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Effect of substituting maize in broiler diet with fermented and enzyme-treated *Prosopis juliflora* pod meal on growth performance

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Abstract

The study used 180 Cobb broilers to determine the effect of substituting maize in broiler diets with varying levels of fermented and enzyme-treated prosopis pod meal in broiler diets on performance. The experiment adopted a completely randomized design with three replicates per treatment each with 5 birds offered diets with 0, 15, 30 and 45% levels of either fermented, unfermented or with enzyme-treated pod meal. Feed offered and refusals were recorded daily and feed intake calculated as the difference between the two. Broilers were weighed on a weekly basis. Performance data on were analysed for starter (1-21 days) and finisher (22-42 days). Feed intake, final live weight and feed conversion ratio were significantly highest ($p < 0.05$) at 30 and 45% fermented pods, followed by enzyme-treated processing and lastly unfermented pods at the same level of substitution. The results showed that fermenting pods achieved higher inclusion levels and improved chicken performance as compared to unfermented and enzyme-treated pods.

Keywords: Prosopis pods, fermentation, enzyme-treated, broilers, feed conversion ratio

1. Introduction

It is estimated that by 2050 the world will have around 9.3 billion people and this will double demand for maize which is the preferred staple food ^[21]. The situation is made worse by climate changes that is threatening to reduce the production of maize. Overreliance on maize as staple feed ingredient in chicken production can therefore lead to collapse of the sector if alternative sources are unavailable ^[13]. The use of alternative ingredients is the solution to replace the conventional ingredients. The new feeds should offer nutrients that are cost-effective in a way that the poultry performance will either be improved or improved ^[24]. Prosopis pods have proved to be an alternative feed ingredient in feeding of non-ruminants ^[24]. The pods have high energy and protein content 12. Their full utilization is impeded by the presence of anti-nutritive factors such as tannins, fibre and non-starch polysaccharides ^[16], ^[24], ^[10]. These is need for interventions to overcome these particular challenges. Fermentation and enzyme treatment have been suggested as technologies that would enhance the nutritive value of feeds and address the negative impacts of anti-nutritive factors ^[2].

2. Materials and Methods

2.1 Study site

The feeding trial was undertaken at the Kenya Agricultural and Livestock Research Organization (KALRO) in Naivasha Poultry Research Unit (PRU). The location of the Institute is. The Research Institute is located in Naivasha sub-county in Nakuru County, at an elevation of about 1,700 meters above sea level and receives an average annual rainfall of 1,100 millimetres. In the months of July and August, the lowest temperature is 8 °C, while in January and February, the highest temperature is 25 °C ^[15].

2.2 Prosopis pods harvesting, drying, storage and milling

Prosopis pods were obtained from Marigat Sub County in Baringo County in Kenya. Dry and ripened mature pods were collected after shaking the trees.

Pods with evidence of any discoloration, browsing, livestock and attack by insects or moulds were discarded to avoid aflatoxin infection [6]. Pods were sun-dried until a constant weight was achieved. The pods were first ground without passing through a sieve. The second grinding was done according to the procedure described by [5] and flour passed through a 5 mm sieve and thereafter the pod meal stored in airtight containers.

2.3 Fermentation of prosopis pod meal experimental diets

The pods were fermented spontaneously for six days. The other ingredients were procured from suppliers of animal feeds and raw materials. These ingredients were finely ground to a particle size of 5 mm sieve and utilized in the formulation of the experimental diets. The feeding trial was divided into starter and finisher phases. The compounded diets were iso-caloric and iso-nitrogenous. There were four levels of prosopis pods (0, 15, 30 and 45%) and three forms of prosopis pods based on biotechnologies used in processing the pods namely; -unfermented (UNF), fermented (FER) and enzyme (ENZ) treated. The enzyme used was Natuzyme® which provided 2,000 units/g of xylanase, 6000 units/g of cellulase, 1500 units/g of phytase, 700 units/g of beta-glucanase, 700 units/g of protease and 400 units/g of alpha-amylase. Vitamin premix provided the following per kg of diet: Vitamin A, 10,000 IU; Vitamin D₃, 2000 IU, Vitamin E, 5 mg; Vitamin K, 2 mg; Riboflavin, 4.2 mg; Nicotinic acid, 20 mg; Vitamin B₁₂, 0.01mg; Pantothenic acid, 5 mg; Folic acid, 0.5 mg; Choline, 3 mg; Mg, 56 mg; Fe, 20 mg; Cu, 10 mg; Zn, 50 mg; Co, 125 mg; Iodine, 0.08 mg.

2.4 Analysis of feeds

Chemical analysis of formulated feeds and feeds offered and refused was performed at Animal Nutritional Laboratory at Egerton University. The proximate composition in terms dry matter, ash content, ether extract, crude fiber content and crude protein was determined following the procedures of [4]. Crude protein (CP) was determined using the factor $N \times 6.25$

where N was the total nitrogen from the proximate analysis.

2.5 Management of experimental birds

A total of 180 unsexed day old Cobb strain chicks were purchased from Kenchic® Company Limited, Nakuru. They were allocated to 12 dietary treatments in triplicates in a completely randomized design each replicate with five birds. The chicks were brooded using 250 watt infrared electric bulbs with gradual height adjustment as sources of heat and light in single-tier deep litter cages. The room temperature was maintained at between 20-25 °C. The floor was covered with wood shavings. Clean water was offered *ad libitum* throughout the experiment period. Vaccination, brooding and housing management were performed as described by [12]. This experiment obtained approval from Egerton University Institutional Scientific and Ethic Review Committee (EUISERC/APP/193/2022) and license to conduct the research from National Commission for Science and Technology (NACOSTI/P/24/38178).

2.6 Feeding trial and data collection: All 180 broilers were offered the respective dietary treatments and daily feed intake (feed offered minus feed refusals from 0700-1800 h) recorded daily. Refusal feed were collected and weighed before the next feeding. Feed offered and left over were sampled daily and pooled per treatment for the entire experimental period for chemical analysis. The first week was used for the adaptation period where the birds were fed on respective experimental diets. Feeding trials were divided in to two phases; starter phase from 8th to 21st day and finisher phase from 22nd to 42nd day. Birds in a group pen were weighed weekly at 0900 hours before morning feeding at using a sensitive balance with 0.1 g sensitivity. Mean live weight gain for each experimental unit were represented by the mean pen weight for a given period of time. Weekly feed conversion ratio (FCR) per bird were calculated as the ratio of feed consumed to the body weight gain. Incidences were recorded and the general health of the status of birds monitored.

Table 1: Composition of ingredients and chemical composition of the rations experimental broiler starter diet

Treatments										
	0% pod meal	15% pod meal			30% pod meal			45% pod meal		
Ingredients (%)	Control	UNF	ENZ	FER	UNF	ENZ	FER	UNF	ENZ	FER
Fermented pods	-	-	-	9.00	-	-	18.00	-	-	27.00
unfermented pods	-	9.00	9.00	-	18.00	18.00	-	27.00	27.00	-
Maize	60.00	51.00	51.00	51.00	42.00	42.00	42.00	33.00	33.00	33.00
Fish meal	6.85	6.85	6.85	6.85	6.55	6.55	6.55	6.25	6.25	6.25
Soybean	31.35	30.85	30.75	30.65	30.65	30.55	30.65	30.65	30.55	30.65
Vegetable oil	0.00	0.50	0.50	0.70	1.00	1.00	1.00	1.30	1.30	1.30
Limestone	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DCP	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Iodized salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin premix	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Natuzyme®	-	-	0.10	-	-	0.10	-	-	0.10	-
Total in Diet	100	100	100	100	100	100	100	100	100	100
Determined Values										
CP (%)	22.01	22.22	22.16	22.28	22.29	22.25	22.71	22.77	22.73	23.15
CF (%)	3.31	5.00	5.02	4.77	6.70	6.69	6.25	8.41	8.40	7.73
ME (MJ/Kg)	12.05	12.04	12.04	12.13	12.07	12.06	12.14	12.06	12.05	12.15

Table 2: Composition of ingredients and chemical composition of the rations experimental broiler finisher diet

Treatments										
	0% pod meal	15% pod meal			30% pod meal			45% pod meal		
Ingredients (%)	Control	UNF	ENZ	FER	UNF	ENZ	FER	UNF	ENZ	FER
Fermented pod	-	-	-	9.77	-	-	19.53	-	-	29.30
Unfermented pod	-	9.77	9.75	-	19.53	19.50	-	29.30	29.25	-
Maize	65.00	55.34	55.25	55.34	45.57	45.50	45.57	35.81	35.75	35.81
Fish meal	6.35	5.85	5.85	5.85	5.75	5.75	5.25	5.55	5.55	5.55
Soybean	26.80	26.20	26.20	26.20	25.80	25.80	25.8	25.50	25.5	25.5
Vegetable oil	-	1.00	1.00	1.00	1.50	1.50	2.00	2.00	2.0	2.00
Limestone	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
DCP	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Iodized salt	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Vitamin premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Natuzyme®	-	-	0.10	-	-	0.10	-	-	0.10	-
Total in Diet	100	100	100	100	100	100	100	100	100	100
Determined Values										
CP (%)	20.23	20.23	20.22	20.51	20.53	20.51	20.65	20.81	20.80	21.38
CF (%)	3.26	5.08	5.08	4.84	6.92	6.91	6.43	8.76	8.74	8.02
ME (MJ/Kg))	12.24	12.39	12.38	12.43	12.40	12.39	12.63	12.41	12.40	12.53

2.7 Experimental design

The experiment used a completely randomized design with a 4 x 3 factorial arrangement. There were 12 experimental units with 5 birds per treatment replicated 3 times. The statistical model used for analysis was as follows:

$$Y_{ijk} = \mu + A_i + B_j + (A*B)_{ij} + \varepsilon_{ijk}$$

Where:

Y_{ij} = dependent variables

μ = overall mean

A_i = Effect due to i^{th} percentage of the prosopis pod meal in the diet ($i = 1 \dots 4$)

B_j = Effect due to j^{th} type of biotechnology used in treating prosopis pod meal ($j = 1 \dots 3$),

$A*B_{ij}$ = Effect due to interaction of i^{th} percentage of prosopis pod meal and j^{th} type of biotechnology used in treating prosopis pod meal ($ij = 1 \dots 12$)

ε_{ijk} = Random error term

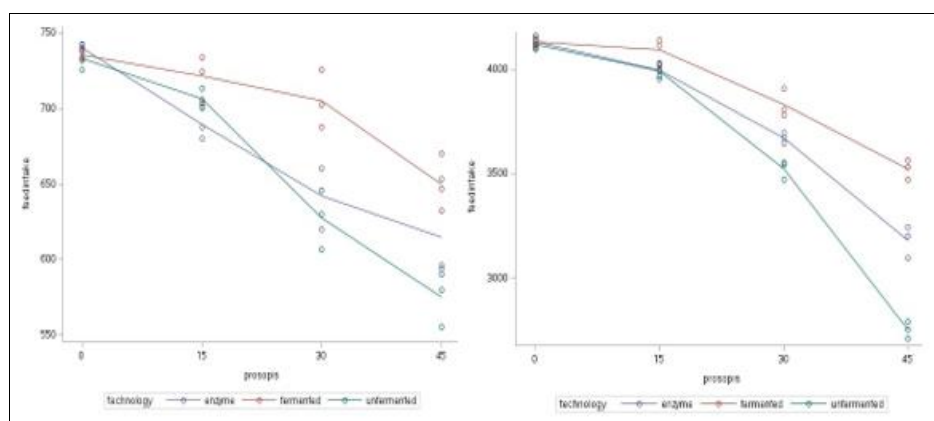
2.8 Statistical analyses

Data were first tested for normality (Shapiro-Wilk test) and homogeneity of variances (Levene's test). Then analyzed using general linear model (GLM) procedure of statistical analysis system version 9.0. Significant means were separated using Tukey's test at 5% probability.

3. Results

3.1 Feed intake

There was significant interaction ($p < 0.05$) between levels of PPM and biotechnology used in treating PPM. In the starter phase, broilers offered unfermented and enzyme-treated 30% pods and fermented and enzyme-treated 45% level had similar ($p > 0.05$) feed intake but lower ($p < 0.05$) feed intake as compared to broilers receiving control diets, unfermented and fermented 15% pods and fermented 30% PPM. In the finisher phase, control and all broilers receiving treatments in the 15% level had similar ($p > 0.05$) feed intake. Those offered 30% of fermented and enzyme treated pods had similar feed intake but which was higher ($p > 0.05$) than in unfermented pods. In 45% fermented, the feed intake was higher ($p < 0.05$) than in enzyme treated which was lower than in unfermented.

**Fig 1:** Feed intake for starter and finisher phase

3.2 Final live weight

Final live weight (FLW) for initial phase was lower ($p < 0.05$) in broilers receiving 45% unfermented pods than all other treatments. FLW in birds offered control and both unfermented and fermented 15% pods was similar. In 30% fermented the FLW was higher ($p < 0.05$) as compared to unfermented and enzyme treated that were similar to each other. In fermented 45% level, broilers had higher ($p < 0.05$) FLW than those receiving enzyme-treated which was also higher than broilers on unfermented pods. At the end of finisher phase, all pods types at 0% resulted in similar ($p > 0.05$) FLW. At 15% pods, the broilers on diets with fermented pods had higher ($p < 0.05$) FLW than in both unfermented and enzyme-treated pods base diets which recorded similar weights. In diets with 30% fermented, the FLW was higher ($p < 0.05$) as compared to those with unfermented and enzyme-treated that were also ($p < 0.05$) different. Similar findings were observed in diets with 45% level where the fermented pods had higher ($p < 0.05$) FLW than in diets with

enzyme-treated pod meal which was also higher than diets with unfermented PPM. Final live weight for initial phase was lower ($p < 0.05$) in birds receiving 45% unfermented pods than all other treatments.

3.3 Feed conversion ratio

In the starter phase, broilers received control treatments had similar ($p > 0.05$) feed conversion ratio (FCR) similar to all treatments at 15% level. Both 30% and 45% levels of PPM had lower ($p < 0.05$) FCR than unfermented and enzyme-treated PPM. In the finisher phase, at 0% level, unfermented, fermented and enzyme treated pods resulted in similar ($p > 0.05$) FCR in broilers. At 15%, broilers offered fermented and enzyme-treated pods had similar FCR but the lower ($p < 0.05$) than unfermented pods. At 30 and 45% levels, there was lower ($p < 0.05$) FCR in birds receiving fermented than in enzyme-treated which was also lower than in broilers offered unfermented pods.

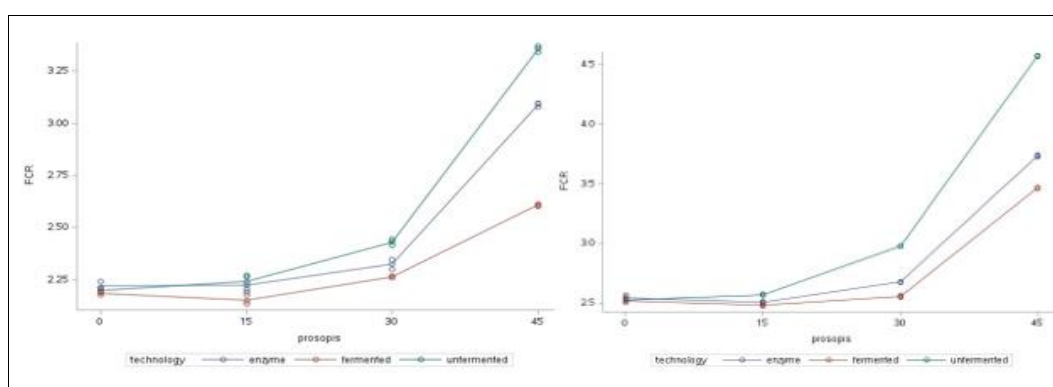


Fig 2: Feed conversion ratio for starter and finisher phases

Table 3: Performance of broilers in starter and finisher phases

Treatments		Initial weight (g/bird)	Starter phase			Finisher phase		
Prosopis pod meal (%)	Biotechnology		Final weight (g/bird)	Feed intake (g)	FCR	Final weight (g/bird)	Feed intake (g)	FCR
0	Unprocessed	135.92	468.93 ^{ab}	733.28 ^{ab}	2.19 ^{hi}	1806.55 ^{ab}	3384.8 ^a	2.52 ^{gh}
15	Unfermented	135.57	450.43 ^{bc}	706.00 ^{ab}	2.24 ^{fg}	1728.25 ^c	3283.9 ^a	2.57 ^f
15	Enzyme	135.89	445.48 ^c	689.12 ^{bc}	2.22 ^{gh}	1763.88 ^{bc}	3303.2 ^a	2.51 ^{hi}
15	Fermented	135.31	470.71 ^{ab}	721.27 ^{ab}	2.15 ⁱ	1829.36 ^a	3370.1 ^a	2.48 ⁱ
30	Unfermented	134.46	393.70 ^{de}	627.49 ^d	2.43 ^d	1365.55 ^f	2895.7 ^c	2.98 ^d
30	Enzyme	136.39	411.84 ^d	642.05 ^{cd}	2.32 ^e	1544.89 ^e	3028.9 ^b	2.68 ^e
30	Fermented	135.28	446.84 ^c	705.05 ^{ab}	2.26 ^f	1669.44 ^d	3124.3 ^b	2.56 ^f
45	Unfermented	135.79	306.83 ^g	575.16 ^f	3.36 ^a	783.57 ⁱ	2179.3 ^e	4.57 ^a
45	Enzyme	133.32	334.52 ^f	614.58 ^{de}	3.09 ^b	1019.42 ^h	2566.3 ^d	3.73 ^b
45	Fermented	136.21	384.59 ^e	649.75 ^{cd}	2.61 ^c	1213.65 ^g	2872.0 ^c	3.47 ^c
SEM		0.08	1.53	1.53	0.01	9.58	10.38	0.02
p-value		NS	<0.001	0.0026	<0.001	<0.001	<0.001	<0.001
a,b,c Means within a column with different superscripts are significantly different; NS = not significant								

4. Discussion

4.1 Feed intake

In the starter phase, broilers receiving control diets, unfermented and fermented 15% PPM, and fermented 30% PPM showed higher feed intake compared to those receiving 30% unfermented and enzyme-treated pods, as well as 45% fermented and enzyme-treated PPM. Fermenting feeds can be used as processing the feed to increase the digestibility [19]. It has also been reported that fermented feeds were preferred by broilers improving the feed consumption consequently

fermented feed can be regarded as quality feed as compared to unfermented feed [25]. This suggests that higher levels of PPM and the type of treatment applied can negatively impact feed intake during the early growth stages especially due to underdeveloped GIT that is key to handling the feeds [3]. Similar findings were reported by [7], who demonstrated that enzyme supplementation can improve nutrient digestibility and feed intake, although its effectiveness may vary depending on the level of inclusion and the specific feed ingredient used. The similarity in feed intake between

unfermented and enzyme-treated 30% pods, as well as between fermented and enzyme-treated 45% PPM, indicates that enzyme treatment alone might not be sufficient to mitigate the negative effects of higher PPM levels or that fermenting technique is superior to enzyme treatment. Fermentation also has advantage of enhancing microbial activity which helps in pre-digestion of feed components, making nutrients more accessible and reducing the challenge of digesting high fibre diet. ^[20]

In the finisher phase, all birds receiving control diets and 15% PPM, regardless of the treatment, showed similar feed intake. This consistency suggests that lower PPM levels are well-tolerated by broilers especially at the finisher phase when the GIT is mature ^[14]. In the 30% PPM group, birds consuming fermented and enzyme-treated pods had higher feed intake compared to those consuming unfermented pods, highlighting the positive impact of fermentation and enzyme treatment at this PPM level as reported by ^[25]. This aligns with the findings of ^[11], who noted that enzyme supplementation improved feed intake and nutrient utilization in broilers fed diets containing flaxseed. At the 45% PPM level, feed intake was highest in birds consuming fermented pods, followed by enzyme-treated and then unfermented pods, also being supported by the fact that fermentation improve the feed quality in broilers ^[25] while enzymes supplement the work of endogenous enzymes ^[3]. This suggests that fermentation might be more effective than enzyme treatment alone in improving the palatability and digestibility of higher PPM levels, as also supported by the work of ^[9] on the role of feed enzymes in promoting gut health and nutrient absorption.

4.2 Final Live weight

The final live weight is a product of feed intake and the quality of feed. During the starter phase, birds receiving 45% unfermented PPM had a significantly lower FLW ($p < 0.05$) compared to all other treatments. This suggests that high levels of unfermented PPM contain anti-nutritional factors that negatively impact growth. ^[16] highlighted that Prosopis pods contain anti-nutritional factors that can impair animal performance. Birds fed 15% unfermented and fermented PPM, as well as the control, had similar FLW. At the 30% inclusion level, fermented PPM resulted in higher FLW compared to unfermented and enzyme-treated PPM, which recorded similar FLW. At the 45% level, fermented PPM had higher FLW ($p < 0.05$) than enzyme-treated PPM, which was also higher than unfermented PPM. It indicates that fermentation likely improves digestibility ^[19] and reduces anti-nutritional factors ^[22] enhancing growth performance ^[25]. This is also supported by ^[17], who demonstrated that fermentation reduces tannins and other anti-nutritional compounds in feed ingredients ^[18].

At the end of the finisher phase, all treatments at the 0% inclusion level had similar FLW ($p > 0.05$). At the 15% inclusion level, fermented PPM resulted in higher FLW ($p < 0.05$) compared to unfermented and enzyme-treated PPM, which were similar. This indicates that at 15%, the anti-nutritive factors and crude fibre was not high to cause a difference between enzyme treated and diets with unfermented pods. At the 30% level, fermented PPM had higher FLW compared to unfermented and enzyme-treated PPM, which also differed significantly. The same trend was observed at the 45% level, where fermented PPM had higher

FLW than enzyme-treated PPM, which in turn was higher than unfermented PPM. This indicates that the consistency observed in feed intake aligns well with final live weight. Similar trends were observed when the entire experimental period is considered. These findings align with the research by ^[1], who found that fermentation and enzyme treatment can enhance nutrient availability and improve growth performance in poultry.

4.3 Feed conversion ratio

Birds consuming fermented feeds can convert feed into body mass more efficiently due to better nutrient availability and absorption ^[23]. In the starter phase, control treatments had similar FCR to all treatments at the 15% PPM level. At both the 30% and 45% inclusion levels, the FCR was lower in birds receiving fermented PPM compared to those receiving unfermented and enzyme-treated PPM. The lower FCR in fermented PPM indicates better feed efficiency and suggests that fermentation enhances nutrient availability and utilization with such benefits coming from the effect of balanced microflora on enhanced feed utilization ^[26]. These results are consistent with research by ^[26], thereby improving feed efficiency. The enzymes also reduce the effect of high crude fibre by freeing nutrients to be utilized by broilers for growth ^[19].

During the finisher phase, at the 0% inclusion level, diets with unfermented, fermented, and enzyme-treated PPM had similar FCRs. At the 15% inclusion level, both fermented and enzyme-treated PPM resulted in similar FCRs but had lower FCRs compared to unfermented PPM. At the 30% and 45% levels, fermented PPM showed lower FCR compared to enzyme-treated PPM, which also had a lower FCR than unfermented PPM. This trend indicates that fermented PPM provides better feed conversion, likely due to enhanced digestibility and reduced anti-nutritional factors. This can be supported by the fact that fermented feeds reduce the effect of pathogenic bacteria by encouraging growth of useful bacteria ^[19], thereby ensuring that the feeds offered to the broilers were efficiently used leading to reduced FCR. These findings also align well with ^[1], who reported that enzyme treatment and fermentation could reduce energy required for digestion, thereby channeling more energy to growth resulting to improve feed conversion efficiency in poultry ^[26]. It is also observed that the finisher phase had lower FCR which can be attribute to developed GIT as compared to starter phase.

5. Conclusion and Recommendations

5.1 Conclusion

As the level of prosopis pod meal in the diet increased, performance was better in broilers offered diets with fermented pods, followed by diets enzyme treated with those on unfermented pods performing poorly. Fermenting pod therefore improved the feeding quality of prosopis pod meal and could be used to substitute maize.

5.2 Recommendations

The findings provide some important implications for chicken feeding, indicating that incorporating fermented prosopis pods could enhance broiler performance. Fermentation and enzyme biotechnologies can mitigate the negative effects of anti-nutritional factors in prosopis pods, resulting in better feed conversion ratios and higher final live weights. Unfermented

feeds, especially at higher levels of prosopis pods, show lower performance due to the presence of anti-nutritional factors and lower palatability, leading to reduced feed intake and growth. It is recommended to ferment the pods and use enzyme to achieve higher inclusion levels and improve chicken performance.

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7. Conflict of Interest

Not available.

8. Financial Support

Not available.;

9. References

- Adeola O, Cowieson AJ. Board-invited review: Opportunities and challenges in using exogenous enzymes to improve non-ruminant animal production. *J Anim Sci.* 2011;89(10):3189-218.
- Ahiriwe EU, Ejiofor I, Oladipupo OA, Ogbuewu IP, Aladi NO, Obikaonu HO, *et al.* Effect of composite enzyme supplementation on production parameters, intestinal segment measurements, and apparent nutrient digestibility of broiler chickens fed low energy and protein diets. *Trop Anim Health Prod.* 2022;54(6):399.
- Al-Marzooqi W, Al-Kharousi K, Kadim IT, Mahgoub O, Zekri S, Al-Maqbaly R, *et al.* Effects of feeding *Prosopis juliflora* pods with and without enzyme on performance, meat quality, and health of broiler chickens. *Int J Poult Sci.* 2015;14(2):76-88.
- AOAC. Official Methods of Analysis. 15th ed. Arlington (TX): Association of Official Analytical Chemists; c1996.
- Choge SK, Odee D, Okeyo M. Management and control of *Prosopis* species in Baringo District of Kenya. Pilot project terminal technical report. FAO TCP/KEN/3002. KEFRI; c2006.
- Choge SK, Pasiecznik NM, Harvey M, Wright J, Awan SZ, Harris PJC, *et al.* *Prosopis* pod as human food with special reference to Kenya. *Water SA.* 2007;33(3):419-424.
- Cowieson AJ, Singh DN, Adeola O. Prediction of ingredient quality and the effect of a combination of xylanase, amylase, protease, and phytase in the diets of broiler chicks. 1. Growth performance and digestible nutrient intake. *Br Poult Sci.* 2006;47(4):477-489.
- Li J, Tao L, Zhang R, Yang G. Effects of fermented feed on growth performance, nutrient metabolism, and cecal microflora of broilers. *Anim Biosci.* 2021;35:596-604.
- Kiarie E, Romero LF, Nyachoti CM. The role of added feed enzymes in promoting gut health in swine and poultry. *Nutr Res Rev.* 2013;26(1):71-88.
- Maud BA, Kingori AM, Matofari JW. Effect of incorporation of fermented *Prosopis* pods in rabbit diets on feed intake, feed conversion ratio, weight gain, and growth rate. *Int J Vet Sci Anim Husbandry.* 2023;8(5S):236-241.
- Meng X. Improved nutrient utilization and growth performance of broiler chickens fed diets supplemented with multicarbohydrase enzyme preparations; c2005.
- Meseret G, Mengistu U, Getachew A. Ground *Prosopis juliflora* pods as feed ingredient in poultry diet: Effects on nutrient intake, muscle fatty acid composition, sensory quality, and haematology of broilers. *Pak J Nutr.* 2012;11(11):1014-1022.
- Moses C, Manyeula F, Radikara MV, Mareko MHD, Madibela OR. Carcass characteristics and meat quality of Ross 308 broiler chickens fed malted red and white sorghum-based diets. *Poult.* 2022;1(3):169-179.
- Mountzouris KC, Tsirtsikos P, Kalamara E, Nitsch S, Schatzmayr G, Fegeros K, *et al.* Evaluation of the efficacy of a probiotic containing *Lactobacillus*, *Bifidobacterium*, *Enterococcus*, and *Pediococcus* strains in promoting broiler performance and modulating cecal microflora composition and metabolic activities. *Poult Sci.* 2007;86(2):309-317.
- Muremera C, Ambula M, King'ori A. Performance of improved indigenous grower chicken in Kenya fed enzyme-treated *Moringa (M. oleifera)* leaf meal-based diets. *Int J Vet Sci Anim Husbandry.* 2022;7(3):48-52.
- Odero-Waitituh J, King'ori AM, Ambula MK. Lactation performance of New Zealand White rabbits fed fermented ground mature *Prosopis juliflora* pods replacing maize. *Anim Res Int.* 2020;17(2):3736-3746.
- Olukomaiya OO, Adiamo OQ, Fernando WC, Mereddy R, Li X, Sultanbawa Y, *et al.* Effect of solid-state fermentation on proximate composition, anti-nutritional factor, microbiological and functional properties of lupin flour. *Food Chem.* 2020;315:126238.
- Ozolina K, Sarenkova I, Muizniece-Brasava S. The anti-nutritional factors of legumes and their treatment possibilities: A review. *Res Rural Dev.* 2023, 38.
- Palupi R, Lubis FNL, Pratama ANT. Effects of *Lactobacillus*-fermented feed on production performance and carcass quality of broiler chickens. *J World's Poult Res.* 2023;13(1):127-135.
- Sharma R, Garg P, Kumar P, Bhatia SK, Kulshrestha S. Microbial fermentation and its role in quality improvement of fermented foods. *Fermentation.* 2020;6(4):106.
- Shiferaw B, Prasanna BM, Hellin J, Bänziger M. Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. *Food Sec.* 2011;3:307-327.
- Sugiharto S, Ranjitkar S. Recent advances in fermented feeds towards improved broiler chicken performance, gastrointestinal tract microecology, and immune responses: A review. *Anim Nutr.* 2019;5(1):1-10.
- Sun H, Chen D, Cai H, Chang W, Wang Z, Liu G, Deng X, *et al.* Effects of fermenting the plant fraction of a complete feed on the growth performance, nutrient utilization, antioxidant functions, meat quality, and intestinal microbiota of broilers. *Animals.* 2022;12:1-18.
- Wanjohi DM, King'ori AM, Wachira AM, Guliye AY. Effect of replacing complete grower diet with ground

- Prosopis juliflora* pods on performance of improved indigenous chicken in Kenya. Livest Res Rural Dev., 2017, 29(157).
25. Widodo AR, Setiawan H, Sudiyono S, Indreswari R. Kecernaan nutrisi dan performansi puyuh (*Coturnix coturnix japonica*) jantan yang diberi ampas tahu fermentasi dalam ransum. Trop Anim Husbandry. 2013;2(1):51-57.
26. Xu L, Wei Z, Guo Y, Guo B, Cai L, Yan J, *et al.* Effects of dietary supplementation with fermented flaxseed meal on the growth performance, immune function, and intestinal microbiota of growing pigs. Anim Feed Sci Technol. 2024;316:116079.

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