International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; 9(10): 470-475
www.biochemjournal.com
Received: 08-08-2025
Accepted: 10-09-2025

ON Hariprakash Reddy
M.V.Sc Scholar, Department of Poultry Science, Veterinary College, Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU), Bidar, Karnataka, India

Dr. BU Umesh
Department of Livestock Farm Complex, Veterinary College, Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU), Bidar, Karnataka, India

Dr. TN Krishnamurthy
Department of Poultry Science, Veterinary College, Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU), Bidar, Karnataka, India

Dr. HC Indresh
Department of Poultry Science, Veterinary College, Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU), Bidar, Karnataka, India

Corresponding Author:
ON Hariprakash Reddy
M.V.Sc Scholar, Department of Poultry Science, Veterinary College, Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU), Bidar, Karnataka, India

Effect of feeding fermented rapeseed meal with or without enzymes on gut health in broilers

ON Hariprakash Reddy, BU Umesh, TN Krishnamurthy and HC Indresh

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i10g.6064

Abstract
An experiment was conducted to evaluate the effect of dietary inclusion of fermented rapeseed meal (FRSM) with or without enzyme supplementation on the gut health of broilers. A total of 240 day-old Cobb broiler chicks were randomly assigned to eight dietary treatments with three replicates of ten birds each for six weeks period. All diets were formulated to be iso-caloric and iso-nitrogenous, as per BIS (2007) [3] standards. The control group (T_1) received a corn-soybean meal based basal diet without FRSM or enzymes, while T_2 was fed the basal diet with 0.02% enzyme supplementation. The treatment groups T_3, T_5 and T_7 were supplemented with FRSM at 2.5, 5.0 and 7.5%, respectively, without enzymes, whereas T_4, T_6 and T_8 received 2.5, 5.0 and 7.5% of FRSM with 0.02% enzymes, respectively. The results revealed no significant differences (p>0.05) among treatment groups with respect to gut morphology (villus height, crypt depth of different segments of the intestine), whereas microbial load showed significant reduction in *E. coli* counts and increased *Lactobacillus* counts compared to control group. It was concluded that dietary inclusion of FRSM up to 7.5%, with or without enzyme supplementation, has no detrimental impact on gut morphology and positively modulates the gut microbial population in broilers.

Keywords: Fermented rapeseed meal, enzymes, villus height, crypt depth, *E. coli*, *Lactobacillus*

Introduction

India's livestock sector, particularly the poultry industry, has witnessed remarkable growth in recent years, contributing substantially to agricultural output and rural employment. As per the Basic Animal Husbandry Statistics (BAHS, 2024) and the Ministry of Fisheries, Animal Husbandry and Dairying (2024), the poultry population has reached 851.81 million, with broiler meat contributing nearly half of the country's annual meat production of 10.25 million tonnes. Despite this expansion, the sector faces challenges such as escalating feed costs and sustainability concerns, largely due to the heavy reliance on soybean meal, the principal but costly protein source in poultry diets.

Rapeseed meal (RSM), a by-product of oil extraction from *Brassica napus*, offers a cost-effective and protein-rich alternative, containing 34-42% protein along with appreciable levels of choline, biotin, folic acid, and a favourable amino acid composition (Zhu *et al.*, 2019; Swati *et al.*, 2015) [14, 9]. Globally, rapeseed is the third most important oilseed crop, and RSM serves as a valuable protein source in animal feeding systems (30-45% crude protein) with high lysine and sulfur-containing amino acids (Swati *et al.*, 2015) [9]. However, its broader utilization in poultry nutrition has been limited due to the presence of anti-nutritional factors such as glucosinolates, erucic acid, tannins, phytates, and non-starch polysaccharides (Bellostas *et al.*, 2007; Qin *et al.*, 2017) [2, 8]. High glucosinolate levels have been linked to hypothyroidism, reduced feed digestibility, liver and kidney damage, and overall impaired bird performance (Qin *et al.*, 2017) [8]. Although breeding of low-glucosinolate cultivars has improved its nutritive value, challenges persist-particularly phosphorus utilization, as nearly 65% of phosphorus remains bound in phytate form, limiting its availability to birds (Zhu *et al.*, 2021) [13].

To address these limitations, fermentation has emerged as a promising strategy for improving the nutritional efficiency of RSM. Microbial fermentation significantly reduces anti-nutritional compounds such as glucosinolates (up to 97%), phytates, and fiber, while of Fisheries, Animal Husbandry and Dairying (2024), the poultry population has reached 851.81 million, with broiler meat contributing nearly half of the country's annual meat production of 10.25 million tonnes. Despite this expansion, the sector faces challenges such as escalating feed costs and sustainability concerns, largely due to the heavy reliance on soybean meal, the principal but costly protein source in poultry diets.

Rapeseed meal (RSM), a by-product of oil extraction from *Brassica napus*, offers a cost-effective and protein-rich alternative, containing 34-42% protein along with appreciable levels of choline, biotin, folic acid, and a favourable amino acid composition (Zhu *et al.*, 2019; Swati *et al.*, 2015) [14, 9]. Globally, rapeseed is the third most important oilseed crop, and RSM serves as a valuable protein source in animal feeding systems (30-45% crude protein) with high lysine and sulfur-containing amino acids (Swati *et al.*, 2015) [9]. However, its broader utilization in poultry nutrition has been limited due to the presence of anti-nutritional factors such as glucosinolates, erucic acid, tannins, phytates, and non-starch polysaccharides (Bellostas *et al.*, 2007; Qin *et al.*, 2017) [2, 8]. High glucosinolate levels have been linked to hypothyroidism, reduced feed digestibility, liver and kidney damage, and overall impaired bird performance (Qin *et al.*, 2017) [8]. Although breeding of low-glucosinolate cultivars has improved its nutritive value, challenges persist-particularly phosphorus utilization, as nearly 65% of phosphorus remains bound in phytate form, limiting its availability to birds (Zhu *et al.*, 2021) [13].

To address these limitations, fermentation has emerged as a promising strategy for improving the nutritional efficiency of RSM. Microbial fermentation significantly reduces anti-nutritional compounds such as glucosinolates (up to 97%), phytates, and fiber, while enhancing protein digestibility, bioactive peptide content, and vitamin availability (Hu *et al.*, 2016; He *et al.*, 2014) [14, 6]. Solid-state fermentation using bacteria, fungi, and yeast has been particularly effective, as it degrades glucosinolates and non-starch polysaccharides without compromising protein quality (Zaworska *et al.*, 2023) [12]. Strains including *Bacillus* spp., *Saccharomyces cerevisiae*, and *Wickerhamomyces anomalus* have been shown to lower glucosinolate levels by up to 83% while enhancing nutrient utilization (Vlassa *et al.*, 2022) [10]. In addition, exogenous enzyme supplementation (e.g., protease, xylanase, glucanase, phytase) further improves the digestibility of proteins and carbohydrates, thereby enhancing broiler growth performance and feed efficiency (Zhu *et al.*, 2021) [13]. Fermentation also promotes hydrolysis of phytates and degradation of complex polysaccharides, improving phosphorus bioavailability and energy utilization.

Overall, these approaches establish fermented rapeseed meal as an economically viable and sustainable feed ingredient that can partially substitute soybean meal, while maintaining growth performance, gut health, immunity, and meat quality in broiler production systems (Hu *et al.*, 2016; Zhu *et al.*, 2021) [7, 13].

Materials and Methods

Venkateshwara Hatcheries Pvt. Ltd. provided 240 day-old commercial broiler chicks for this investigation, the fermented rapeseed meal was procured from Hi-gain Feeds & Farms Pvt. Ltd., Mandya feed manufacturing plant and the enzyme mixture Vetzomix® was procured from Bionnar Healthcare Pvt. Ltd., Vijayawada, Andhra Pradesh. The chicks were first evaluated based on their weight upon acquisition and then randomly divided into six experimental groups. Each group had three replicates, with 10 chicks in each replicate. Following the Bureau of Indian Standards (BIS) 2007 [3] guidelines, the control group (T_1) received a corn-soybean meal based basal diet without FRSM or enzymes, while T_2 was fed the basal diet with 0.02% enzyme supplementation. The treatment groups T_3, T_5 and T_7 were supplemented with FRSM at 2.5, 5.0 and 7.5%, respectively, without enzymes, whereas T_4, T_6 and T_8 received 2.5, 5.0 and 7.5% of FRSM with 0.02% enzymes, respectively. The chicks were reared under standard management practices in a deep litter system until six weeks of age. The birds were vaccinated as per a standard vaccination schedule, and food and water were provided *ad libitum* throughout the trial. The study was approved by the Institutional Animal Ethics Committee, KVAFSU, Bidar, Karnataka.

At the end of the experiment, two birds from each replicate were sacrificed, and the tissue samples from the duodenum, jejunum, and ileocecal junction were collected for histopathological studies, including measurements of villus height and crypt depth. Additionally, microbiological parameters were assessed by quantifying *Lactobacillus* and *Escherichia coli* counts from the intestinal contents and the data were statistically analyzed.

Results

1. Gut morphology

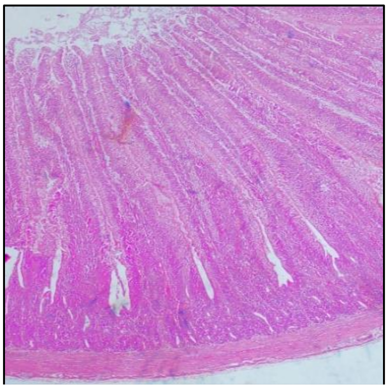
The results of the effect of feeding fermented rapeseed meal with or without enzymes on intestinal villi height and crypt depth in broilers from different treatment groups is presented in Table 1.

Statistical analysis revealed no significant difference (p>0.05) in villi height of duodenum, jejunum and ileocecal junction compared to control and other treatment groups at the end of experiment.

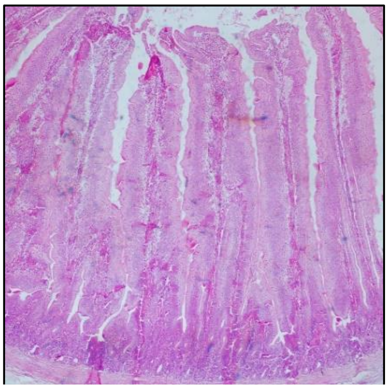
Statistical analysis revealed no significant difference (p>0.05) in crypt depth of duodenum, jejunum and ileocecal junction compared to control and other treatment groups at the end of experiment.

Table 1: Effect of feeding fermented rapeseed meal with or without enzymes on intestinal villi height and crypt depth (µm) (Mean±SE) in broilers.

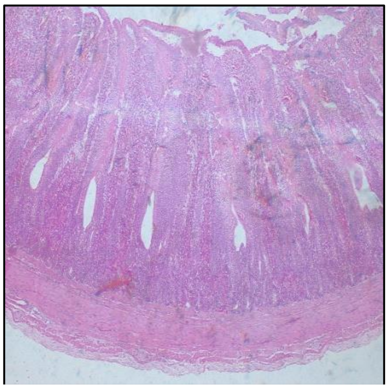
Experimental group	Duodenal villi height	Duodenal crypt depth	Jejunal villi height	Jejunal crypt depth	Ileum villi height	Ileum crypt depth
T_1	1155.00±9.33	158.17±3.91	890.17±5.68	141.67±8.22	646.17±15.02	145.17±9.87
T_2	1174.17±9.63	171.33±8.44	913.50±6.91	154.67±9.62	679.33±20.11	152.83±13.16
T_3	1151.33±10.61	160.50±9.59	894.83±18.91	146.33±6.97	650.33±12.22	147.33±4.12
T_4	1186.17±16.63	175.00±4.03	922.33±18.84	165.33±6.99	686.67±8.27	156.67±9.16
T_5	1158.67±14.95	164.17±6.12	897.67±19.87	149.83±5.36	656.00±11.62	147.83±5.86
T_6	1192.67±7.75	178.00±7.17	932.17±5.79	170.00±4.86	692.50±6.30	158.33±10.59
T_7	1162.17±12.06	169.00±5.86	900.67±12.70	151.83±7.62	666.67±12.97	148.67±7.14
T_8	1200.83±15.86	178.50±2.4	940.67±5.84	173.83±7.06	700.67±9.55	158.83±9.47



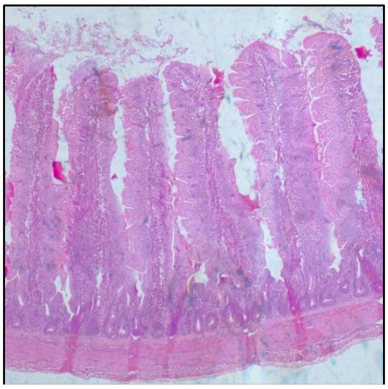
T_1 Duodenum



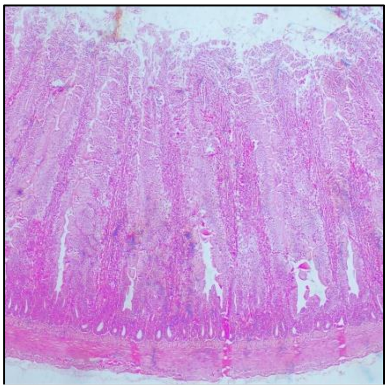
T_2 Duodenum



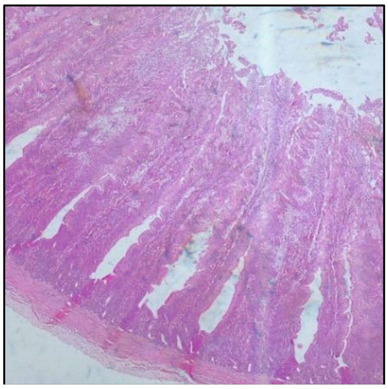
T_3 Duodenum



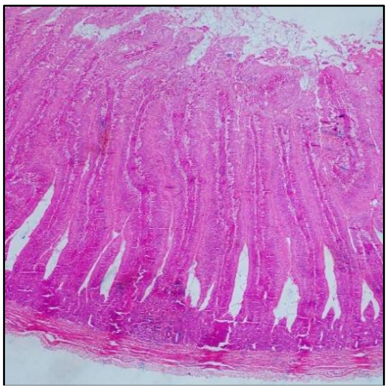
T_4 Duodenum



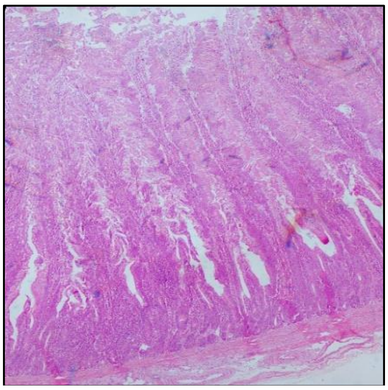
T_5 Duodenum



T_6 Duodenum

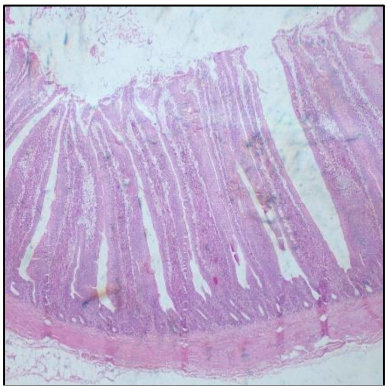


T_7 Duodenum

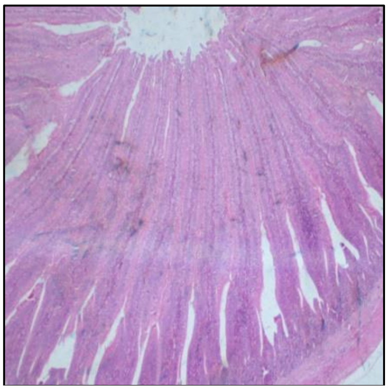


T_8 Duodenum

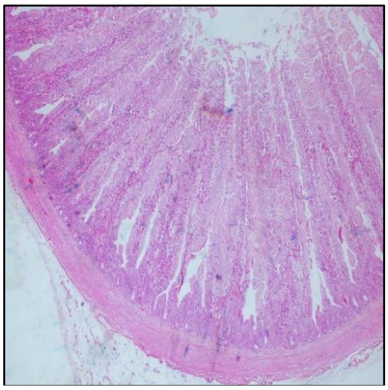
Plate 1: Section of duodenum from 42nd day old broilers fed with diets containing fermented rapeseed meal with or without enzymes on duodenum villi height and crypt depth.



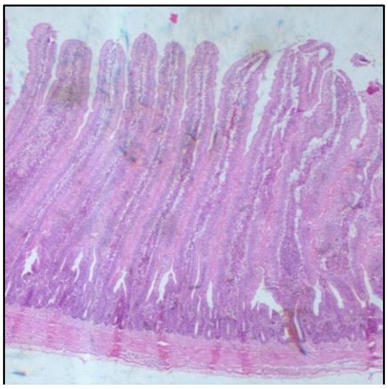
T_1 Jejunum



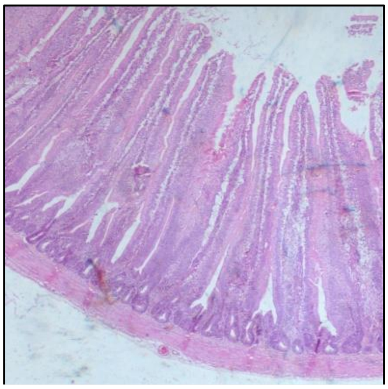
T_2 Jejunum



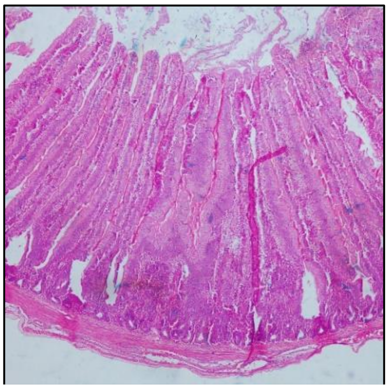
T_3 Jejunum



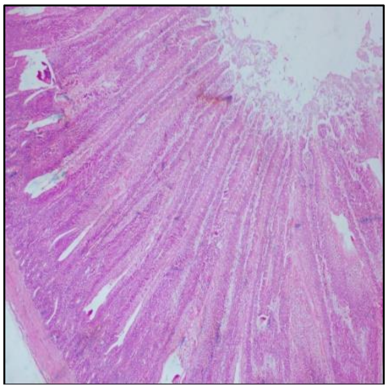
T_4 Jejunum



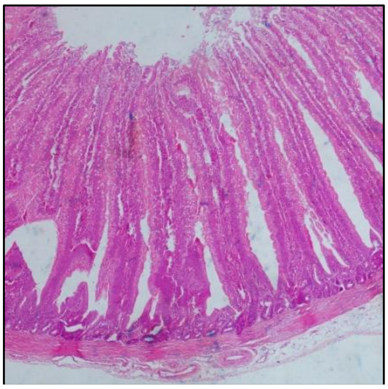
T_5 Jejunum



T_6 Jejunum

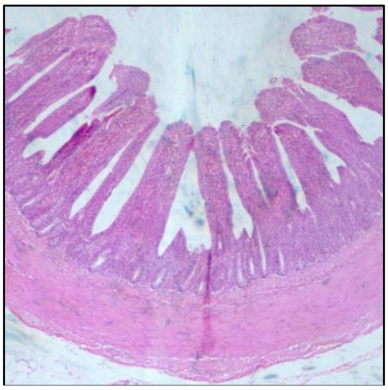


T_1 Jejunum

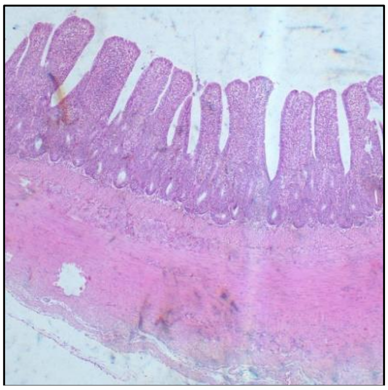


T_2 Jejunum

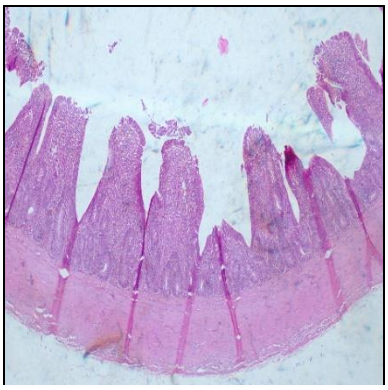
Plate 2: Section of jejunum from 42nd day old broilers fed with diets containing fermented rapeseed meal with or without enzymes on jejunum villi height and crypt depth.



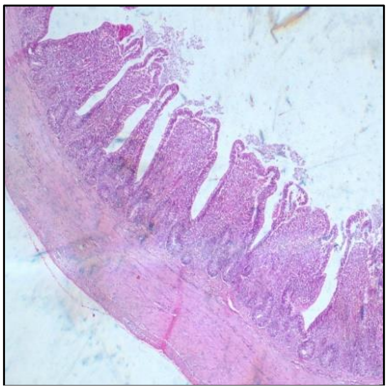
T_1 Ileocecal Junction



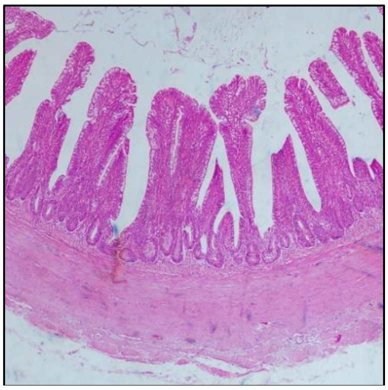
T_2 Ileocecal Junction



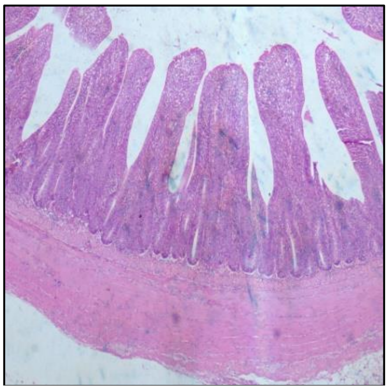
T_3 Ileocecal Junction



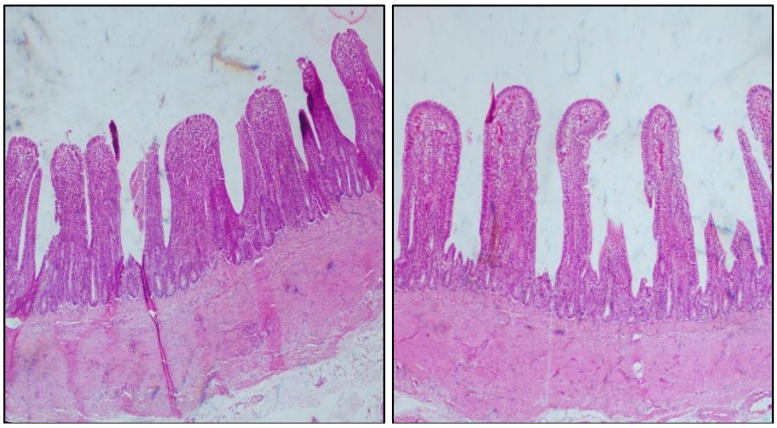
T_4 Ileocecal Junction



T_5 Ileocecal Junction



T_6 Ileocecal Junction



T_6 Ileocecal Junction T_6 Ileocecal Junction

Plate 3: Section of Ileocaecocolic junction from 42nd day old broilers fed with diets containing fermented rapeseed meal with or without enzymes on Ileocaecocolic junction villi height and crypt depth.

2. Gut microbial count

The results of the effect of feeding fermented rapeseed meal with or without enzymes on gut (intestinal) microbial load (log10 CFU/g) in broilers is represented in Table 2. Statistical analysis revealed a significant difference ($p \leq 0.05$) among the treatment groups at the end of experiment. The treatment groups T_5, T_6, T_7 and T_8 showed significantly ($p \leq 0.05$) lower *E. coli* count and higher *Lactobacillus* count than the groups T_1, T_2, T_3 and T_4. There was no significant difference ($p > 0.05$) in *E. coli* count and *Lactobacillus* counts among groups T_5, T_6, T_7 and T_8 and also among groups T_1, T_2, T_3 and T_4.

Table 2: Effect of feeding fermented rapeseed meal with or without enzymes on gut microbial load (*log10* CFU/g) (Mean±SE) in broilers

Experimental group	*E. coli*	*Lactobacillus spp.*
T_1	6.636 ± 0.059^b	6.665 ± 0.052^a
T_2	6.648 ± 0.087^b	6.672 ± 0.100^a
T_3	6.656 ± 0.070^b	6.678 ± 0.057^a
T_4	6.658 ± 0.042^b	6.688 ± 0.023^a
T_5	6.416 ± 0.047^a	6.972 ± 0.053^b
T_6	6.405 ± 0.050^a	6.979 ± 0.042^b
T_7	6.409 ± 0.039^a	6.982 ± 0.048^b
T_8	6.408 ± 0.026^a	6.994 ± 0.040^b

^{a,b}Means in the same column with no common superscript differ significantly ($p \leq 0.05$)

Discussion

There was no significant difference ($p \leq 0.05$) in gut morphology of the birds fed with fermented rapeseed meal with or without enzymes compared to the control group at the end of the experiment.

The results of the present study were in agreement with Fahimi *et al.* (2023) [5] who observed supplementation of fermented rapeseed meal at 50% in broiler diet showed no significant effect on intestinal villi characteristics compared to the control group.

The results of the present study were in disagreement with Wu *et al.* (2022) [11] who observed supplementation of fermented rapeseed meal at 10% in broiler diet showed significantly increased duodenal villus height and villi height/crypt depth ratio compared to control group There was a significant difference ($p \leq 0.05$) in gut microbial count of the birds supplemented with modified lignin compared to the control group at the end of the experiment.

There was a significant difference ($p \leq 0.05$) in gut microbial count of the birds fed with fermented rapeseed meal with or without enzymes compared to the control group at the end of the experiment.

The results of the present study were in agreement with Ashayerizadeh *et al.* (2018) [1] who reported that supplementation of fermented rapeseed cake at all levels in broiler diets showed significantly higher population of lactic acid bacteria in the crop and a lower population of coliform bacteria in the ileum compared to the control group. They attributed this effect to the unique characteristics of fermented feeds, particularly their high lactic acid content, which helps to acidify the upper gastrointestinal tract. This creates favourable conditions for the growth and establishment of beneficial bacteria, such as lactic acid bacteria. These beneficial microbes contribute to a competitive exclusion effect, forming a natural defence barrier against infections and pathogenic bacteria, including *Salmonella* and coliforms.

The results of the present study were in disagreement with Drazbo *et al.* (2020) [4] who observed supplementation of fermented rapeseed cake at 150 g/kg in turkey diet showed significantly decreased *Lactobacillus* counts in the ceca compared to the control group.

Conclusion

Based on the findings of the present study, it was concluded that inclusion of fermented rapeseed meal up to 7.5%, with or without enzyme supplementation at 0.02% in the diet, has no detrimental impact on gut morphology and positively modulates the gut microbial population in broilers. Hence, the incorporation of fermented rapeseed meal up to 7.5% in broiler diets, with or without enzyme supplementation, can be recommended without any adverse effects.

References

1. Ashayerizadeh A, Dastar B, Shargh MS, Mahoonak AS, Zerehdaran S. Effects of feeding fermented rapeseed meal on growth performance, gastrointestinal microflora population, blood metabolites, meat quality, and lipid metabolism in broiler chickens. Livestock Science. 2018 Oct 1;216:183-190.
2. Bellostas N, Sørensen H, Sørensen S. Quality of rapeseed meal for animal nutrition and as a source of value-added products-glucosinolates, protein and fibres. Bulletin. 2007 Mar;(24).

3. BIS IS. Poultry feed specifications. 5th revision. New Delhi: Bureau of Indian Standards; 2007.
4. Drażbo AA, Juśkiewicz J, Józefiak A, Konieczka P. The fermentation process improves the nutritional value of rapeseed cake for turkeys-effects on performance, gut bacterial population and its fermentative activity. Animals. 2020 Sep 22;10(9):1711.
5. Fahimi S, Dastar B, Ashayerizadeh O, Mirshekar R. The effect of raw and fermented rapeseed meal on performance, carcass, and morphology of intestinal villi in broiler chickens under normal rearing conditions and ascites induction. Journal of Animal Environment. 2023 Dec 4;15(4):1-9.
6. He R, He HY, Chao D, Ju X, Aluko R. Effects of high pressure and heat treatments on physicochemical and gelation properties of rapeseed protein isolate. Food and Bioprocess Technology. 2014 May;7(5):1344-1353.
7. Hu Y, Wang Y, Li A, Wang Z, Zhang X, Yun T, *et al.* Effects of fermented rapeseed meal on antioxidant functions, serum biochemical parameters and intestinal morphology in broilers. Food and Agricultural Immunology. 2016 Mar 3;27(2):182-193.
8. Qin S, Tian G, Zhang K, Ding X, Bai S, Wang J, *et al.* Influence of dietary rapeseed meal levels on growth performance, organ health and standardized ileal amino acid digestibility in meat ducks from 15 to 35 days of age. Journal of Animal Physiology and Animal Nutrition. 2017 Dec;101(6):1297-1306.
9. Swati S, Sehwag SS, Das M. A brief overview: present status on utilization of mustard oil and cake. [Internet]. [cited 2025 Oct 22]; Available from: (source/link not provided).
10. Vlassa M, Filip M, Țăranu I, Marin D, Untea AE, Ropotă M, *et al.* The yeast fermentation effect on content of bioactive, nutritional and anti-nutritional factors in rapeseed meal. Foods. 2022 Sep 23;11(19):2972.
11. Wu Z, Chen J, Ahmed Pirzado S, Haile TH, Cai H, Liu G. The effect of fermented and raw rapeseed meal on the growth performance, immune status and intestinal morphology of broiler chickens. Journal of Animal Physiology and Animal Nutrition. 2022 Mar;106(2):296-307.
12. Zaworska-Zakrzewska A, Kasprowicz-Potocka M, Kierończyk B, Józefiak D. The effect of solid-state fermentation on the nutritive value of rapeseed cakes and performance of broiler chickens. Fermentation. 2023 Apr 30;9(5):435.
13. Zhu X, Wang L, Zhang Z, Ding L, Hang S. Combination of fiber-degrading enzymatic hydrolysis and lactobacilli fermentation enhances utilization of fiber and protein in rapeseed meal as revealed in simulated pig digestion and fermentation *in vitro*. Animal Feed Science and Technology. 2021 Aug 1;278:115001.
14. Zhu YW, Yang WC, Liu W, Yin XH, Luo XB, Zhang SA, *et al.* Effects of dietary rapeseed meal inclusion levels on growth performance, organ weight, and serum biochemical parameters in Cherry Valley ducks. Poultry Science. 2019 Dec 1;98(12):6888-6896.