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Effect of supplementation of rice bran oil and rumen protected fish oil on the sensory attributes of goat milk

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Abstract
This research was conducted to analyse the sensory attributes of milk from Malabari goats supplemented with rice bran oil and calcium salts of fish oil. The aim of the supplementation was to examine how it would affect milk production and the milk's fatty acid composition. Twelve Malabari does on the sixth day of lactation were selected to conduct trial at the Goat Farm, Instructional Livestock Farm Complex, College of Veterinary and Animal Sciences, Wayanad, Kerala, India. The animals were randomly divided in to two groups and the control group was maintained on the standard feeding practices followed in the farm, 400 g concentrate mixture and green grass *ad lib.* The treatment group was provided with 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. Milk samples were collected fortnightly on 14th, 28th, 42nd and 56th day. The sensory attributes of the milk samples were assessed by the reference from American Dairy Science Association guide for scoring off-flavours in milk, with slight modifications (American Dairy Science Association, 1987). No significant differences in sensory attributes were observed between the control group and the treatment group.

Keywords: Rice bran oil and rumen, fish oil, sensory attributes, goat milk

1. Introduction
Malabari goats 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. Composition of goat milk differs from other mammalian milk in terms of alkalinity, better digestibility, buffering capacity and its nutraceutical properties. Hence, goat milk is endorsed for children, aged and unhealthy people. According to Park *et al.* (2007) [11] breed, nutrition, stage of lactation, environment and animal health are the key factors influencing goat milk output and composition.

Due to acceptability, attractive odour and taste of the goat milk, it can substitute cow milk. Goat milk is less allergenic and has higher digestibility (Park *et al.*, 2007) [11]. Goat milk contains both polyunsaturated fatty acid (PUFA) and conjugated linoleic acid (CLA) which are proved to have potential health benefits. Health benefits of omega-3 PUFA includes decreased risk of cardiovascular diseases, increased development of brain and visual ability in small children and modulation of inflammatory disorders. Health benefits of CLA includes anti-carcinogenic and anti-atherogenic properties (Kinsella, 1986; Whigham *et al.*, 2000) [6, 14].

Despite being a hereditary feature, goat milk output and composition, particularly fatty acid profile and flavour can be effectively changed by dietary supplementation with lipids (Nudda *et al.*, 2006) [10]. Supplementation of goat's feed with vegetables oils, which has higher amount of linoleic acid increases the CLA (Luna *et al.*, 2008) [8], while inclusion of rumen protected fish oil enhances omega-3 fatty acids like eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) content in milk fat (Kitessa *et al.*, 2001; Cattaneo *et al.*, 2006) [7, 2]. There are various publications in the area of nutritional manipulations to improve the fatty acid profile of goat milk in a healthier way (Raval *et al.*, 2021[12]; Adeyemi *et al.*, 2016; Marín *et al.*, 2012) [1, 9]. In this context, vegetable oils have been employed to boost dietary energy density and to enhance the quality of goat milk and its byproducts. The important sources of supplementation include linseed oil, rice bran oil, fish oil, sesame oil (*Sesamum indicum* L.) and castor oil (*Ricinus communis* L.) (Marín *et al.*, 2012; de Medeiros *et al.*, 2013; Dauber *et al.*, 2022) [9, 4, 3]. However, the effects of these oils as supplements in animal diets and its effects on changes in sensory attributes of milk and milk products are still poorly understood. Hence, this research was undertaken to study the effect of supplementation of rice bran oil and rumen protected

fish oil on the sensory attributes of goat milk.

2. Materials and Methods

2.1 Animal selection

The study was conducted in twelve Malabari goats in the first week of lactation. The animals were randomly selected from the Goat Farm, Instructional Livestock Farm Complex (ILFC), College of Veterinary and Animal Sciences, Pookode, Wayanad, Kerala, India. The animals were fed with 400 g concentrate mixture and green grass *ad lib*itum as per the recommended feeding regimen of the instructional goat farm.

2.2 Experimental Design

The animals were randomly allotted to two groups of six each as per design of experiment (Table 1).

Table 1: Experimental design

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) [13]	Treatment group (Supplementation of dietary fat)

2.2.1 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 (Garg, 1997) [5]. The product formed was crushed to powder form and was used for the experiment Plate 1.

Plate 1: Bypass fat or calcium salts of fish oil

2.3 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

2.4 Sensory evaluation of milk

The sensory evaluation of milk was done in the department of Livestock Products Technology, College of Veterinary and Animal Sciences, Pookode. 150 ml of milk sample was collected in a conical flask on 1st, 14th, 28th, 42nd, 56th day of the experiment. Six samples from each group were collected fortnightly. Then the milk was boiled separately before evaluation. The reference from American Dairy Science Association (ADSA) guide for scoring off-flavours in milk was used with slight modifications (American Dairy Science Association, 1987). The scores of ADSA were presented in the Table 3.

Table 3: The American Dairy Science Association Guide for scoring off-flavours in milk

Flavors Criticisms	Intensity of Defect and Corresponding Score		
	Slight	Definite	Pronounced
Acid	3	1	0
Astringent	8	7	6
Barny	5	3	1
Bitter	5	3	1
Carton/Paperboard[b]	9	8	6
Coagulated[b]	0	0	0
Cooked	9	8	6
Goaty	6	4	1
Feed	9	8	6
Fermented/Fruity	5	3	1
Flat	9	8	7
Foreign	5	3	1
Garlic/Onion	5	3	1
Lacks Freshness	8	7	6
Malty	5	3	1
Oxidized- Light	6	4	1
Oxidized- Lipid	5	3	1
Rancid	4	1	0
Salty	8	6	4
Unclean	3	1	0
Other			

[a]Normal range is 1-10. "No Criticism" is assigned a score of "10"
9-10 Excellent
8-9 Good
7-8 Fair-good
<6 Poor/unacceptable
[b]Criticism not included in original ADSA guideline.

3. Results and Discussion

1. Sensory Attributes of Milk Samples (Flavour)

The results of the sensory attributes of milk samples are presented in table 4. The scores for the T_1 milk for acceptance test fortnightly from 1st to 8th week of lactation were 9.73±0.08, 9.70±0.09, 9.67±0.09, 9.67±0.09 and 9.67±0.09, respectively. The scores for the T_2 milk for acceptance test fortnightly from 1st to 8th week of lactation were 9.77±0.06, 9.70±0.09, 9.567±0.09, 9.67±0.09 and 9.80±0.07, respectively.

Table 4: Sensory attributes (Flavour) of milk samples

Fortnightly interval	Sensory attributes (Flavour) Mean±SE (n=6)		Statistical analysis	
Day	Control T_1	Treatment T_2	z-value	p-value
01	9.73±0.08	9.77±0.06	0.296^{ns}	0.767
14	9.70±0.09	9.70±0.09	00^{ns}	1.00
28	9.67±0.09	9.567±0.09	0.790^{ns}	0.430
42	9.67±0.09	9.67±0.09	00^{ns}	1.00
56	9.67±0.09	9.80±0.07	1.158^{ns}	0.247

ns- Non significant

The statistical analysis with Mann-Whitney Test revealed that there was no significant difference between the groups. The American Dairy Science Association Guide for scoring off-flavours in milk was considered in both the groups (T1 and T2) in different fortnights. The scores varied between 9-10, hence the milk was considered to be excellent for human consumption.

4. Conclusion

The sensory features of the samples were quite similar in terms of their sensory descriptors; therefore, no changes (p>0.05) were identified between the milk from control and supplemented group for any of the attributes tested. In general, vegetable oils and fish oil, which are high in PUFA were generally well tolerated by goats, and did not significantly alter the sensory properties of milk.

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