indicating that the fitted equations can predict weight for younger sheep with better accuracy than for older ones. This is in agreement with literature (Mengistie et al., 2010; Thiruvenkadan, 2010).

Chest girth was the first variable to explain variation in weight for age groups 0PPI and 4PPI followed by body length. However, in age groups 1, 2 and 3PPI height at withers and body length accounted for the greatest amount of variation in body weight.

With regard to sex, the coefficients of determination of prediction equations were almost similar ranged from 75.5-83.8 for female sheep and 76.7-89.3 for male sheep. Chest girth was the first variables to explain more variation followed by body length in both male and female sheep. The highest coefficient of determination was obtained when the equations were fitted for the pool (for all age group) which is in agreement with other findings (Thiruvenkadan, 2010). Chest girth was the first variable to explain most of the variation in weight. Hence, this regression equation alone may be used to predict the body weight of Farta sheep at different age groups.

In general, much of the variation in weight was explained when many traits were included in the model.

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Table 2 - Correlation coefficients between body weight and linear body measurements of Farta sheep by age and dentition groups

Parameter	Measurements	WH	BL	CG	PW	EL
	BW	0.78**	0.78**	0.87**	0.73**	0.12**
	WH		0.75**	0.72**	0.63**	0.19**
Overall	BL			0.66**	0.65**	0.21**
	CG				0.72**	0.11**
	PW					0.16**
Dentition						
	BW	0.75**	0.68**	0.78**	0.60**	0.17**
	WH		0.62**	0.60**	0.51**	0.16**
0PPI	BL			0.44**	0.45**	0.23**
	CG				0.58**	0.15**
	PW					0.11*
	BW	0.64**	0.41**	0.50**	0.35**	-0.02^{NS}
	WH		0.57**	0.31*	0.24^{NS}	0.18^{NS}
1PPI	BL			-0.01^{NS}	0.21^{NS}	0.25*
	CG				0.30*	-0.22^{NS}
	PW					0.11^{NS}
	BW	0.51**	0.47**	0.43**	-0.00^{NS}	-0.27*
	WH		0.44**	0.19^{NS}	-0.2^{NS}	-0.12^{NS}
2PPI	BL			0.02^{NS}	0.06^{NS}	0.03^{NS}
	CG				0.21^{NS}	-0.24^{NS}
	PW					0.21^{NS}
	BW	0.46**	0.62**	0.50**	0.49**	-0.03^{NS}
	WH		0.52**	0.14^{NS}	0.13^{NS}	-0.06^{NS}
3PPI	BL			0.10^{NS}	0.33**	0.01^{NS}
	CG				0.27*	0.06^{NS}
	PW					0.07^{NS}
	BW	0.35**	0.45**	0.64**	0.23**	0.00^{NS}
	WH		0.44**	0.25**	0.18**	0.18**
4PPI	BL			0.12**	0.22**	0.14**
	CG				0.16**	-0.03^{NS}
	PW					0.07^{NS}
Sex						
	BW	0.75**	0.76**	0.86**	0.71**	0.11**
	WH		0.73**	0.70**	0.62**	0.20**
Female	BL			0.62**	0.62**	0.20**
	CG				0.69**	0.09**
	PW					0.14**
	BW	0.86**	0.83**	0.87**	0.71**	-0.00^{NS}
	WH		0.79**	0.78**	0.62**	0.01^{NS}
Male	BL			0.67**	0.62**	0.09^{NS}
	CG				0.70**	0.00^{NS}
	PW					0.03^{NS}

***P<0.01; *P<0.05; NS Not significant; BW - Body Weight; CG - Chest Girth; BL - Body Length; PW - Pelvic Width; WH - Wither Height; EL - Ear length; 0PPI - sheep with milk teeth (>about 9 months); 1PPI - sheep with 1 pair of permanent incisor (PPI); 2PPI - sheep with 2 PPI; 3PPI - sheep with 3 PPI; 4PPI - sheep with 4 PPI and above*

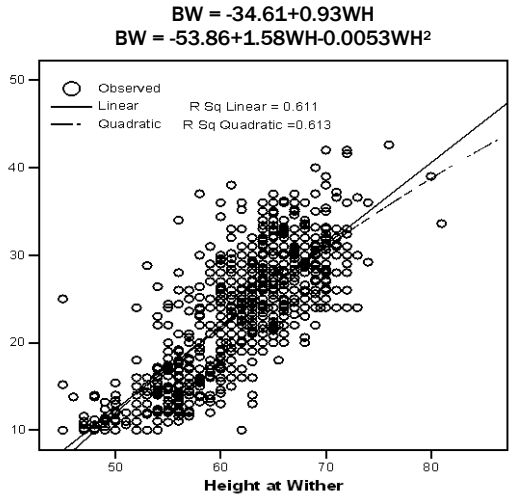

Figure 1. Estimation of weight using height at wither

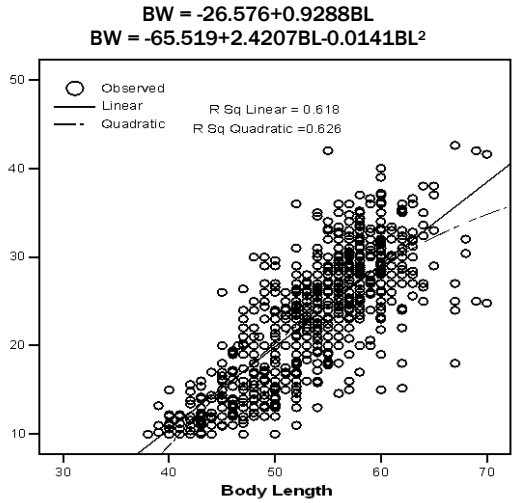

Figure 2. Estimation of weight using body length

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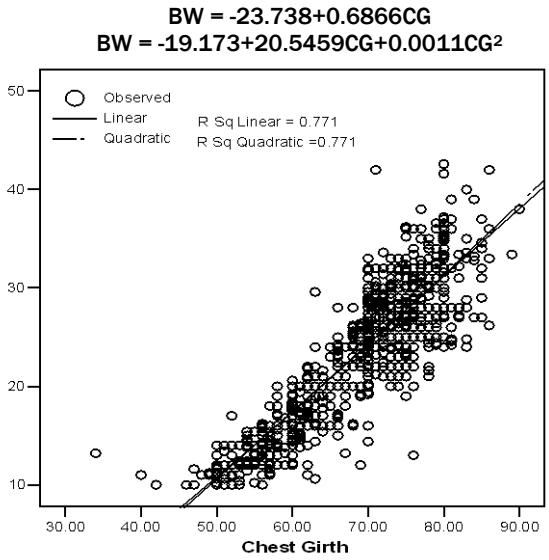

Figure 3. Estimation of weight using chest girth

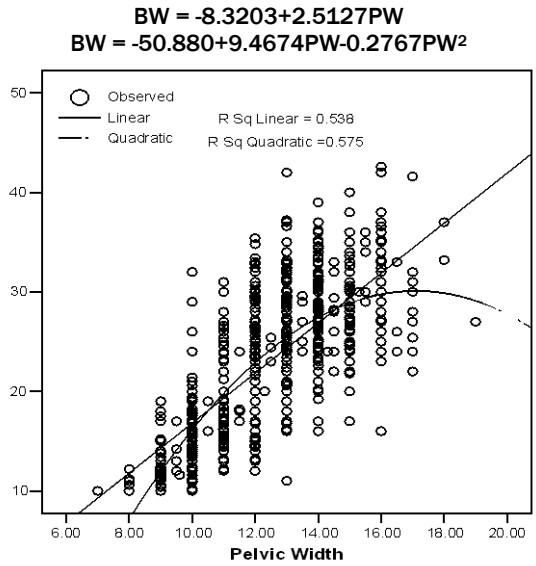

Figure 4. Estimation of weight using pelvic width

Table 3 - Linear and Multiple linear regression equations for predicting body weight from linear body measurements for sex and dentition groups

Age	Model	B_0	X_1	X_2	X_3	X_4	X_5	R^2	R^2 Change	SE
Dentition										
0PPI	CG	-11.482	0.461					0.625	0.625	2.316
	CG+BL	-20.777	0.353	0.324				0.765	0.140	1.837
	CG+BL+WH	-24.781	0.286	0.228	0.224			0.802	0.038	1.686
	CG+BL+WH+PW	-24.815	0.269	0.218	0.214	0.194		0.806	0.003	1.675
1PPI	WH	-17.747	0.665					0.416	0.416	3.740
	CG+WH	-30.006	0.269	0.558				0.516	0.100	3.432
2PPI	WH	-6.071	0.510					0.259	0.259	3.181
	CG+WH	-21.420	0.271	0.442				0.376	0.117	2.945
	CG+BL+WH	-35.729	0.287	0.414	0.286			0.469	0.093	2.741
3PPI	BL	-7.121	0.600					0.396	0.396	3.099
	CG+BL	-32.775	0.385	0.557				0.588	0.192	2.578
	CG+BL+PW	-34.245	0.341	0.495	0.610			0.624	0.036	2.481
4PPI	CG	-16.677	0.601					0.411	0.411	3.192
	CG+BL	-35.765	0.556	0.392				0.549	0.139	2.794
Sex										
Females	CG	-24.306	0.694					0.755	0.755	3.273
	CG+BL	-34.503	0.516	0.416				0.830	0.076	2.722
	CG+BL+PW	-34.108	0.478	0.381	0.319			0.834	0.004	2.691
	CG+BL+PW+WH	-36.183	0.452	0.331	0.288	0.113		0.838	0.003	2.667
	CG+BL+PW+WH+EL	-35.454	0.448	0.336	0.294	0.119	-0.124	0.838	0.001	2.663
Males	CG	-23.534	0.691					0.767	0.767	3.598
	CG+BL	-35.569	0.455	0.525				0.877	0.110	2.625
	CG+BL+WH	-38.688	0.365	0.381	0.269			0.893	0.016	2.453
Pooled										
	CG	-23.686	0.686					0.771	0.771	3.32
	CG+BL	-34.038	0.497	0.433				0.846	0.076	2.72
	CG+BL+WH	-36.822	0.456	0.358	0.156			0.852	0.006	2.67
	CG+BL+WH+PW	-36.399	0.428	0.335	0.149	0.255		0.855	0.002	2.65
	CG+BL+WH+PW+EL	-35.404	0.424	0.341	0.154	0.265	0.255	0.856	0.001	2.64

[2]Dependent Variable: BW (Body weight) - Body Weight; CG - Chest Girth; BL - Body Length; PW – Pelvic Width; WH - Wither Height; EL - Ear length. [1]Dentition 0PPI - sheep with milk teeth (> 9 months); 1PPI - sheep with 1 pair of permanent incisor (PPI); 2PPI - sheep with 2 PPI; 3PPI - sheep with 3 PPI; 4PPI - sheep with 4 PPI and above

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Comparison of Actual Weight and Predicted Weight

An effort to investigate the disparity between the actual weight and the predicted weight using the models developed for the pool (for all sex and age group) resulted with no significant difference between the actual weigh and the predicted weight except for model 5. Though, there were increments and decrements of values of the individual observations from the actual weight when using the equations, the mean of these values indicated that there were no as such a difference.

Table 4 - Comparison of the predicted weight values with the actual weight (for the pool)

Model	Mean	Std. Deviation	Range	Minimum	Maximum
Model 1	23.55[a]	6.04	34.30	3.75	38.05
Model 2	23.52[a]	6.38	36.06	2.78	38.84
Model 3	23.52[a]	6.40	34.30	4.03	38.33
Model 4	23.58[a]	6.41	34.27	4.06	38.33
Model 5	27.51[b]	6.54	35.25	7.73	42.98

Means with in a column with different superscripts are significantly different at 0.05

CONCLUSION

Body weight and other linear body measurements were significantly and positively correlated with weight and each other. From the result, it can be concluded that using linear body measurements can be a simple and reliable method for estimating body weight for Farta sheep. The higher association of body weight with heart girth, in general, over other linear measurements indicates use of this measurement alone or in combination with others can estimate weight with better accuracy and relative ease.

As a method to estimate weight using linear body measurements, it is possible to use these linear body measurements for selection in an effort to improve body weight of Farta sheep. In addition, the difference in the correlation coefficients between weight and other linear measurements for different age groups indicates the possibility of using different body measurements at different ages to predict weight and use for selection as well.

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	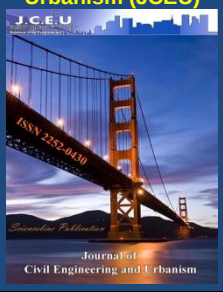	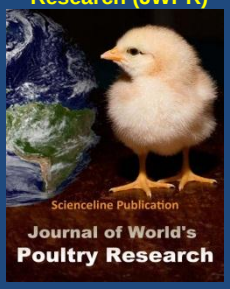	
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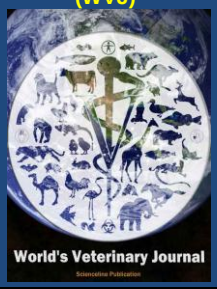		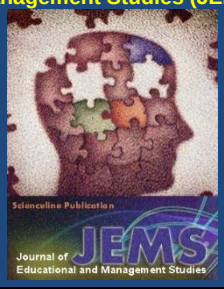	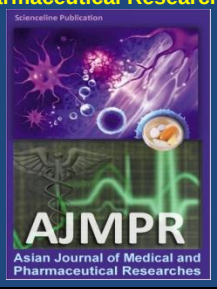
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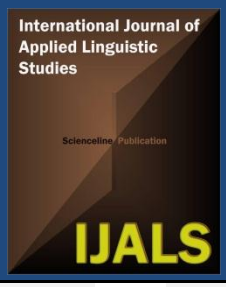	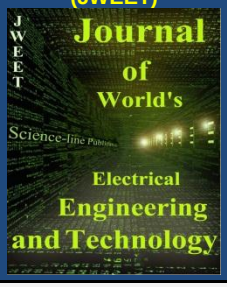		

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