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Short communication

Effect of jackfruit peel inclusion in diets on nutrient utilization and haemato-biochemical profile of Osmanabadi goats

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Abstract

Lactating Osmanabadi goats (n = 12) were randomly divided into three groups: T0, T1 and T2. The control group (T0) was offered a regular concentrate mixture, whereas in the treatment groups, Jackfruit peel (JFP) was included at 10% (T1) and 20% (T2) levels in a concentrated mixture on a dry matter (DM) basis. For the nutrient utilization study, 350 g of concentrate mixture was offered in the morning and evening, and green forage (hybrid napier fodder) was given *adlib* throughout the day. Inclusion of JFP did not show any significant effect (p >0.05) on the intake, outgo (g/d) and digestibility (%) of nutrients (DM, OM, CP, EE and NFE). The effect of the inclusion of jackfruit peel was non-significant on the apparent absorption of Ca and P. No significant change was observed on hemoglobin (g/dl), packed cell volume (%) and serum biochemical parameters, *viz*., total protein, albumin, globulin (g/dl) and A:G ratio (p >0.05) due to the inclusion of JFP. Serum ALT level was not affected, whereas AST level was significantly lower in T2 (64.72 IU/L) compared to T0 (90.34 IU/L). Thus, JFP could be safely included up to 20% level in a concentrated mixture of Osmanabadi goats.

Keywords: Haemato-biochemical profile, Jackfruit peel, Nutrient utilization, Osmanabadi goats

Jackfruit is used both as a vegetable and fruit for human consumption in countries like India, Burma, Malaysia, and the East Indies. In India, the overall area under jackfruit farming is about 1,85,000 hectares. It is also grown between other crops in the field, resulting total production of about 18,30,000 MT (NHB, 2018). The topmost states growing jackfruit trees are Kerala, Assam, West Bengal, Chhattisgarh, Madhya Pradesh, Tamil Nadu, Tripura and Karnataka (Arun *et al*., 2020). Their wide uses as vegetables in the above regions lead to a generation of much quantity of jackfruit waste. Inventiveness for the use of waste from Jackfruit processing in livestock feed, would help to preserve their nutrient value as well as decrease the cost of livestock production besides minimizing pollution hazards. Besides fruits, the nutritious leaves of plants also suffice the fodder needs of the animals (Gupta *et al*., 2023). Among the Jackfruit wastes, the peel is one of the underutilized vegetable by-products, with the least research conducted for its successful inclusion in livestock feed (Ajey, 2013). The peel constitutes 40.05-57.17% of fruit in different Jackfruit varieties (Akter and Haque, 2019). Jackfruit peel (JFP) has been observed to be a rich source of bioactive compounds like vitamin C, beta-carotene, and various phytonutrients such as alkaloids, lignans, isoflavones, and saponins (Swami *et al*., 2012). Its feeding value as an ingredient in cattle feed due to its high carbohydrate, protein and fiber content has been reported earlier (Subburamu *et al*., 1992). Recently, goat husbandry has been attracting the attention of landless and marginal farmers as well as entrepreneurs of India, evidenced by a 10.14% increase in their number in the livestock census (2019) over the previous livestock census (2012). Nutrition is the major factor guiding profit or loss in goat rearing, and the lesser profit margin from goat husbandry is essentially attributed to their inadequate nutrition (Shinde and Mahanta, 2020). To meet the nutrition of goats thoroughly is a challenge due to the existence of a huge gap between the demand and supply of feed and fodder for livestock (Mahanta *et al*., 2020; Kumar *et al*., 2023) and emphasis is especially laid on balanced feeding of large livestock species like cattle and buffalo to improve their milk production. Keeping the above in view, the present study was conducted to evaluate the potential of Jackfruit peel waste on dietary nutrient utilization and haemato-biochemical parameters in Osmanabadi goats.

Fresh Jackfruit peel was collected from the local market of the Durg district of Chhattisgarh State as vegetable waste free of cost. After drying in a neat and clean place for 2-3 days under sunlight, the dried Jackfruit peel was ground in a hammer mill using 1-mm sieve and stored in a polythene bag. Twelve lactating Osmanabadi goats, around 30 kg BW were randomly divided into three groups (T0, T1 and T2). The control group (T0) was offered a concentrated mixture prepared using maize, de-oiled rice bran, soybean meal, cotton seed cake, mineral mixture and salt. In the treatment groups, Jackfruit peel (JFP) was included at 10% (T1) and 20% (T2) of the concentrate mixture on DM basis (Table 1). The chemical composition (%DM) of green fodder and concentrate mixture was recorded (Table 2). The goats were offered about 350 g concentrate mixture in the morning (8.00 AM) and evening (6.00 PM) and green forage (hybrid napier fodder) was given *adlib* throughout the day. After an adaptation period of 21 days to experimental diets, goats were transferred to metabolic cages. After 3 days of adaptation in the cages, a metabolic trial of 5 days duration was conducted. Following feeding, the residue left was weighed the next day before offering fresh feed.

Table 1. Ingredient composition of concentrate mixture

Ingredients	Concentrate I (T_0)	Concentrate II (T_1)	Concentrate III (T_2)
Maize	35	30	25
De-oiled rice bran	40	34	27
Soybean meal	12	13	14
Cottonseed cake	11	11	12
Jackfruit peel	0	10	20
Mineral mixture and salt	2	2	2

The records of the quantity of feed offered daily and residue left, faces, and urine voided during 24 h of feeding were made. The milk samples were collected daily during the trial period.

Representative samples of feed, fodder and residue were collected daily and dried in hot air oven at 70°C. From weighed faeces 1/10th of aliquot on a fresh basis was pooled and dried for further analysis. For fecal N estimation, an aliquot of fresh feces was collected into 25% of H_2SO_4. Aliquot of fresh urine was preserved daily in containers containing 25% H_2SO_4 for further analysis. Dried daily samples of feed, fodder, residue and feces were mixed and ground to pass through 1-mm sieve. The samples were analyzed for proximate principles (AOAC, 2000), calcium (Talapatra *et al*., 1940) and inorganic phosphorus (Fiske and Subbarow, 1925). Collected milk samples were analyzed for fat, SNF, protein and lactose by an automatic milk analyzer.

At the end of the trial, the blood sample was collected from the jugular vein and serum was separated and analyzed for total protein, albumin, SGOT (AST) and SGPT (ALT) in a semi-automated analyzer using diagnostic kits. For hemoglobin (Hb) and packed cell volume (PCV), blood samples from the jugular vein were collected into bottles containing ethyl diamine tetra acetic acid (EDTA) as an anticoagulant. Haemoglobin was estimated by the cyanomethemoglobin method using Drabkin's solution (Dacie and Lewis, 1968) and PCV was determined by the micro-hematocrit method (Jain, 1986). For interpretation of results, the data obtained in the experiment were subjected to analysis of variance following a completely randomized design as per Snedecor and Cochran (1994) and the significance of differences among the groups was analyzed by the Duncan Multiple Range Test.

The effect of dietary supplementation of JFP on dry matter intake and digestibility of DM, OM, CP, EE, CF and NFE was recorded (Table 3). DM intake due to supplementation of different levels of JFP did not differ significantly (p >0.05) among the groups. The dry matter intake (g/d) was 1194.55, 983.82 and 978.83 in groups T0, T1 and

Table 2. Chemical composition (%DM basis) of fodder and concentrate mixture

Particulars	Hybrid napier	Concentrate I	Concentrate II	Concentrate III
Dry matter (DM)	30.28	91.93	91.50	91.25
Moisture	69.71	8.07	8.50	8.75
Crude protein	9.36	16.68	16.47	16.36
Ether extract	1.74	2.87	2.89	3.01
Crude fibre	26.78	6.96	7.61	8.27
Nitrogen free extract	46.28	66.22	66.01	65.63
Total ash	15.84	7.27	7.02	6.73
Calcium	0.45	0.28	0.32	0.31
Phosphorus	0.17	0.31	0.29	0.27

Table 3. Effect of inclusion of jackfruit peel on nutrient utilization in Osmanabadi goats

Particulars	**T0**	**T1**	**T2**
Feed (DM) intake			
DM intake (g/d)	1194.55 ± 68.04	983.82 ± 102.68	978.83 ± 135.16
Body weight (kg)	32.08 ± 0.67	30.74 ± 1.88	29.40 ± 1.42
DMI (%)	3.72 ± 0.15	3.26 ± 0.45	3.34 ± 0.46
DMI (g/ kgW$^{0.75}$)	88.54 ± 4.00	76.24 ± 9.65	77.68 ± 10.45
Nutrient digestibility (%)			
DM	70.82 ± 1.56	69.59 ± 0.72	67.08 ± 1.74
OM	73.66 ± 0.95	73.95 ± 2.22	70.69 ± 1.39
CP	66.25 ± 3.14	66.51 ± 3.82	66.04 ± 5.64
EE	79.58 ± 1.34	81.47 ± 1.65	77.48 ± 1.74
CF	61.45 ± 0.51	60.59 ± 8.01	59.06 ± 4.84
NFE	80.22 ± 1.65	81.60 ± 1.28	75.97 ± 2.38
DCP	7.69 ± 0.43	8.08 ± 0.57	8.20 ± 1.04
TDN	65.77 ± 0.87	66.70 ± 2.12	63.77 ± 1.52

T2, respectively. Jackfruit residue silage at 25 and 50% levels replacing finger millet straw also did not exhibit any significant effect on DM intake in lambs (Arun *et al*., 2020). Similar findings were observed in cattle when 5 kg fresh jackfruit waste was supplemented, replacing one-third of concentrate in a concentrate: mixed grass: paddy straw-based diet. DM intake per kg metabolic body size differed non-significantly among the groups and ranged from 76.24 to 88.54 g/ kg BW$^{0.75}$.

The inclusion of JFP in diet had no significant effect on OM, CP, EE and CF digestibility (p >0.05). Higher polyphenol in jackfruit peel was reported to have an anti-inflammatory effect (Meera *et al*., 2018). However, no adverse effect of polyphenol was recorded on protein digestibility in the present study. Unlike present findings, Azevêdo *et al.* (2015) observed decreased OM digestibility and improved CP digestibility on, including jackfruit silage replacing 333, 666, 1000 g/kg corn from concentrate of lambs. That could be due to the variation in cellular and cell wall carbohydrate concentration in corn and jackfruit. Thus, they concluded that jackfruit could not be a suitable replacement for starch-rich grains like corn. Like present observations, jackfruit waste did not alter CP (68.23%) and EE (78.12%) digestibility in cows when one-third of the concentrate was replaced with 5 kg of fresh jackfruit waste (Das *et al*., 2001). Silage from jackfruit waste also did not affect the digestibility of CP, NDF and ADF when replaced 25 and 50% of finger millet straw in the diet of lambs (Arun *et al*., 2020).

The nitrogen retention (%) was 39.53, 34.90, and 36.98% in groups T0, T1 and T2, respectively (p >0.05) (Table 4). The inclusion of JFP probably did not alter the RDP: UDP ratio significantly enough to cause any considerable shift in N metabolism (Mishra and Rai, 1996). On supplementing different sources of protein, such as Cassava leaves hay or Gliricidia leaves hay with jackfruit, there was significant variation in nitrogen retention (22.2 and 19.22 g/d, respectively) in growing sheep (Kusmartono, 2007). Dietary calcium concentration is very important for dairy goats because low calcium diets lead to reduced milk production. Indeed, farm animals require diets that should contain between 0.5 and 1 percent calcium (Long, 2016). In the present study, Ca concentration in all the diets was within the above-reported range. Higher Ca intake than the requirement was observed to decrease the apparent absorption coefficient (17.85%).

The inclusion of JFP at different levels did not show any significant variation in milk composition (fat, snf, protein, lactose) among groups (Table 5). Srikrishna (2005) observed that Jackfruit seed powder could be included up to 40% in the concentrate mixture without any adverse effect on milk yield and milk composition in cattle. Fruit waste like whole mango meal supplemented at 10, 20, and 30% replacing ground corn in the diet reported no effect on milk production (4% fat-corrected) and milk composition of goats (Silva *et al*., 2016). Arco-Pérez *et al*. (2017) reported no effect on milk yield and milk composition of lactating goats supplemented with tomato surplus silage on replacing oat hay. In contrast, many researchers observed improvement in milk production and its composition when different fruit or vegetable waste was incorporated into the diet of animals. Romero-Huelva *et al*. (2012) reported an increase in polyunsaturated fatty acid proportions in milk without compromising the milk yield of dairy goats by replacing 35% of cereal-based concentrate with *ad libitum* supply of feed blocks containing either waste fruits of tomato or cucumber.

Table 4. Effect of inclusion of jackfruit peel on nitrogen retention and mineral absorption status in Osmanabadi goats

Particulars	**T0**	**T1**	**T2**
N intake (g/d)	22.12 ± 0.99	19.43 ± 1.88	18.87 ± 1.75
Faecal N (g/d)	7.53 ± 0.99	6.69 ± 1.30	6.69 ± 1.70
Urinary N (g/d)	4.38 ± 0.65	4.43 ± 0.80	4.08 ± 0.47
N in milk (g/d)	1.53 ± 0.15	1.40 ± 0.08	1.35 ± 0.06
N balance (g/d)	8.69 ± 1.29	6.64 ± 0.81	6.75 ± 0.39
N retention (%)	39.53 ± 5.79	34.90 ± 4.10	36.98 ± 4.75
Ca intake (g/d)	8.83 ± 0.67	6.98 ± 0.84	7.39 ± 1.48
Ca absorption* (%)	59.32 ± 1.74	55.76 ± 3.51	54.39 ± 2.57
P intake (g/d)	5.21 ± 0.25	4.44 ± 0.40	4.36 ± 0.50
P absorption* (%)	49.36 ± 3.93	45.37 ± 3.70	42.82 ± 3.14

*Apparent

Table 5. Effect of inclusion of Jackfruit peel on milk composition of Osmanabadi goats

Particulars	T0	T1	T2
Total milk (ml/day)	317.75 ± 26.13	280.75 ± 10.41	259.75 ± 8.89
Total FCM yield (ml/day)	323.08 ± 29.11	302.35 ± 12.72	274.87 ± 33.06
Fat (%)	4.10 ± 0.09	4.53 ± 0.27	4.33 ± 0.66
SNF (%)	8.37 ± 0.38	8.22 ± 0.33	8.74 ± 0.21
Protein (%)	2.98 ± 0.17	3.08 ± 0.09	3.2 ± 0.04
Lactose (%)	4.5 ± 0.24	4.55 ± 0.17	4.88 ± 0.08

Table 6. Effect of dietary inclusion of Jackfruit peel on haemato-biochemical parameters

Particulars	T0	T1	T2
Hb (g/dl)	10.15 ± 0.18	9.70 ± 0.21	9.93 ± 0.35
PCV (%)	29.14 ± 0.86	27.92 ± 1.47	26.87 ± 1.85
Serum protein (g/dl)	0.15 ± 0.18	9.70 ± 0.21	9.93 ± 0.35
Serum albumin (g/dl)	29.14 ± 0.86	27.92 ± 1.47	26.87 ± 1.85
Serum globulin (g/dl)	2.97 ± 0.17	3.13 ± 0.05	3.01 ± 0.99
Albumin: globulin ratio	1.25 ± 0.09	1.11 ± 0.06	1.17 ± 0.03
ALT (SGPT) (IU/L)	24.28 ± 1.19	23.99 ± 2.22	22.86 ± 1.59
AST (SGOT)* (IU/L)	$90.34^{a} \pm 6.29$	$81.23^{ab} \pm 7.61$	$64.72^{b} \pm 7.13$

*Means in the same row with different superscripts differed significantly (p <0.05)

The hemoglobin (Hb) and packed cell volume (PCV) in goats fed different levels of JFP were recorded (Table 6). The Hb (g/dl) and PCV (%) did not vary significantly due to dietary inclusion of JFP in goat feed. The Hb% was 10.15, 9.70, and 9.93 in T0, T1, and T2 groups, respectively. The PCV was reported at 29.14, 27.92, and 26.87% in the T0, T1, and T2 groups, respectively. The hematological values observed in the current study fall within the normal values (Patil *et al*., 2014; Manimaran *et al*., 2022). It indicates that the goats were properly nourished and were not anemic or did not show any sign of sickness. Several other fruit residues, like banana peel powder and pineapple waste, were found to alter the Hb and PCV concentration when included in the diet of goats (Al-Absawi *et al*., 2020; Ayandiran *et al*., 2019).

The serum biochemical parameters in goats with different dietary supplementation of JFP were recorded (Table 6). The effect of supplementation of JFP at different levels was non-significant on serum total protein, albumin, globulin, and albumin: globulin ratio. Total serum protein (g/dl) was 6.65, 6.59, and 6.56 in groups T0, T1, and T2, respectively. Albumin concentration was 3.68, 3.46, and 3.52 in groups T0, T1, and T2, respectively. Ayandiran *et al*. (2019) reported increased concentration of total protein, albumin, and globulin with increased supplementation (0, 20, 30, and 40%) of wheat offal carried pineapple waste to goat. No significant effect of dietary supplementation of JFP on the activity of alanine aminotransferase (ALT) was observed in the present study. The values were 24.28, 23.99, and 22.86 IU/L in the T0, T1, and T2 groups, respectively. The supplementation of a higher level (20%) of JFP had a significant effect on the value of liver enzyme AST as compared to a control group. The value for AST enzyme was significantly (p <0.05) lower in a goat-fed diet supplemented with 20% JFP (64.72 IU/L) as compared to the control (90.34 IU/L) group. A decreased liver enzyme concentration was reported to be associated with reduced oxidative stress in experimental animals. So, the high phenolic content of JFP possibly contributed to the better antioxidative properties of a 20% JFP-supplemented diet (Meera *et al*., 2018).

It was concluded that supplementation of JFP up to 20% on a DM basis as a replacer of concentrate feed did not affect nutrient utilization and blood hematological and biochemical parameters in lactating Osmanabadi goats.

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