


EFFECTS OF CONCENTRATE SUPPLEMENTATION ON REPRODUCTIVE TRAITS OF CO GOATS AND GROWTH PERFORMANCE OF THEIR KIDS UNDER GRAZING CONDITION

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➤ Supporting Information

ABSTRACT: The experiment was conducted in A Luoi district, Thua Thien Hue province of Vietnam, to evaluate the effect of concentrate supplementation on the reproductive traits of local Co goats and growth performance of their kids. A total of 20 pregnant Co goats in the last 1.5 month of pregnancy were monitored in two reproductive cycles. Goats were randomly divided into two dietary treatments as control (CG), in which animals freely grazed, and experiment (EG), in which concentrates were supplemented at 1.0% and 1.5% BW in the late gestation and lactation periods, respectively. After kidding, kids in each treatment were kept with their mother to access milk for the whole study period. In the CG, the kids have no supplements, and in the EG, the kids of 1 to 3 months of age were supplemented the concentrate at 1.5% BW/day. The results indicated that higher body condition scores and body weights of does after kidding, 1 and 2 months postpartum were in the EG than in the CG. The supplementation of concentrate also reduced the postpartum and kidding intervals; and increased the number of litters per year of does. Furthermore, the supplementation of concentrate improved significantly the weaning weight of kids and financial benefit per doe/per litter. In conclusion, the supplementation of concentrate in late pregnancy period and lactation diets improved reproductive traits of local Co goats and also concentrate supplementation in kids' diet improved growth performance under grazing conditions.

Keywords: Body condition score, Lactation, Local breeds, Pregnant, Small ruminants.

INTRODUCTION

Goat production has been developing in different regions of Vietnam, contributing to the poor alleviation and income improvement, especially for mountainous people (Abu Hatab et al., 2019; Liang and Paengkoum, 2019). In 2021, the goat population in Vietnam accounted approximately 2.7 million heads, consisting for 7.56 percent of total farm animals (GSO, 2021). The largest number of goats was observed in the Northern mountainous region and the Midland, followed by the North Central Coast and the Central coastal region (GSO, 2021).

The indiscriminate crossbreeding under natural selection or crossbreeding with imported breeds for several years were used to create the Vietnamese local goat breeds (Thuy et al., 2009; Binh et al., 2017). In recent years, goat production had been developing in Vietnam. Goat production played an important role in poverty and hunger alleviation in these rural areas (Nguyen et al., 2022). Almost of goats in A Luoi were kept by small-scale farms with an average of 5.2 heads per farm. Local Co goats were the most popular goat breed (89.84% of total) raised in A Luoi, followed by Bach Thao goats (8.02%) and crossbred goats (2.14%) (Hong et al., 2022). The animals were freely grazing in a fallow or crop harvested land areas.

The increased productivity could only be achieved through improvement of animal health, nutrition and reproduction management (Norton et al., 2009). However, these practices have been mostly restricted to the mountainous and remote areas of Vietnam. The litter size and number litter per year of local Co does were 1.5 and 1.4, respectively, lower than Bach Thao goats (Thuy et al., 2009). However, in our recent survey, the number litter per year of local Co goat in A Luoi district was lower than the data published by Thuy et al. (2009). The low pre- and post-weaning growth rates were also recorded in local Co goats in A Luoi with 1.56 kg, 6.75 kg, and 10.12-12.36 kg at birth, 3 and 6 months of age, respectively (Hong et al., 2022). The low productivity in goat farming in A Luoi was a consequence of endemic diseases, poor nutrition and a lack of reproduction management (Hong et al., 2022). Local Co goats were allowed to graze daily from 10:00 h to 16:00 h in grazing areas. They were kept in rudimentary facilities and their performance depended on grazing poor natural pastures with no supplementary feeding in rudimentary facilities. Therefore, it was difficult to meet the nutrient requirements for goats, especially in the gestation and lactation periods. These factors had all contributed to the high mortality rate, low growth performance of kids and poor reproductive efficiency of does, which in turn, resulted in severe economic losses of goat production. Furthermore, the poor management practices in farming may cause deterioration of genetic potential and productivity of local Co goat in A Luoi district (Hong et al., 2022).

Exploitation of available local feed resource to overcome the above facts was our objective research. Many authors indicated that supplementation of feeds during late pregnancy had improved birth weight, enhanced the immune system, reduced mortality and the incidence of hypothermia (Hashemi et al., 2008; Mahboub et al., 2013). According to Sharma and Ogra (1990), supplementation of concentrate had improved significantly total DM intake, growth rate and FCR of kids. Therefore, feeding and nutrition improvement, efficient use of the feed resources were the keys to enhance goat productivity (Nampanzira et al., 2015). However, very limited information related to the performance of Co goats and their kids under grazing on poor conditions, especially in A Luoi, where has poor husbandry practices been published. In this study, the effects of supplementation of concentrate on local Co goat reproductive and growth performance of their kids under grazing condition in A Luoi district was investigated.

MATERIALS AND METHODS

This study was carried out from 2020 to 2022 with the permission from Hue University. The experiment was performed based on the Animal Research: Reporting of In Vivo Experiments (ARRIVE) guidelines and the international ethical regulations for farm animal studies (Hurnik and Lehman, 1988).

Location of the study

This research was conducted between the years 2021 and 2022 in A Luoi district, Thua Thien Hue province, Vietnam. A Luoi is mountainous district with 600-800 meters above the sea level. This district is the habitant of minority people.

Animal, diet and experimental design

In this study, 20 pregnant Co goats of average weight of 28.3 kg, which were both in the third or fourth parity and in the last 1.5 month of pregnancy, were monitored in two reproductive cycles. The goat body condition scores (BCS) at the beginning of the experiment were recorded by 3/5 points. The goats were balanced for parity and randomly divided into two dietary treatments as control diet (10 heads) and experiment diet (10 heads) to estimate the effect of supplemental feeding on goat reproductive efficiency and performance of their kids. All animals were allowed to graze daily from 10:00 h to 16:00 h in grazing areas as normally farmers did. The goats in CG were not supplemented concentrate. Meanwhile, the goats in EG were supplemented concentrate at 1.0% BW/day and 1.5% BW/day in the late gestation (1.5 months before giving birth) and lactation period (within 2 months postpartum), respectively. All local Co does in the EG were kept in a pen. The ingredients and chemical composition of formulated concentrate for does and kids are presented in Table 1. The animals in EG were fed concentrate twice a day (7:30 – 9:30 h and 17:00 – 19:00 h). After kidding, all the residues from the does' feeding troughs were removed at the end of their feeding time before the kids were mixed with their does. Feeds were renewed daily. Clean water was offered *ad libitum*, and changed before 16:00 h. The goat body condition score was recorded every 2 weeks to adjust to the BCS to 3.5/5 at kidding time. The body weight of goats was recorded monthly in the morning before feeding.

After kidding, the does and kids were weighed to record the parturition weight and birth weight, respectively, within 2 hours. Kids were kept with their mother for the whole study period. All kids had access to their dams' milk. No additional feed was provided to the kids of the does in the control group during the study. From 10 days to 1 month old, the kids of does in the treatment group were creep feeding with 69.5% maize and 29.5% roasted soybean diet. From 1 to 3 months of age, the kids in the treatment group were fed with concentrated feed at 1.5% BW/day twice a day (7:30 – 9:30 h and 17:00 – 19:00 h). The ingredients and chemical composition of concentrated feed for kids are given in Table 2. During feeding, the kids in the treatment group were separated from the does and kept in the feeding compartments adjacent to their pens. Feeds were renewed daily. Clean water was offered *ad libitum*, and changed before 16:00 h. The body weight of kid goats was recorded monthly in the morning before feeding.

Table 1 - The ingredients and chemical composition of concentrate for pregnant doe and kids

Ingredients (kg/100 kg as dry matter)	Doe	Kids
Rice bran	30.0	30.0
Maize meal	22.5	29.0
Cassava meal	25.0	15.0
Dried soybean residue	20.0	-
Roasted soybean	-	24.0
Urea	0.5	-
Vitamin-mineral premix*	1.0	1.0
Salt	1.0	1.0
Total	100	100
Chemical composition (%) and price		
Moisture	14	14
Crude protein	16	18
Crude fibre	7.8	7.5
Metabolizable energy (kcal/kg)	2,900	3,000
Price (1,000 Vietnam dong)	7.8	10.5

* 1 kg contains 3,600,000 UI vitamin A; 520,000 UI vitamin D3; 2,100 UI vitamin E; 200 mg vitamin K3; 600 mg vitamin B1; 160 mg vitamin B2; 200 mg vitamin B6; 3,200 mcg vitamin B12; 14,000 mcg biotin; 160 mcg folic acid; 3,600 mg nicotinic acid; 1,600 mg pantothenic acid; 32,400-39,600 mg Fe; 14,400-17,600 mg Cu; 46,800-57,200 mg Zn; 18,000-22,000 mg Mn; 39.6-48.4 mg Co; 540-660 mg I; 36-44 mg Se, rice hull and CaCO₃

Measurements

Reproductive traits included body score condition (BSC) of does were determined based on a 5-point scale ranging from 1 (very thin) to 5 (very fat); body weights of does at the beginning of the experiment, after kidding, 1 and 2 months postpartum; litter size; postpartum interval (days); kidding interval (days); number of litters per year; and concentrate intake. Growth performance included body weights at birth, 1 and 2 months old of kids; and concentrate intake of kids, and estimating benefit of two dietary treatments. The feed intake was calculated based on total feed offered and residues in the feeding troughs. The weight loss percentage of does (%) was also calculated as below:

The weight loss percentage of doe (%) = (Doe parturition weight - Doe 1-month postpartum weight)/ Doe parturition weight × 100.

Statistical analysis

All the collected data were compiled, organized and analysed using SPSS software (version 15.0; SPSS Inc.). The Paired-samples T-Test was used to compare the means with a 95% confidence interval. The differences were considered to be significant at $p < 0.05$.

RESULTS AND DISCUSSION

Reproductive performance of Co does

The effects of concentrate supplementation on reproductive performance of Co does are presented in Table 2. There was no significant difference in body weight and BCS of goats between two groups at the beginning of study. The BCS of Co does in EG was increased, and reached 3.5 before kidding. Higher body weight of does after kidding, 1 and 2 months postpartum were observed ($p < 0.05$) in EG than in CG. The supplementation of concentrate affected the weight loss percentage, postpartum interval, kidding interval, and number of litters per year of goats. The results in Table 2 indicated that feeding goats with concentrate from the 1.5 months before kidding to 2 months postpartum reduced the postpartum and kidding intervals; and increased the number of litters per year of does.

Table 2 - Effects of supplemental concentrate feeding on reproductive performance of Co does (n=10)

Parameters	CG	EG	SEM	p-value
Initial weight, kg	27.6	29.0	0.58	NS
Initial BCS	3.0	3.1	0.05	NS
BCS of does at kidding	3.0	3.5	0.04	***
Parturition weight, kg	24.6	32.9	0.80	***
1-month postpartum weight, kg	22.8	31.7	0.97	**
Weight loss percentage, %	7.4	3.4	1.23	NS
2 months postpartum weight, kg	23.4	32.0	0.73	***
Litter size, head per litter	1.30	1.30	0.15	NS
Postpartum interval, days	105.2	49.6	0.87	***
Kidding interval, days	254.8	194.6	0.49	***
Number of litters per year	1.43	1.88	0	***
Total concentrate intake, kg DM	0	43.1		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; NS = not significant; CG: control; EG: experiment

Growth performance of Co kids

During the study, a total of 23 kids were born in each group. The effects of supplementation of concentrate on growth performance of kids are presented in Table 3. The average birth weight of kids in EG was 24.2% higher than that in CG; however, this difference was not significant. Previous results reported that the birth weight of kids from does given supplements were heavier than those from un-supplemented ones (Sumartono et al., 2016; Godah et al., 2022). According to Godah et al. (2022), the low plane of nutrition during late pregnancy of goats kept almost exclusively on the natural pasture would be unable to adequately nourish the fetus in the final stage of pregnancy and consequently birth weight will be reduced.

The body weight of goat in EG was dramatically increased and reached the average weaning weight of 10.0 kg (Table 3). Meanwhile, the slow growth rate was observed with kids in CG and was 5.0 kg per head at weaning. The average daily gain of kids at pre-weaning period in EG was higher significantly than that in CG. This result shows that supplementation of concentrate from 10-day-old to weaning enhances growth performance of kids. According to Mandal et al. (2006), the birth weight and early growth rate of animals are affected by the genetic potential, the maternal and environmental factors. The higher growth rate at pre-weaning period cannot only be sustained by milk supply from their dams (Htoo et al., 2015). Many studies also indicated that supplementation of feed for pregnant animals during late gestation period may provide adequate energy and protein so they produce more milk yield that improved growth rate of their kids (Oeak et al., 2005; Castillo-Gutierrez et al. 2022; Godah et al., 2022). Furthermore, the supplementation of

creep feed can help improve the pre-weaning growth performance of goat kids and increase the net profit for the farmer (Machen, 2002; Htoo et al., 2015).

Economic benefit of supplementation of concentrate

The economic benefit of concentrate supplementation in diets for doe and their kids is presented in Table 4. In this calculation, the cost of labour, housing, veterinary services were not counted. Results on preliminary economic benefit showed that the one reproductive goat and her kid received supplemented concentrate in diets could get benefit of 489,41 Vietnam dong/litter as compared to the control (without concentrate supplementation), and this finding is in agreement with Abou-Elkhair et al. (2020) who studied economic impact of energy concentration of maternal diets in performance of kids. In case of twin kidding, the more benefit could be achieved. In addition, the early concentrate feeding for kids would stimulate rumen development, improve growth performance, and reduce diseases.

Table 3 - Effects of supplemental concentrate feeding on growth performance of kid

Parameters	CG	EG	SEM	p-value
Birth weight, kg	1.65	2.05	0.18	NS
1 month old weight, kg	2.77	4.81	0.51	**
2 months old weight, kg	4.37	7.00	0.79	**
Weaned weight at 3 months old, kg	5.01	10.00	0.39	***
Average daily gain, g/day	37.3	88.3	4.00	***
Total concentrate intake, kg DM	0	5.3		

*p < 0.05; ** p < 0.01; *** p < 0.001; NS = not significant; CG: control; EG: experiment

Table 4 - Estimated benefit of concentrate supplementation (1,000 VND)

Parameters	CG	EG
1. Weight gain at weaning, kg per head	3.36	7.95
2. Increased weight gain compare to the control group at weaning, kg	0	4.59
3. Amount of concentrate consumed by doe during the 105 days of experiment, kg/doe	0	43.1
4. Feed cost for doe during 105 days of experiment = (3) x 7.8*	0	336.18
5. Amount of concentrate consumed by kid from 30-90 days of age, kg/kid	0	5.3
6. Feed cost for kids from 30-90 days of age = (5) x 10.5*	0	55.65
7. Save dues reduction of kidding interval = (4)/105 x 60.2 days		192.74
8. Extra profits from increased weigh gain of kid at weaning = (2) x 150**		688.50
9. Balance or benefit per litter = (8)-(4)-(6)+(7)		489.41

*: Price of concentrate was calculated by ingredient price; **: Price at farm gate; VND : Vietnam dong; CG: control; EG: experiment

CONCLUSION

It can be concluded that supplementation of concentrate in diets for local Co doe from late pregnancy to 2 months postpartum and early concentrate supplementation for their kids improved doe reproductive and growth performance of weaning kids, and increased benefit for reproductive goat farm. It can be suggested that concentrate supplementation with local feed for does and their kids helps economizes goat production in upland areas.

DECLARATIONS

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Authors' contribution

H.T.T. TRAN contributed at designing the experiment, data collection, data analyses, giving comment on the manuscript. A.T.Q. NGUYEN contributed to implementing the experiment, data collection. H.T. DUONG contributed to implementing the experiment, data collection. C.V. NGUYEN contributed to implementing the experiment, data collection. T.H. HOANG contributed to implementing the experiment, data collection. N.T. TRAN contributed at implementing the experiment, data collection. D.V. DINH contributed by giving comments on the manuscript. B.X. NGUYEN contributed to designing the experiment, giving comments on the manuscript. C.L.Q. HO contributed at writing the manuscript, designing the experiment, data collection, data analyses. All authors read and approved the final manuscript.

Conflict of interests

We have no conflict of interest for this article.

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