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The effect of dietary fat supplementation on production performance of Malabari does during early and mid-lactation

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Abstract
This research was conducted to study the responses of early and mid-lactating Malabari does due to dietary supplementation of rice bran oil and calcium salts of fish oil. 12 Malabari does were selected of first week of lactation as control T_1 and experimental T_2 with six does in each group. The proximate composition of green grass and feeds were analysed. The feeding trial was conducted till 60 days of lactation with recording the daily feed intake and milk production performance during early and mid-lactation. There was no significant difference of daily feed intake like green grass intake, concentrate intake and dry matter intake between T_1 and T_2 group. There was no significant difference in milk yield of Malabari does between T_1 and T_2 group statistically, but there was a non-significant increase in the average milk yield was recorded in the Malabari does of T_2 group throughout the experiment when compared to T_1 group. The yield in the treatment group was 6.0 per cent higher than the control group.

Keywords: malabari does, calcium salts of fish oil, feed intake, milk yield

1. Introduction
India has a goat population of 135.17 million, which place it at the first position in the world's goat population of 921 million. The goat milk production in India was 15.2 million metric tons during 2014-2015 as per Basic Animal Husbandry and Fisheries Statistics, (2015) [4] and India was the highest goat milk producer in the world. In Kerala, there are 12.3 lakhs of goats and they are the second major livestock species by population next to cattle with 14.1 lakh heads. Malabari goat originated from the habitat of Malabar area of Northern Kerala. This breed is a dual purpose breed with an average milk yield of 600 g per day. The production of goat milk in Kerala was 112.03 tons and the per capita availability was 203 gram per day during 2013-14.

Goat milk today is considered to have certain nutritional advantages over cow milk. Goat milk has been identified as an alternative for infants and adults who are either sensitive or allergic to cow milk. Supplemental fat sources have increased milk yield and fat concentration as well as milk fatty acid composition of dairy goats (Sampelayo *et al*., 2004) [12]. Supplementing with fat in the diet leads to increase the body condition of the goats.

2. Materials and Methods
The animals were randomly allotted in to two groups of six each as per the design of experiment which is represented in the Table 1.

Group	Feed	Group designation
T_1	Farm feeding schedule (400 g concentrate mixture + green grass *ad lib*)	Control group
T_2	Farm feeding schedule (400 g concentrate mixture + green grass *ad lib*) + Rice bran oil at a rate of 35 g/day and calcium salts of fish oil at a rate of one per cent of their concentrate diet (Tsiplakou and Zervas, 2013) [15]	Treatment group (Supplementation of dietary fat)

2.1 Preparation of bypass fat or calcium salts of fish oil: (Fusion method)
Fish oil was directly heated with the calcium hydroxide to obtain calcium salts. Sixteen gram of calcium hydroxide was added to 100 g of fish oil. Contents were heated to 160˚ C for three hours. The product formed was crushed to powder form and was used for the experiment.

2.2 Feeding management

The feeding trial was conducted from 6th to 60th day of lactation. The does were provided green grass *ad-lib* and the daily feed intake of the animals was recorded. The lactating does were fed with concentrate mixture (with 14 % DCP and 70 % TDN) as per ICAR feeding standards (2013). Other management practices prevailing in the farm were followed similarly throughout the experimental period. The percentage ingredient composition on dry matter basis is given in Table 2.

Table 2: Composition of basal ration (parts/100 kg) on DM (per cent) basis

Ingredients	T_1	T_2
Maize	45	45
Gingili oil cake	18	18
Soybean meal	24	24
Wheat bran	10	10
Mineral mixture	2	2
Salt	1	1
Total	100	100

The proximate composition of the feed offered was analysed as per AOAC, (2012) [2] in the Department of Animal Nutrition. The fibre fraction of the feed was analysed as per (Van Soest, 1991) [16]. Daily voluntary feed and fodder intake of all lactating goats were recorded from 6th to 60th day. The animals were fed twice daily. Weighed quantity of concentrate feed and fodder was provided in the manger for individual animals and the residue was weighed after feeding to calculate the Average Daily Feed Intake (ADFI). The kids were weaned on 6th day after the parturition. The does were hand milked from the 6th day of parturition twice daily. The milk yield from each doe was recorded by using graduated plastic container (1000 ml capacity). First milking was done in the morning (8.00 AM) and second milking was done in the afternoon (3.30 PM) and the lactation yield was recorded. The kids were separated from the lactating does and the milk was fed to kids using feeding bottles.

3. Results

3.1 Proximate composition of fodder and feeds

3.1.1 Proximate composition of green grass (Co3)

Table 8: Proximate Composition of Green grass (Co3)

Nutrients of Green grass (Co3)	Mean± SE (n=6) (per cent)
Moisture	84.55 ± 0.15
Crude protein	10.55 ± 0.13
Ether extract	2.17 ± 0.15
Total ash	13.85 ± 0.02
Acid insoluble ash	2.22 ± 0.175
Crude fibre	28.88 ± 0.65

3.1.2 Proximate composition of concentrate feed

Table 9: Proximate composition of concentrate feed

Nutrients (%)	Mean± SE (n=6)	
	Control (T_1)	Treatment (T_2)
Moisture	11.67 ± 0.13	10.805 ± 0.05
Crude protein	4.145 ± 0.61	4.15 ± 0.60
Ether extract	0.45 ± 0.05	5.675 ± 0.075
Total ash	6.99 ± 0.1	7.06 ± 0.07
Acid insoluble ash	0.675 ± 0.15	0.77 ± 0.15
Crude fibre	18.91 ± 0.85	17.88 ± 0.56

The ether extract content of feed of T_1 and T_2 were 0.45 ± 0.05 and 5.675 ± 0.075 respectively. There was a significant difference in the values of ether extract obtained between T_1 and T_2 group due to the supplementation of rice bran oil and calcium salt of fish oil in the feed of treatment group (T2).

3.2. Fibre fraction analysis of fodder and feed

3.2.1 Fibre fraction analysis of green grass (Co3)

The fibre fraction analysis of Green Grass (Co3) revealed the presence of 71.45 and 43.46 per cent of nutrient detergent fibre (NDF) and acid detergent fibre (ADF), respectively.

3.2.2 Fibre fraction analysis of concentrate feed

The NDF and ADF of concentrates to T_1 group were 36.01 and 19.95 per cent, respectively. The NDF and ADF of concentrates to T_2 group were 35.15 and 18.33, respectively. There was no much difference in the values of NDF and ADF between control (T_1) and treatment (T_2) groups.

3.3 Feed intake

3.3.1 Average green grass, concentrate and dry matter intake

The statistical analysis was done with Independent t-test, the difference of average daily green grass intake, concentrate intake and dry matter intake was statistically no significant between T_1 and T_2 group of the experiment.

Table 13: Average green grass, concentrate and dry matter intake

	Mean ± SE (n=6)		Statistical analysis	
Intake /day	Control T_1	Treatment T_2	t-value	p-value
Green grass (kg/d)	3.92 ± 0.084	4.07 ± 0.030	1.677^{ns}	0.143
Concentrate (g/d)	396.56 ± 0.18	395.72 ± 0.42	1.827^{ns}	0.112
Dry matter (DM) (g/d)	0.955	0.981	0.332^{ns}	0.746

ns- non significant

3.4 Milk yield

3.4.1 Average milk yield

The results of average milk yield of Malabari does in control T_1 and treatment T_2 group are presented in the Table 14. The average milk yield of T_1 and T_2 group were 375.68 ± 21.54 mL/d and 399.81 ± 43.34 mL/d respectively.

Table 14: Average milk yield of Malabari does

	Mean ± SE (n=6)		Statistical analysis	
Yield/ day	Control T_1	Treatment T_2	t-value	p-value
Milk (mL/d)	375.68 ± 21.54	399.81 ± 43.34	0.498^{ns}	0.629

ns- non significant

There was no significant difference in the milk yield between T_1 and T_2 group.

3.4.2 Average daily milk yield at weekly interval

Table 15: Average daily milk yield at weekly interval

Week of lactation	Average milk yield mL/day Mean ± SE (n=6)		Statistical analysis	
	Control T_1	Treatment T_2	t-value	p-value
1	384.05 ± 33.57	532^{a} ± 68.20	1.954^{ns}	0.90
2	380 ± 34.81	420.71^{ab} ± 54.21	0.617^{ns}	0.551
3	382.02 ± 35.09	406.58^{ab} ± 51.33	0.394^{ns}	0.702
4	351.19 ± 20.82	356.79^{c} ± 40.41	0.123^{ns}	0.905
5	387.14 ± 21.59	367.26^{bc} ± 36.10	0.464^{ns}	0.655
6	392.86 ± 24.21	377.14^{bc} ± 40.61	0.332^{ns}	0.746
7	376.19 ± 21.76	395.71^{b} ± 44.76	0.392^{ns}	0.703
8	362.74 ± 13.13	366.31^{c} ± 40.85	0.083^{ns}	0.936
F-value	0.777	6.999**		
p-value	0.462	0.009		

ns- non significant; ** significant at 1% level Means with different superscript differed significantly at P <0.05

The statistical analysis with Independent t-test was done between the groups and within the groups. There was no significant difference between T_1 and T_2 group. But there was a significant difference at 1 per cent level within the T_2 group.

4. Discussion

4.1 Proximate composition of fodder and feed

The proximate composition of green grass (CO3) in the present study correlated with the studies previously conducted by other workers. The crude protein content was almost same as that reported by Murugan *et al.*, 2016. However, the average ether extract, total ash, acid insoluble ash and crude fibre reported was 3.11, 14.8, 4.5 and 32.02 per cent, respectively compared to the values 2.17 ± 0.15, 13.85 ± 0.02, 2.22 ± 0.175 and 28.88 ± 0.65 per cent, respectively obtained in the present study. The slight variation in the contents of nutrients could be attributed to the season and stage at which the fodder was harvested.

The proximate composition of concentrate feed of control group (T_1) and treatment group (T_2) revealed a significant difference in the per cent of ether extract. The difference resulted due to the inclusion of oil in the form of rice bran oil and calcium salt of fish oil in the concentrate diet prepared for treatment (T_2) group. Similar differences in composition between concentrate diets of control and treatment group following inclusion of vegetable oils like soybean oil and fish oil (Fawzi and Azmi, 2011; Tsiplakou and Zervas, 2013; Parnerkar, 2013) [7, 15, 10].

4.2 Fibre fraction analysis of feed and fodder

The NDF and ADF values of 71.45 and 44.46 per cent, respectively for green grass (CO3) were well within the range reported by other workers. The NDF and ADF values of 72.81 and 31.33 per cent, respectively were reported for green grass CO3 (Murugan *et al*., 2013) [13]. The higher NDF and ADF values in the present study indicated the maturity of the plant with more content of stem. Similarly, the NDF and ADF values of concentrate feed of (T_1) group did not differ significantly from the treatment (T_2) group.

4.3 Feed intake or dry matter intake

The average daily green grass and concentrate intake did not significantly vary between the T_1 and T_2 groups indicating that supplementation of rice bran oil and calcium salts of fish oil did not interfere with the daily intake of green grass and concentrate. Reddy *et al*. (2003) [11] reported a non-significant decrease in the average dry mater intake of sorghum straw diet with dietary protected fat at 0.15 level in Deccan sheep when compared to diet with 0, 0.05 and 0.10 level of protected fat. The results of the present study is supported by the findings of Titi (2011) [14] where in diet of early lactating Shami goats supplemented with different percent of calcium salts of fatty acids showed no significant difference in daily feed intake (hay and concentrate). In a similar study conducted in dairy goats, the dry matter intake did not significantly differ between the groups following supplementation of soybean oil and fish oil in diets (Tsiplakou and Zervas, 2013) [15].

4.4 Milk yield

The average milk yield in control group was 375.68 ± 21.54 ml/day. According to Verma *et al.* (2009) [17], the daily average milk yield of Malabari goats were 0.5 to 1.5 L/d which was higher than the present findings. A non-significant increase in the average milk yield was recorded in the Malabari does of T_2 group throughout the experiment when compared to T_1 group. The yield in the treatment group was 6.0 per cent higher than the control group. Parnerker (2013) reported a 5.95 per cent higher milk yield in Surti goats supplemented with commercially available bypass fat compared to control. However, Sampelayo *et al.* (2002) [12], Yilmaz *et al.* (2009) [18] reported that daily milk production in goats was not affected significantly by dietary protected fat supplementation. Tsiplakou and Zervas, (2013) [15] did not observe any effect on the milk yield following supplemtation of goat diet with soybean and fish oil either. The present results are also in agreement with the results described by Chilliard *et al*. (2007) [5] where in supplementation of calcium salts of palm oil in the mid and late lactation did not affect the milk yield. Further, no modification of Saanen goat's milk yield was observed by following supplementation of concentrate with rumen inert fat as calcium salts of fatty acids. The reasons cited by the above authors for non-increase in the milk yield following supplementation of diets containing different amounts of rumen inert fatty acids in the form of calcium salts could be due to similar metabolizable energy intakes among the diets as dietary energy is considered as an important factor limiting milk production (Gomes *et al.*, 2015) [8].

The milk yield of Malabari does of control T_1 group during 1, 2, 3, 4, 5, 6, 7, 8 weeks of lactation also did not significantly differ from the treatment group. However, a significant difference was noted between weeks of lactation in treatment group. The milk yield showed a gradual decline in yield till the fourth week of lactation followed by a gradual increase till the seventh week of lactation.

Das and Singh (2000) [6] reported that there was significant difference in the milk during the different stages of lactation and the highest yield was recorded in 3rd week of lactation then it started to decline after 5th week and reached as low

milk yield on 11th week of lactation. Similarly, Agnihotri and Rajkumar (2007) [1] mentioned that the milk yield differed significantly between the stages of lactation and the highest yield was noted in week 2nd of lactation followed by a decline ($p< 0.01$) after 6th week and reached as low milk yield on 13th week of lactation.

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