

Clinical Investigations and Research

Research Article

Nutritional Evaluation of Fermented *Hunteria umbellata* Seed Meal as a Partial Substitute for Soybean meal in Growing Rabbits

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Abstract

This study investigated the potential of fermented *Hunteria umbellata* seed meal (FHUM) as a sustainable protein alternative to Soybean meal in rabbit nutrition. A total of 50 male growing rabbits (Chinchilla × New Zealand White) with an average initial weight of 693.0 ± 0.16 g were randomly assigned to five treatments (T1-T5), with 10 rabbits per treatment, each serving as a replicate. Following a 2 weeks adjustment period, a 60 day feeding trial was conducted using a Completely Randomized Design. The control group (T1) received a standard diet, while T2, T3, T4 and T5 replaced soybean meal with FHUM at levels of 5 %, 10 %, 15 % and 20 % respectively. All diet were formulated to be isonitrogenous and isocaloric. Feed and clean water was supplied at all times. Proximate composition of FHUM showed that it contained dry matter (87.89 %), crude protein (42.14 %), crude fibre (3.42 %), ether extract (5.66 %), ash (10.43 %) and energy (3200.8 Kcal/kg) while phytochemical profile revealed the presence of phenols, tannins, alkaloids, flavonoids, saponins and phytates at 14.78 %, 6.09 %, 3.17 %, 12.05 %, 2.64 % and 0.18 % respectively. Results obtained indicated that body weight gain, feed consumption and dressing percentage were significantly ($p < 0.05$) higher in FHUM groups (T2-T5) compared to T1. Best feed to gain ratio was recorded in FHUM treatments while relative weights of liver, heart and kidney were similar across the treatment ($p > 0.05$). Significant differences were noted in the relative weight of spleen, intestinal length, crude protein, dry matter, ether extract, ash, organic matter digestibility as values were higher in T2-T5 and lower in T1 ($p < 0.05$). The findings suggests that FHUM can effectively replace Soybean meal up to 20 % in the diet of growing rabbits, enhancing growth performance, nutrient utilization without compromising the internal organ weight.

Keywords: *Hunteria umbellata*, Fermentation, Soybean meal, Rabbit, Performance, Digestibility.

Introduction

The global livestock industry is currently facing a sustainable crisis driven by the rising cost of conventional feedstuffs [1]. Soymeal remains one of the excellent source of protein in monogastric diet, however, the competition between animals and human have led to a significant increase in their prices particularly in developing countries [2]. These economic pressure necessitates the evaluation of non-conventional feed resources that are locally available, inexpensive and do

not compete with human nutrition [3]. Among the potential alternative is *Hunteria umbellata* seeds. Their seeds are underutilized due to their physical and chemical defenses [4]. The primary constraint in utilizing *Hunteria umbellata* is the presence of highly lignified and a suit for anti-nutritional factors including, oxalates, phytates, alkaloids amongst others [5]. Anti-nutritional factors can interfere with the absorption of nutrients and reduce palatability [6]. Adopting the use fer-

mentation will help to degrade these anti-nutrients and fibre in seeds into smaller easily absorbed molecules [6, 7]. Fermentation introduces beneficial organisms into diet, lower intestinal pH to allow the growth of lactic acid bacteria while inhibiting pathogenic organisms [7, 8].

Previous research by [9, 10, 11, 12] suggests that Moringa seed meal can replace Soyabean meal at up to 25 – 50 % without causing any adverse effect on growth performance and blood constituents of growing rabbits. Fermented *Canna bidentata* seed have shown positive effect on the average daily weight gain and feed consumption of weaner rabbits when used to partially replace soybean meal at 25 %. *Annona muricata* seeds and neem seed cake have been used to replace Soybean meal at up to 10 % without causing any deleterious effect on carcass characteristics and nutrient utilization of weaner rabbits. However, there is little or no research on the effect of partial replacement of Soyabean meal with fermented *Hunteria umbellata* seed meal.

By evaluating fermented *Hunteria umbellata* seed meal as partial substitute for soybean meal will help to determine the optimal threshold where it can maintain the rabbit's high protein requirement without the toxicity associated with the raw seed. This provides a scientific framework for transitioning from expensive conventional protein sources to a nutritionally optimized, processed alternative that supports growth performance, nutrient utilization and health status of growing rabbits.

Materials and Methods

Experimental location, Duration and Sanitation

The study was conducted from March to July 2025 at the Rabbit Unit of Gandhi College of Agriculture, Rajasthan. Before the commencement of the trial, galvanized cages measuring 35 cm by 30 cm by 20 cm (length × width × height) and pens were thoroughly disinfected using a 1:1 ratio of Morigad plus® and Hypo®. Feeding and watering troughs were also washed with detergent and the facility was then rested for 2 weeks before introducing the animals to the pen.

Collection and processing of fermented *Hunteria umbellata* seed meal

Fresh fermented *Hunteria umbellata* seed was purchased from an open market in Rajasthan India. The plant seeds were identified and authenticated at Herbarium Unit of Botany Department, Gandhi College of Agriculture, Rajasthan, India. The seeds were screened to remove undesirable materials such as stones and other impurities, after which they were washed with running tap water and cracked manually to increase their surface area for microbial activity. Cracked seeds were placed in a clean plastic container and covered with water (ratio 1:3 w/v) under room temperature for 5 days to promote the growth of lactic acid bacteria. Fermented seeds were sundried for 10 days milled into powder and the powder kept in an air-tight polythene bags until needed for

feed formulation and other laboratory analysis.

Animal Management, diet and experimental design

A total of 50 growing male rabbits (*Chinchilla* × *New Zealand White*) with an average initial weight of 693.0 ± 0.16 g were procured from a reputable breeding farm in Ajmer, India and managed according to Indian Society of Animal Production and Management standards. Upon arrival, animals were given anti-stress and standard diet formulated to meet their nutritional requirements [13] and placed on two weeks adjustment period. All rabbits were treated with oxytetracycline® and ivermectin plus® at 1 mL/10 kg and 1 mL/50 kg, respectively, prior to the onset of the experiment. At the start of the 3rd week, rabbits were weighed and balanced to ensure uniform initial weight across all experimental groups. A completely randomized experimental design was adopted and the rabbits were assigned to 5 treatments (T1-T5) with 10 replicates. Diet was compounded to be isocaloric and isonitrogenous with fermented *Hunteria umbellata* seed meal (FHUM) replacing soyabean meal at the following levels:

Treatment 1 (control): 0 % FHUM

Treatment 2: 5 % FHUM

Treatment 3: 10 % FHUM

Treatment 4: 15 % FHUM

Treatment 5: 20 % FHUM

Growth performance indices

Feed was weighed daily for rabbits in each replicate and the quantity consumed for the day was obtained by difference between the quantity supplied and the left over. The body weight gain was obtained by calculating the difference between the body weight for the preceding week and current week. The feed conversion ratio was determined by dividing the quantity of feed consumed by the body weight gain of the birds in each replicate in grams.

Digestibility trial

Digestibility study was carried out on the last day of the trial. Five rabbits were selected from each treatment; weighed, isolated and subjected to digestibility trial for seven days in a metabolic cage. Within the seven days, two days were used as an adjustment period while five days were used for data collection. Total droppings voided from each replicate were weighed and recorded. Wet droppings were oven dried at 65°C for 36 hours and dry matter content determined. Droppings from the same treatment were thoroughly pooled and ground. Record of feed consumed was also taken. The nutrient digestibility was determined using the formula:-

Nutrient Digestibility

= $\frac{\text{Nutrient in feed} - \text{Nutrient in droppings}}{\text{Nutrient in feed}} \times 100$

Nutrient in feed

Carcass Evaluation

At the end of the trial, 5 rabbits per treatment after 12 hour of fasting were randomly selected, weighed to record the

live weight after which they were slaughtered and weighed again. Weights of the liver, heart, kidney and spleen were recorded and expressed as percentage of their live weight. The length of the intestine were also recorded. Dressing percentage was calculated as:

$$\text{Dressing percentage} = \frac{\text{Dressed weight}}{\text{Live weight}} \times 100$$

Proximate and phytochemical analysis of samples

Dry matter, crude protein, crude fiber and ether extract of raw / fermented *Hunteria umbellata* seed meal and the experimental diets as well as the droppings from digestibility trial was carried out in accordance with AOAC [14] standard procedure. Organic matter was calculated by subtracting ash from 100 (100 – ash). Ash content was determined using NooF Atomic Absorption Spectrophotometer (AAS3200C, Netherlands). The phytochemical contents of raw and fermented *Hunteria umbellata* seed meal were assayed as previously described by Singh et al. [15].

Statistical analysis

The differences between experimental groups were statistically analyzed by using the general linear model (GLM) procedures of SAS (2004), by applying one-way analysis of variance (ANOVA). Significant differences between groups' means were separated by Duncan's multiple range test [16]. All results were analyzed using the following statistical model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where: Y_{ij} = the observation of ij ; μ = overall mean; T_i = effects of treatments, ($i = 1, 2, 3, 4$ and 5) and e_{ij} = experimental random error. The

Experimental results obtained

Proximate composition of raw and fermented *Hunteria umbellata* seed is revealed in Table 1. Dry matter (86.03 %), crude protein (15.61 %), crude fibre (7.70 %), ether extract (3.51 %), ash (5.92 %) and energy (2800.5 kcal/kg) while fermented *Hunteria umbellata* seed contained crude protein (42.14 %), dry matter (87.89 %), crude fibre (3.42 %), ether extract and energy of 10.43 % and 3200.8 Kcal/kg respectively.

In table 2, phytochemical components of Raw and fermented *Hunteria umbellata* seed. Raw *Hunteria umbellata* seed has alkaloids in higher concentrations (7.92 %) followed by flavonoids (4.01 %), phenols (3.81 %), saponins (1.81 %), tannins (1.73 %) and phytate (1.63 %). Conversely, fermented *Hunteria umbellata* seed contained phenols in higher concentrations (14.78 %) with phytates at the lowest concentration of 0.18 %.

Growth performance of weaner rabbit fed graded levels of fermented *Hunteria umbellata* seed meal is revealed in Table 4. Final body weight, body weight gain, daily body weight and feed consumption were similar ($p > 0.05$) among treatments T2-T5 but significantly higher ($p < 0.05$) than in T1 (control). Feed to gain ratio values obtained were lower ($p < 0.05$) in T2 (3.35), T3 (3.39), T4 (3.39) and T5 (3.38) than in T1 (4.65). Whereas dressing percentage, relative percentage of spleen, abdominal fat and intestinal length were higher ($P < 0.05$) for rabbits in T2-T5, other carcass parameters were similar ($P > 0.05$) among the treatments as presented in Table 5.

Nutrient digestibility of weaner rabbit fed graded levels of fermented *Hunteria umbellata* seed meal is revealed in Table 6. Except for dry matter, organic matter, crude protein, ether extract and ash digestibility which were affected ($p < 0.05$) by dietary treatments, crude fibre digestibility showed no ($p > 0.05$) difference (Table 6).

Components	Raw <i>Hunteria umbellata</i> seed	Fermented <i>Hunteria umbellata</i> seed
Dry matter	86.03	87.89
Crude protein	15.61	42.14
Crude fibre	7.70	3.42
Ether extract	3.51	5.66
Ash	5.92	10.43
Energy (Kcal/kg)	2800.5	3200.8

Table 1: Proximate composition of Raw and fermented *Hunteria umbellata* seed

Constituents (%)	Raw <i>Hunteria umbellata</i> seed	Fermented <i>Hunteria umbellata</i> seed
Phenols	3.81	14.78
Tannins	1.73	6.09
Alkaloids	7.92	3.17
Flavonoids	4.01	12.05

Saponins	1.81	2.64
Phytate	1.63	0.18

Table 2: Phytochemical components of Raw and fermented *Hunteria umbellata* seed

Ingredients	Treatment 1 (control)	Treatment 2 (5 % FHUM)	Treatment 3 (10 % FHUM)	Treatment 4 (15 % FHUM)	Treatment 5 (20 % FHUM)
Maize	40.00	40.00	40.00	40.00	40.00
Fermented <i>Hunteria umbellata</i> meal (FHUM)	0	2.00	4.00	6.00	8.00
Wheat bran	14.00	14.00	14.00	14.00	14.00
Palm kernel meal	20.00	20.00	20.00	20.00	20.00
Soybean meal	20.00	18.00	16.00	14.00	12.00
Bone meal	5.00	5.00	5.00	5.00	5.00
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20
Growers Mineral-Vitamin Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.35	0.35	0.35	0.35	0.35
Total	100.0	100.0	100.0	100.0	100.0
Determined analysis					
Crude protein	17.46	17.31	17.22	17.19	17.15
Crude fibre	13.28	11.23	11.18	11.17	11.16
Crude fat	1.92	2.04	2.06	2.08	2.10
Calcium	1.51	1.55	1.55	1.55	1.55
Phosphorus	0.87	0.88	0.88	0.88	0.88
Methionine	0.61	0.63	0.63	0.63	0.63
Lysine	0.85	0.88	0.88	0.88	0.88
Methionine+ Cysteine	0.89	0.92	0.92	0.92	0.92

Each 2.5 kg contain: 10,000 IU Vit. A; 6000 IU Vit. D3; 4000 mg Vit. E; 2000 mg Vit. K3; 2000 mg Vit. B1; 4000 mg Vit. B2; 2000 mg Vit. B6; 10 mg Vit. B12; 50 mg Biotin; 100 mg Pantothenic acid; 500 Niacin; 30 mg Folic acid; 250 mg Choline; 850 mg Mn; 500 mg Zn; 500 mg Fe; 200 mg I; 100 mg Se, 50 mg

Table 3: Ingredient and chemical composition of experimental diet

Parameters	Control (T1)	T2 (5 % FHUM)	T3 (10 % FHUM)	T4 (15 % FHUM)	T5 (20 % FHUM)	SEM	P-value
Initial live weight (g)	693.2	694.1	693.7	693.2	694.4	10.73	0.31
Final live weight (g)	1981.2b	2605.6a	2609.3a	2610.4a	2615.2a	29.45	< 0.001
Body weight gain (g)	1288.0b	1911.5a	1915.6a	1917.2a	1920.8a	23.88	< 0.001
Daily body weight (g)	21.46b	31.85a	31.92a	31.95a	32.01a	0.04	0.01
Feed consumption (g)	6000.1b	6411.2a	6509.2a	6510.1a	6510.4a	67.81	0.001
Daily feed consumption (g)	100.0b	107.1a	108.4a	108.5a	108.5a	0.03	0.18
Feed to gain ratio	4.65a	3.35b	3.39b	3.39b	3.38b	0.01	< 0.001

^{a,b} Means in the same row with different superscript are significantly ($P < 0.05$) different; T1 (0 % FHUM); T2 : 5 % FHUM; T3: 10 % FHUM; T4: 15 % FHUM; T5: 20 % FHUM; SEM: standard error of mean; P-value: probability value

Table 4: Growth performance of weaner rabbit fed graded levels of fermented *Hunteria umbellata* seed meal

Parameters	Control (T1)	T2 (5 % FHUM)	T3 (10 % FHUM)	T4 (15 % FHUM)	T5 (20 % FHUM)	SEM	P-value
Average live weight (g)	1868.9b	2490.7a	2511.7a	2523.8a	2538.7a	24.16	0.14
Dressed weight (g)	1006.9b	1533a	1540.6a	1551.2a	1552.7a	19.74	0.11
Dressing percentage	53.87b	61.54a	61.33a	61.46a	61.16a	0.25	0.001
Spleen (%)	0.07b	1.02a	1.05a	1.07a	1.08a	0.02	0.66
Liver (%)	3.92	3.93	3.91	3.96	3.97	0.04	0.35
Heart (%)	0.31	0.33	0.36	0.35	0.32	0.01	0.46
Kidney (%)	0.53	0.51	0.55	0.53	0.52	0.01	0.38
Intestinal length (cm)	309.3b	366.7a	372.1a	378.9a	380.6a	4.68	0.57

^{a,b} Means in the same row with different superscript are significantly ($P < 0.05$) different; T1 (0 % FHUM); T2 : 5 % FHUM; T3: 10 % FHUM; T4: 15 % FHUM; T5: 20 % FHUM; SEM: standard error of mean; P-value: probability value

Table 5: Carcass characteristics of weaner rabbit fed graded levels of fermented *Hunteria umbellata* seed meal

Parameters	Control (T1)	T2 (5 % FHUM)	T3 (10 % FHUM)	T4 (15 % FHUM)	T5 (20 % FHUM)	SEM	P-value
Dry matter	76.31b	82.71a	83.45a	83.62a	83.80a	4.07	0.18
Organic matter	65.88b	70.62a	71.13a	72.04a	72.84a	3.63	0.35
Crude protein	71.66b	83.81a	84.01a	84.27a	84.32a	4.81	0.43
Crude fibre	51.45	50.92	50.51	50.08	50.02	2.59	0.87
Ether extract	59.13b	66.74a	67.05a	67.44a	64.95a	2.77	0.05
Ash	38.16b	47.18a	48.59a	48.63a	48.71a	1.83	0.07

^{a,b} Means in the same row with different superscript are significantly ($P < 0.05$) different; T1 (0 % FHUM); T2 : 5 % FHUM; T3: 10 % FHUM; T4: 15 % FHUM; T5: 20 % FHUM; SEM: standard error of mean; P-value: probability value

Table 6: Nutrient digestibility of weaner rabbit fed graded levels of fermented *Hunteria umbellata* seed meal

Discussion

Fermentation serves to degrade complex structural components and reduce anti-nutritional factors like phytates, tannins, saponins and alkaloids which are prevalent in raw *Hunteria umbellata* seeds. The crude protein and ether extract of raw *Hunteria umbellata* seeds (15.61 %) and 3.51 % recorded in this study was higher than 12.25 % and 2.20 % reported by [17, 18, 19]. Crude protein [Cp] (42.14 %) in fermented *Hunteria umbellata* seed is comparable to the Cp of soya bean meal suggesting that it can serve as a potential alternative protein source for animals [20, 21]. Crude fibre of 3.42 % makes it advantageous in the diet of monogastric such as broilers and growing rabbits. High crude fibre and ether extract can impede the digestibility of other nutrients and improve palatability and add to energy density of diets [22]. The high ash content in fermented *Hunteria umbellata* seed indicates its abundance in minerals which are co-factors for enzymatic activities [21]. In this current study, fermented *Hunteria umbellata* seed has rich concentration of bioactive compounds with therapeutic properties including, antimicrobial, antioxidant, anti-inflammatory, immune-stim-

ulatory, anti-tumor, anti-diabetic, anti-hemorrhagic, anti-cancer, antidiarrheal, cytotoxic, gastro-protective, cytotoxic and hepato-protective [22, 23].

The growth performance result demonstrate that rabbits fed graded level of fermented *Hunteria umbellata* seed meal in T2 – T5 significantly improved body weight gain of the growing rabbits compared to the control diet in T1. Notably, T2 (1911.5 g), T3 (1915.6 g), T4 (1917.2 g) and T5 (1920.8 g) suppressing T1 (1288.0 g). This outcome suggests that fermented *Hunteria umbellata* seed meal acts as a natural growth promoter by modulating gut microbiota, suppressing the activities of pathogens and improving feed to gain ratio [24]. Body weight gain range observed in this experiment (1288.0 – 1920.8 g) was also similar to the result of [24] who discovered that growing rabbits fed *Moringa oleifera* seed had a body weight gain which varied from 1500 – 2000.0 g. The presence of bioactive compounds especially phenol and flavonoids in fermented *Hunteria umbellata* seed meal could also stimulate the secretion of endogenous enzymes to facilitate the digestion of feed [23]. Feed consumption was

lower in T1 (6000.1 g) than T2 (6411.2 g), T3 (6509.2 g), T4 (6510.1 g) and T5 (6510.4 g). This result suggests fermenting *Hunteria umbellata* seed significantly reduced the effect of alkaloids which has the characteristics of bitter taste [24]. Fermentation improved the palatability and appetite of animals, this result is in agreement with reports of [25]. The feed consumption range 6000.1 – 6510.4 g was similar to the reports of [26] who recorded a feed intake between 6100.2 – 6500.3 g when *Phyllanthus amarus* was supplemented in the diet of weaner rabbits but lower than (6511.2 – 7300.6 g) reported by [27] when growing rabbits were fed graded level of Neem seed cake.

Dressing percentage was lower in T1 (53.87 %) than T2 (61.54 %), T3 (61.33 %), T4 (61.46 %) and T5 (61.16 %). This result suggests that the presence of bioactive compounds in *Hunteria umbellata* seed meal significantly lowers the pH of the gastrointestinal tract, which improves the activation of proteolytic enzymes like pepsin. Enhanced protein digestion directly correlates with improved muscle mass development and a higher dressing percentage [28]. Higher values in relative weight of the spleen indicates that *Hunteria umbellata* has immune-modulatory properties [29, 30, 31, 32]. Relative weights of the liver, kidney and heart were not affected suggesting the bioactive compounds in *Hunteria umbellata* can support hepatic health, prevent renal stress and cardio-protective properties [33, 34]. Intestinal length increased in T2-T5 compared to T1 reflecting increased surface area for nutrient absorption, microbial activity and fermentation efficiency [29].

Dry matter, organic matter, crude protein, ether extract and ash digestibility were higher among rabbits fed fermented *Hunteria umbellata* seed meal (T2-T5) compared to the control (T1). This result indicates that fermented *Hunteria umbellata* seed meal's modulation of intestinal enzymes accelerates the breakdown of complex nutrients into absorbable units [35]. Findings on the dry matter (76.31 – 83.30 %) was similar to the report by [36, 37, 38] who discovered that the dry matter range for weaner rabbits fed graded levels of *Sphenocentrum jollyanum* seed meal ranged from 70.08 – 88.77 %, Crude protein, organic matter, ether extract and ash content recorded in this study is in agreement with findings of [39, 40].

Conclusion

Based on the findings of this 60 days trial, fermented *Hunteria umbellata* seed meal is a viable and efficient alternative to soyabean meal in the diets of growing rabbits. The replacement of soyabean meal at levels up to 20 % significantly improved performance, feed efficiency and carcass dressing percentage. Furthermore, the inclusion of FHUM enhanced the digestibility of key nutrient, including, crude protein, organic matter without inducing any adverse effect on the relative weights of organs. It was concluded that FHUM indicates

its high nutritional value and safety as a non-conventional feedstuff.

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