



Malabari Kids Fed with Dairy Based Starter Rations

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Nutrient Digestibility and Haemato-Biochemical Profile of Malabari Kids Fed Dairy Based Starter Rations

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ABSTRACT

An experiment was conducted to study the impact of dairy based starter ration on nutrient digestibility and haemato-biochemical profile of pre-weaned Malabari goat kids. Malabari kids (n=18) of fourteen days old of either sex, were selected and were raised under an intensive management system for the period of four months. The experimental kids were randomly assigned to three treatment groups (G1, G2 and G3). Milk was offered for three months of age for G1 group and for 45 days of age for both G2 and G3 groups. The kids in G1 were offered conventional starter while dairy based starters were offered to kids in G2 (5% Skimmed milk powder and 15% whey powder) and G3 (10% Skimmed milk powder and 10% whey powder). The daily milk consumption, feed intake and faecal score of kids were recorded. A digestibility trial was conducted for five days duration towards the end of feeding trial. Blood samples were collected at sixth and sixteenth week of the feeding trial. The total DMI of kids were similar ($p > 0.05$) among groups. The kids in G3 had higher ($p < 0.01$) starter DMI than the kids in G2 and G1. The digestibility coefficient of nutrients was found to be similar ($p > 0.05$) among groups. Similar ($p > 0.05$) fortnightly mean faecal condition score was observed in experimental kids maintained on three different dietary regimes. The haemato-biochemical parameters of kids did not vary significantly among groups. Hence, it can be concluded that early weaning and feeding dairy based starter ration did not have any adverse impacts on the health and nutrient digestibility of the kids.

KEYWORDS: Biochemical profile, Dairy, Digestibility, Faecal condition score, Starter

Article received: 14 August 2025; Article accepted: 15 December 2025.

INTRODUCTION

In India, goat industry is characterized by small-scale operations that play a vital role in the rural economy. Goat farming contributes to the livelihoods of many families, enhancing economic stability and food security in rural societies (Singh et al., 2023). Kid rearing is fundamental to the productivity and profitability of a goat herd. The growth of goat kids during the pre-weaning and weaning periods is crucial for maximizing the future growth, production and lifetime profitability of dairy does (Morand-Fehr et al., 2002). The productivity and profitability of the herd are significantly influenced by nutrient digestibility of feed (Solaiman and Shoemaker, 2009) and hemato-biochemical profile (Nayak et al., 2021) of goats. Improved feed digestibility in goat kids ensures

better feed efficiency and higher weight gain, which are critical for growth and development. Similarly, a balanced biochemical profile serves as an indicator for good nutritional status, contributing to healthier herds and better economic outcomes for goat producers (El-Tarabany et al., 2018). By focusing on improving these aspects through effective management practices, producers can enhance growth rates, reduce costs, and ultimately increase the sustainability of their goat farming operations. Despite its importance, there is notable few published research on the effect of rearing goat kids by providing dairy based starter rations on nutrient digestibility and blood biochemical parameters. This gap in knowledge limits the resources available to producers seeking to optimize productivity and health outcomes for their herds.

By investigating these aspects, the study aims to address this gap by providing a comprehensive analysis of how different feeding regimes affect the digestibility and haemato- biochemical parameters of Malabari kids.

MATERIALS AND METHODS

Malabari kids (n=18) of fourteen days old of either sex, were selected and were raised under an intensive management system for the period of four months. All the kids were ear tagged and dewormed before the start of the experiment. The experimental kids were randomly assigned to three treatment groups (G1, G2 and G3). The G1 kids were fed with

milk up to three months of age and kids in G2 and G3 were weaned off milk by 45 days of age. All the kids were provided with starter ration (CP-23%; TDN-70%) and hybrid Napier fodder from 14 days of age. The kids in G1 were offered conventional starter while dairy based starters were offered to kids in G2 (5% Skimmed milk powder and 15% whey powder) and G3 (10% Skimmed milk powder and 10% whey powder). The ingredient composition of experimental rations was listed in the Table 1. The daily milk consumption, feed intake and faecal score of kids were recorded.

Table 1. The ingredient composition (%) of rations fed to experimental kids

Ingredients	T1 (control)	T2	T3
Maize	26	16	16
Corn gluten fibre	19	6.5	5.5
Gingelly oilcake	8	8	7
Coconut oilcake	5	5	5
Soybean meal	10	10	9
Alfa-alfa meal	12	12	11
Wheat Bran	14	15.5	16.5
Black gram husk	4	5	8
Dried whey	-	15	10
Skimmed milk powder	-	5	10
Mineral Mixture	1.5	1.5	1.5
Salt	0.5	0.5	0.5
Total	100	100	100

A digestibility trial for five days duration was carried out using all the experimental kids towards the end of feeding trial by total collection method. All the faecal pellets voided by each animal were collected quantitatively uncontaminated with urine, feed or dirt, at 8 A.M. every day during the digestion trial. The faecal pellets collected were weighed individually and stored in double lined polythene bags in deep freezer (-20 °C). The moisture and the crude protein (CP) were estimated (AOAC, 2016) using the fresh samples. Balance samples were dried at 65°C for 48 h and finely ground for analysis of crude fibre (CF), ether extract (EE), total ash (TA), neutral detergent fibre (NDF) and acid detergent fibre (ADF) using standard procedures. Representative samples of kid starter and green fodder offered and leftover during the trial were collected for proximate analysis (AOAC, 2016) and fibre fractionation (Van Soest et al., 1991).

Blood samples were collected from all the kids at sixth and sixteenth week of the feeding trial. Whole blood was used to determine the haemoglobin (cyan methaemoglobin method) and serum samples were used to determine serum total protein (Jong and Vegeter, 1950), albumin (Bromocresol green method), blood urea nitrogen (BUN) (modified Berthelot method), serum creatinine (AOAC, 2016), glucose (GOD-PAP methodology), calcium (AOAC, 2016) and phosphorus (Bernhart and Wreath, 1955) by semiautomatic analyser using standard kits supplied by M/s. Agappe Diagnostics Limited, Ernakulam, Kerala.

The data on feed intake, faecal score, digestibility and haemato-biochemical parameters were statistically analysed as per Snedecor and Cochran (1994) using software statistical package for the social sciences (SPSS) version 20.0 by one way ANOVA method.

RESULTS AND DISCUSSION

Chemical composition of milk, feed and fodder

Earlier studies also reported similar composition of Malabari goat milk (Sudharsan et al., 2017; Sasikala, 2018 and Mishra et al., 2022). The CP content in Malabari goat milk was comparable to that of other indigenous goat breeds but slightly higher than the cow milk (Park et al., 2007). Conversely, the CP content of Jamnapari goat milk reported in the work of Mohsin et al. (2019) was 5.8 per cent, which was higher than the values observed

in the present study. The composition of goat milk varies depending on genetic, physiological, nutritional and environmental factors. The mineral composition of goat milk is particularly vital for bone health (Park et al., 2007). Furthermore, Albenzio et al., 2016 emphasized the bioavailability of these minerals in goat milk is higher than in bovine milk. Although goat milk provides significant nutritional advantages, its unrestricted use in goat kids can lead to challenges such as dependency on milk, delayed rumen development, and economic inefficiencies (Jiao et al., 2017).

Table 2. Composition (%) of milk fed to experimental kids maintained on three dietary treatments

Components	Percentage
Total solids	13.90 ± 0.26
Crude protein	3.89 ± 0.14
Fat	3.78 ± 0.09
SNF	10.20 ± 0.27
Total ash	0.82 ± 0.02

The formulated kid starters *viz.*, G1, G2 and G3 contained 91.6 ± 0.26, 91.9 ± 0.32 and 91.73 ± 0.2 per cent dry matter, 23.45 ± 0.05, 23.5 ± 0.04 and 23.58 ± 0.03 per cent CP, 8.45 ± 0.1, 8.57 ± 0.1 and 8.22 ± 0.08 per cent CF, 3.42 ± 0.05, 3.39 ± 0.07 and 3.41 ± 0.06 per cent EE, 8.26 ± 0.15, 8.63 ± 0.18 and 8.57 ± 0.19 per cent TA, 56.37 ± 0.15, 55.93 ± 0.17 and 56.22 ± 0.23 Nitrogen free extract, 35.92 ± 0.33, 30.48 ± 0.59 and 30.62 ± 0.13 per cent NDF, 9.96 ± 0.16, 7.87 ± 0.15 and 8.83 ± 0.17 per cent ADF, 1.45 ± 0.02, 1.55 ± 0.02 and 1.53 ± 0.01 per cent calcium, 0.61 ± 0.01, 0.68 ± 0.02 and 0.69 ± 0.03 per cent phosphorus. The composition of starter obtained were consistent with the findings of Jasmine (2015) and Sasikala (2018). The CP per cent of SMP and dried whey used in the starter ration of kids was found to be 35.08 ± 0.06 and 7.09 ± 0.04, respectively and Patel *et al.* (2005) also obtained similar CP (35.5 per cent) values for spray dried SMP. Contrary to the present findings, Banavara *et al.* (2003) reported that CP content of sweetened whey powder ranges from 8.5 to 14 per cent.

The fodder used for feeding experimental kids was hybrid napier which encompasses 23.49 ± 1.08 per cent dry matter, 16.01 ± 0.15 per cent crude protein, 30.33 ± 0.06 per cent crude fibre, 1.61 ± 0.11 per cent ether extract, 10.2 ± 0.06 per cent total ash, 41.85 ± 0.14 per cent NFE, 58.6 ± 0.16 per cent NDF, 15.03 ± 0.24 per cent ADF, 0.60 ± 0.02 per cent calcium and 0.35 ± 0.02 per cent phosphorus. Madesh *et al.* (2019) reported that the dry matter and

crude protein level of hybrid napier harvested at 30 days of age were 16.68 and 14 per cent respectively. The higher CP level of fodder in the present study could be explained by various factors such as season, soil fertility, fertilization and stage of harvest (Ball et al., 2001; Collins et al., 2017).

Dry matter intake

Abdominal growth appears to be the initial factor governing the maximal feed intake of pre-ruminant animals during the first few days of life. After that, the maximum intake begins to be effectively controlled by energy needs of life (maintenance and growth) (Ternouth et al., 1985; Bas, 1988). It was evident from the earlier studies that the feed intake of animal varies with varied protein (Makun et al., 2016; Santos et al., 2014; Ullah et al., 2012) and energy sources (Adeloye, 2021). However, in the present study the total dry matter intake (DMI) of experimental kids (kg/animal) maintained on three different starter rations was similar ($p > 0.05$) during the entire trial period. The average DMI and average daily DMI per 100 kg body weight of kids fed on three experimental rations was comparable ($p > 0.05$) among groups. The results obtained in the present study were consistent with the findings of Babu et al. (2009), Rahman et al. (2016) and Salehi et al. (2022). On contrary, incorporation of dairy products (Schingoethe, 1976; Morrill and Dayton, 1974) resulted in improved palatability and thereby increased DMI in calves. However, earlier

studies (Supriyati, 2012 and Kamalahasan, 2018) revealed that whole milk fed group had higher ($p < 0.05$) DMI than those fed with dairy based milk replacers.

Total intake of starter (DM) by experimental kids (kg/animal) during the entire trial period was 6.72 ± 1.01 in G1, 8.95 ± 0.48 in G2 and 9.57 ± 0.36 in G3. The data indicated that starter DMI was significantly higher in G2 and G3 groups compared to G1 group. This variation could be attributed to the differences in diet composition and the duration of milk feeding. The kids in G1 were fed milk for an extended period (up to three months), while G2 and G3 offered with milk only upto 45 days of age. Young ruminants prioritize liquid feed sources such as milk, leading to reduced intake of solid feeds. The reliance on milk as a primary energy source likely influenced the DMI of the kids during the present study. Earlier studies (Kertz et al., 1979; Terre et al., 2007; Raeth-Knight et al., 2009 and Alvarez-Rodriguez et al., 2010) also emphasized an inverse relationship between milk and solid feed intake and concluded that limiting milk intake fostered intake of starter and hay, facilitating weaning at about 7 to 8 weeks of age. Furthermore, the starter rations of G2 and G3 included dried whey and SMP, which are

known to enhance palatability and nutrient density. This likely contributed to higher starter DMI in these groups compared to G1, which relied on conventional kid starter rations.

Moreover, the role of dietary composition extends beyond mere intake levels; it significantly influences gastrointestinal development and nutrient absorption in pre-ruminant animals. For instance, a study indicated that ad libitum feeding of dairy milk replacers during the early weeks followed by a gradual reduction in intake, could enhance growth performance without adversely affecting rumen development. This suggests that while protein sources are crucial for immediate feed consumption, the timing and method of introducing solid feeds also play a pivotal role in shaping long-term health outcomes. Furthermore, optimizing starter rations not only aids in maximizing DMI but may also promote better ruminal fermentation processes, leading to improved overall energy efficiency in young livestock. Thus, a comprehensive approach to nutrition that balances both immediate intake and developmental needs is essential for enhancing the productivity of dairy calves and kids alike.

Table 4. Feed intake of experimental kids maintained on three dietary regimes, on DM basis

Parameters	Dietary Treatments			p value
	G1	G2	G3	
Total milk consumed (kg/ animal)	$4.15^a \pm 0.22$	$1.95^b \pm 0.15$	$1.69^b \pm 0.13$	0.00
Total starter intake (kg/ animal)	$6.72^b \pm 1.01$	$8.95^a \pm 0.48$	$9.57^a \pm 0.36$	0.02
Total fodder intake (kg/ animal)	3.4 ± 0.08	3.45 ± 0.15	3.4 ± 0.12	0.95
Total DMI (kg/animal)	14.05 ± 1.21	14.02 ± 0.55	14.37 ± 0.33	0.94
Average daily DMI (kg/animal)	0.13 ± 0.01	0.13 ± 0.01	0.14 ± 0.01	0.94
Average daily DMI (kg) per 100 kg body weight	2.77 ± 0.10	2.54 ± 0.10	2.78 ± 0.14	0.30

¹Mean values of six replicates with SE

Growth performance

Kids weaned early (45 days) and raised on dairy based rations (G2 and G3) showed similar growth characteristics (Fig. 1) with G1, emphasizing nutritional adequacy of dairy based starter rations and physiological adaptability of kids to those rations. Besides, it has been proposed that whey protein (Moller et al., 2001) is high in essential amino acids particularly leucine which could promote adequate muscle growth in early weaned kids. As stated in Meena et al. (2022), sirohi kids weaned at 60 days had a higher body weight at 120 days than those who were weaned later or earlier. The study also found that, weaning at 60 days did

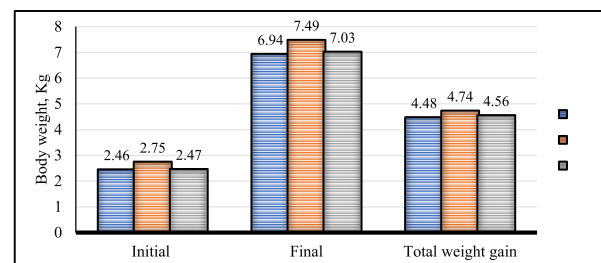


Fig. 1. Initial body weight, final body weight and Total weight gain of experimental kids maintained on three dietary treatments

not impair growth when feeding and management were adequate. According to Vickery et al. (2023), gradual weaning produced inconsistent weight gain

results. However, they also observed that controlling the post-weaning diet (creep/solid feed) had a significant impact on later body weight, which implies that variations between weaning age groups tend to decrease if post-weaning nutrition is adequate.

Faecal condition score

Similar ($p > 0.05$) fortnightly mean faecal condition score (FCS) was observed in experimental kids maintained on three different dietary regimes (Fig. 2), agreeing the earlier findings (Lammers et al., 1998; Huuskonen, 2017). During the initial few weeks of the feeding trial, the average FCS was found to be greater, which then gradually declined over the weeks as also reported earlier (Kamalahasan, 2018). Yasumatsuya et al. (2012) also observed similar ($p > 0.05$) mean FCS among calves in three treatment groups fed with milk replacers having SMP, whey and its combination.

On contrary to the present findings, the incidence of diarrhoea was lower ($p < 0.05$) in whole milk fed calves than the calves fed with casein based milk replacer (Shukla et al., 2017). Similarly, Mahjoubi et al. (2017) noticed that lambs fed SMP based milk replacer at higher levels (20 per cent of body weight) had better faecal score than those lambs maintained either on whole milk or on SMP based milk replacer at a lower level (10 per cent of body weight).

Digestibility of nutrients

The inclusion of SMP and dried whey did not affect ($p > 0.05$) the digestibility (%) of nutrients (Table 5) among groups. The digestible crude protein of ration in G1, G2 and G3 groups were found to be 17.15, 16.85, 17.08 and the total

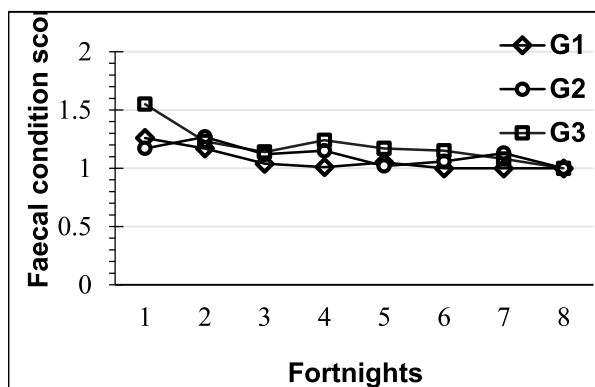


Fig. 2. Fortnightly average faecal condition score of experimental kids maintained on three dietary treatments

digestible nutrient of ration were 68.75 in G1, 68.46 in G2 and 68.43 in G3, respectively. The results of the present study were consistent with the findings of Hill et al. (2016); Rahman et al. (2016); Chai et al. (2017); Kamalahasan (2018) and Araujo et al. (2020). In the present study weaning off milk at 45 days of age has no adverse effect on digestibility of kids as observed earlier (Tao et al., 2018 and Chai et al., 2017). On contrary, Sampelayo et al. (1990) and Suresh (2022) reported that the digestibility of nutrients was significantly higher in whole milk fed calves than in calves offered dairy based (SMP and whey) milk replacer. However, Gibney and Walker (1977) reported that the apparent digestibility of nitrogen and fat was significantly higher in lambs fed with SMP based milk replacer than those fed with soy protein based milk replacer. Similarly, Hasanpour et al. (2023) reported that use of 4.5 per cent whey powder in the starter ration of fattening lambs resulted in higher ($p < 0.05$) apparent digestibility of DM and CP over lambs fed with conventional starter ration and rations containing 1.5 and 3 per cent whey powder.

Table 5. The digestibility coefficient¹ (%) of nutrients of three experimental rations fed to Malabari kids

Parameters	Dietary Treatments			p value
	G1	G2	G3	
Dry matter	72.15±0.59	71.55±1.52	71.79±0.87	0.92
Crude protein	80.84±0.52	79.32±0.88	80.16±0.76	0.37
Crude fibre	58.77±1.46	60.81±2.76	61.01±1.64	0.70
Ether extract	76.20±1.21	79.84±1.45	79.94±1.17	0.10
Nitrogen free extract	73.87±0.74	72.76±1.57	72.52±1.03	0.69
Neutral detergent fibre	71.16±0.85	69.87±1.98	69.97±1.21	0.78
Acid detergent fibre	51.85±1.52	49.60±2.82	50.55±2.10	0.77
Digestible crude protein	17.15±0.18	16.85±0.18	17.08±0.12	0.39
Total digestible nutrient	68.75±0.54	68.46±1.42	68.43±0.79	0.97

¹Mean values of six replicates with SE

Hemato-biochemical parameters

The results indicated that different feeding regimes had no influence ($p>0.05$) on hemato-biochemical parameters (Table) of kids and values remained within the normal range documented for the species (Kaneko et al., 2008). The present results were comparable with the findings of Ortigues-Marty et al. (2003), Lee et al. (2009), Yasumatsuya et al. (2012), Huang et al. (2015) and Benak et al. (2021). However, the glucose values decreased over time irrespective of treatment groups. Pre-ruminants primarily use glucose as their energy source. Because of their under developed rumen epithelium, utilization of volatile fatty acids is limited (Vi et al., 2004). A drop in blood glucose with increase in age might be attributed to the shift in energy source from glucose to volatile fatty acids, as the rumen becomes functional (Hammon et al., 2002). The BUN levels of kids at sixteenth week

were higher than those documented at sixth week. Urea is not only a waste product of nitrogen metabolism but also an important precursor for rumen microbial protein synthesis and plays crucial role in the development of forestomach in ruminants (Harmeyer and Martens, 1980). The urea nitrogen values in goats increases linearly with the increase in age during the first 12 months (Mbassa and Poulsen, 1992). This occurs because kids in early life are solely dependent on dam's milk. Milk proteins are highly digestible and efficiently utilized by the body, resulting in less protein breakdown and, consequently, lower urea production. As age advances starter rations and roughages having comparatively lower protein quality becomes the part of the ration, leading to increased protein catabolism and higher blood urea levels (Owens et al., 1998 and Blome et al., 2003).

Table 6. Hemato-biochemical parameters¹ of experimental kids maintained on three dietary treatments (sixth and sixteenth week)

Parameters	weeks	Dietary Treatments			p value
		G1	G2	G3	
Haemoglobin (g/dL)	6	10.90 ± 0.58	11.80 ± 0.82	11.43 ± 0.85	0.71
	16	11.88 ± 0.23	12.43 ± 0.41	11.63 ± 0.35	0.27
Serum glucose (mg/dL)	6	61.05 ± 1.51	62.13 ± 0.48	61.07 ± 0.99	0.73
	16	59.13 ± 3.19	58.98 ± 3.61	58.15 ± 6.12	0.97
Serum total proteins (g/dL)	6	6.16 ± 0.23	5.75 ± 0.10	6.05 ± 0.26	0.37
	16	6.12 ± 0.35	6.42 ± 0.31	6.15 ± 0.18	0.73
Serum albumin (g/dL)	6	3.76 ± 0.14	3.75 ± 0.06	3.64 ± 0.18	0.80
	16	3.77 ± 0.11	3.69 ± 0.07	3.47 ± 0.09	0.08
Serum calcium (mg/dL)	6	12.15 ± 0.25	12.22 ± 0.21	12.09 ± 0.20	0.92
	16	12.52 ± 0.26	12.26 ± 0.31	12.51 ± 0.14	0.71
Serum phosphorus (mg/dL)	6	8.00 ± 0.13	8.23 ± 0.08	8.18 ± 0.11	0.33
	16	8.08 ± 0.29	8.56 ± 0.21	8.16 ± 0.40	0.52
Blood urea nitrogen (mg/dL)	6	8.78 ± 0.98	9.10 ± 0.82	8.78 ± 0.44	0.94
	16	13.98 ± 0.78	13.98 ± 1.17	13.33 ± 0.60	0.84
Serum creatinine (mg/dL)	6	0.71 ± 0.06	0.72 ± 0.03	0.70 ± 0.02	0.97
	16	0.64 ± 0.01	0.65 ± 0.01	0.69 ± 0.02	0.13

¹Mean values of six replicates with SE

CONCLUSION

On summarising the overall results of the study, it is evident that different starter rations did not significantly affect the overall digestibility of nutrients among the groups. Additionally, the hemato-biochemical parameters remained within normal ranges across all treatment groups, suggesting that these feeding strategies did not

adversely impact the health or nutritional status of the kids. Furthermore, weaning off milk at 45 days can help in reducing the dependency on prolonged milk feeding while maintaining optimal health, thereby improving the economic efficiency of goat farming operations. However, further studies are warranted to explore the long-term effects of these dietary regimes on productivity and profitability in commercial settings.

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