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Haematological response of Osmanabadi goat kids to dietary replacement of maize with ground *Ziziphus mauritiana* fruit

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Abstract
The present study was conducted to evaluate the effect of ground whole *Ziziphus mauritiana* (Ber) fruit inclusion in concentrate feed on haematological parameters in Osmanabadi goat kids. A total of 24 healthy kids (4-5 months old) with uniform initial body weights were randomly allotted to four dietary treatment groups (T_0, T_1, T_2, T_3), each comprising six animals. The control group (T_0) received a concentrate without ber fruit, while T_1, T_2, and T_3 were fed concentrates in which maize was partially replaced with 20%, 30%, and 40% ground ber fruit, respectively. All concentrate mixtures were formulated to maintain 18.5% crude protein and fed for 90 days alongside green fodder. Haematological evaluations, including haemoglobin (Hb) concentration and packed cell volume (PCV), were carried out on Day 0 and Day 90. Results indicated no statistically significant differences ($p > 0.05$) in Hb or PCV levels across treatment groups at either time point. Hb values ranged from 12.23 to 13.55 g/dl, and PCV from 28.75% to 31.00%. These findings suggest that the inclusion of ground ber fruit at up to 40% maize replacement did not adversely affect the haematological health of the animals.

Keywords: Osmanabadi goat kids, *Ziziphus mauritiana*, haemoglobin, packed cell volume, ber fruit, goat nutrition, haematology

Introduction
Goat farming plays a vital role in promoting rural development, acting as a dependable economic buffer during difficult times. It yields several valuable commodities such as meat, milk, skin, manure, and fiber. Compared to other types of livestock, goats need less capital to start, require minimal inputs, reproduce quickly, and are easier to sell in the market. For small-scale and marginal farmers, goat rearing can be an additional source of income without disrupting their main work. In recent times, commercial goat farming has attracted attention from larger farmers, businesspeople, and industrial investors. Their participation, backed by technical knowledge, financial strength, and access to markets, can significantly enhance the growth of the goat farming industry. Furthermore, goat rearing has proven profitable and feasible under both semi-intensive and intensive management systems (Singh *et al.*, 2020) [7]. With the growing demand for sustainable and economical feeding strategies, there is increasing attention on the use of non-conventional feed materials in livestock nutrition. These include agro-industrial by-products, residues from food processing industries, uncommon forage sources, and other alternative feed items. Utilizing these resources can lower feeding expenses, promote environmental sustainability, supply essential nutrients, improve resource utilization, and assist in managing agricultural and food-related waste. Despite these advantages, several obstacles remain-such as variation in nutrient composition, the requirement for appropriate processing, potential anti-nutritional elements, and maintaining consistent quality. Some of the innovative and promising alternatives include protein sources derived from insects, microalgae, unconventional crops used in silage production, and scientifically developed feed mixes. To ensure optimal animal health and productivity, the adoption of such feeds must be supported by scientific research and evaluation (Vikrant, 2024) [8].
Ziziphus mauritiana is a thorny shrub or small tree that can reach heights of up to 15 meters, with a trunk diameter potentially exceeding 40 centimetres.

It grows quickly and has a long-life span, displaying a well-organized, tiered branching pattern. The plant is visually appealing due to its open crown and widely spaced branches along the stem. Its leaves are arranged alternately and are typically ovate to elliptic with four distinct sides, rounded tips, and three sunken veins at the base. The upper side of the leaves is glossy and dark green, while the underside appears lighter, often ranging from pale green to greyish-green. The flowers, which emerge from the axils of the leaves, are small, yellow, and relatively subtle in appearance with fine petals. This species produces edible fruit that varies in both size and form. Wild types generally yield small, nearly round fruits around 3 cm in diameter, whereas cultivated varieties bear larger fruits-typically around 5 cm in length and 4 cm in width. The shapes of fruits from cultivated trees are commonly classified into four categories: round, oval, obovate, and oblong (Ashraf *et al.*, 2015) [2].

The escalating prices of conventional animal feed have led to an increased focus on identifying cost-effective and locally accessible alternatives. Among these, jujube by-products have emerged as a potential non-traditional feed ingredient. Incorporating jujube into livestock diets not only offers a sustainable way to minimize agricultural waste but also helps mitigate the scarcity of standard feed components. In the Indian context, studies exploring the use of *Ziziphus mauritiana* in animal nutrition are quite limited. Therefore, the present research aims to evaluate the effect of incorporating ground whole fruit of *Ziziphus mauritiana* (commonly known as ber) into the concentrate feed of goats by partially replacing maize on haematological parameters of Osmanabadi goat kids.

Materials and methods

Experimental Animal Selection and Grouping

A total of twenty-four Osmanabadi goat kids, aged between 4 to 5 months and with nearly uniform initial body weights (as presented in Table 1), were selected from the Seed Centre for Osmanabadi Goats, College of Veterinary Science & Animal Husbandry, Anjora, Durg. The animals were randomly assigned to four treatment groups, with each group comprising six kids. Prior to the initiation of the trial, all animals were thoroughly dewormed. Throughout the duration of the experiment, the goats were managed under identical intensive rearing conditions.

Table 1: Group-wise Average Starting Body Weights of Goat Kids (kg)

Treatment Group	T_0(Control)	T_1	T_2	T_3
Average Initial Body Weight (kg)	8.90±0.62	8.96±0.70	8.94±0.70	8.90±0.33

Housing, Feeding, and General Management

All goat kids were housed in a well-ventilated shed equipped with proper flooring, and sufficient space for feeding and watering. Standard livestock management practices were followed throughout the study period. The animals were maintained under an intensive management system. Green Berseem, harvested at 40 to 45 days of growth, was processed into hay using standard hay-making techniques. Feed formulations for all treatment groups were designed based on ICAR (2013) nutritional guidelines to meet the dietary requirements of growing goat kids.

In this study, the control group (T_0) was given a concentrate feed without any inclusion of ground whole ber fruit (0%). For the T_2 group, the concentrate mixture was formulated by replacing 30% of maize with ground whole ber fruit. Similarly, the T_1 and T_3 groups received diets where maize was replaced with 20% and 40% ground ber fruit, respectively. The trial was conducted over a period of 90 days. All concentrate mixtures were prepared to have a uniform crude protein content of 18.5%, achieved by substituting varying levels of maize with ground whole ber fruit in the rations. The specific replacement levels used in the experimental diets were: 0% (C0), 20% (C2), 30% (C3), and 40% (C4), as detailed in Table 2.

Table 2: Composition of Various Concentrate Mixtures with Different Levels of Ground Whole Ber Fruit (% by weight)

Ingredients	C0 (0%)	C2 (20%)	C3 (30%)	C4 (40%)
De-oiled Rice Bran	16.0	16.5	17.0	16.0
Maize	40.0	32.0	28.0	24.0
Rapeseed Meal	5.0	5.0	5.0	5.0
Soybean De-oiled Cake	20.0	20.5	21.0	21.5
Wheat Bran	16.0	15.0	14.0	14.5
Ground Whole Ber Fruit	0.0	8.0	12.0	16.0
Mineral Mixture	2.0	2.0	2.0	2.0
Salt	1.0	1.0	1.0	1.0

All groups were provided with green fodder as per their individual requirements. However, the concentrate feed differed across groups. The control group (T_0) received concentrate C0 at a quantity of 200 grams without any inclusion of Ber fruit powder. Treatment group T_1 was given concentrate C2 at 200 grams with a 20% inclusion level of Ber fruit powder. Similarly, group T_2 received 200 grams of concentrate C3 containing 30% Ber fruit powder, while group T_3 was fed concentrate C4 at the same quantity but with a 40% inclusion level of Ber fruit powder.

Haematological Parameters

Blood samples were obtained from the jugular vein of each animal on day 0 (baseline) and day 90 (end of the trial) into tubes containing ethylenediaminetetraacetic acid (EDTA) to prevent clotting. Haemoglobin (Hb) levels were measured using the cyanmethemoglobin method with Drabkin's reagent, following the procedure described by Dacie and Lewis (1968) [3]. The Packed Cell Volume (PCV) was assessed via the microhematocrit technique, in accordance with the method detailed by Jain (1986) [5].

Ethics Approval

All experimental procedures involving animals were carried out in strict accordance with the ethical standards set by the Institutional Animal Ethics Committee (IAEC). The study protocol was reviewed and approved by the IAEC under approval number ANN-PhD-2/2025.

Results

The haemoglobin concentration did not show any statistically significant difference either at the beginning (Day 0, $p = 0.482$) or at the end of the experiment (Day 90, $p = 0.906$) across all treatment groups. On Day 0, values ranged from 12.23 g/dl (T_2) to 13.52 g/dl (T_0), and on Day 90, they varied between 12.97 g/dl (T_2) and 13.55 g/dl (T_0). Similarly, PCV values remained statistically unchanged at both time points: Day 0 ($p = 0.343$) and Day 90 ($p =$

0.328). On Day 0, PCV ranged from 29.00% (T_0) to 31.00% (T_2), and on Day 90, values ranged between 28.75% (T_0) and 30.25% (T_2).

This consistency in Hb levels over time and between treatments suggests that none of the experimental diets had a detrimental or significantly stimulatory effect on haemoglobin synthesis. The lack of significant differences in PCV among the treatment groups suggests that the dietary interventions did not adversely affect the volume of circulating red blood cells or the hydration status of the animals. These stable values further support the interpretation that all animals remained clinically healthy throughout the trial period.

Table 3: Effect of *Ziziphus mauritiana* Fruit Inclusion on Haematological Parameters in Osmanabadi Goat Kids

Particulars	Group				P value
	T_0	T_1	T_2	T_3	
Haemoglobin (Hb) (g/dl)					
0 day	13.52±0.26	12.85±0.91	12.23±0.25	12.48±0.69	0.482
90 days	13.55±0.38	13.03±0.78	12.97±0.40	13.12±0.78	0.906
Packed Cell Volume (PCV) (%)					
0 day	29.00±0.91	29.75±0.85	31.00±0.71	30.00±0.41	0.343
90 Days	28.75±0.48	29.50±0.65	30.25±0.48	30.00±0.71	0.328

Discussion

The present study investigated the effects of various dietary treatments on haemoglobin (Hb) concentration and packed cell volume (PCV) over a 90-day experimental period. The findings revealed no statistically significant changes in Hb or PCV values across all treatment groups at either the beginning (Day 0) or end (Day 90) of the trial. This suggests that the experimental diets used in this study neither enhanced nor compromised erythropoiesis or red blood cell volume, indicating that all animals remained physiologically stable and clinically healthy throughout the duration of the experiment.

Mufwa *et al.* (2019) [6] reported significant increases in several haematological and biochemical parameters, including PCV and Hb, in broiler chickens fed *Ziziphus mauritiana* fruit meal (ZMFM) at varying inclusion levels (0%, 5%, 10%, and 15%). This contrasts with the findings of our study, where no haematological improvements or detriments were detected. The discrepancy may be attributed to species-specific metabolic responses, duration of dietary exposure (4 weeks vs. 12 weeks), or the distinct nutritional profile of *Ziziphus mauritiana* fruit meal (ZMFM) versus the feed used in our study.

Huang *et al.* (2021) [4] further demonstrated the therapeutic potential of Jujube polysaccharides (JP) in improving haematological parameters in a rat model of chronic kidney disease (CKD), particularly in reversing anaemia through increased erythropoietin synthesis and short-chain fatty acids (SCFA) production. Administration of JP in CKD rats notably improved renal function, reduced kidney tissue damage, and enhanced haematological indices such as red blood cell count, haemoglobin levels, haematocrit, and platelet count. Although our study did not involve diseased models or targeted supplementation with bioactive compounds like JP, the contrast underscores the potential bio functional advantage of isolated phytoconstituents such as Jujube polysaccharides under pathological conditions.

The work of Alawode *et al.* (2020) [1] on weaner rats where soybean protein was progressively replaced with *Z. mauritiana* seed at inclusion levels of 0% (control), 25%, 50%, 75%, and 100% over a period of three weeks, showed minimal haematological changes across various inclusion levels of *Ziziphus mauritiana* seed, aligning more closely with our findings. Both studies suggest that certain *Ziziphus* species or parts (e.g., seeds) may offer nutritional value without significantly altering haematological homeostasis, especially when used in moderate quantities or for shorter durations.

Conclusion

The inclusion of ground whole *Ziziphus mauritiana* (ber) fruit in the diets of Osmanabadi goat kids at levels of 20%, 30%, and 40% (as maize replacement) over a 90-day period had no significant effect on haemoglobin concentration or packed cell volume. This indicates that dietary incorporation of ber fruit does not adversely impact haematological parameters or the overall physiological status of growing goats, supporting its potential as a safe alternative feed ingredient in small ruminant nutrition.

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