Impact of Adding Enzyme-Enriched Soybean Hulls to the Diet on Some Productive Traits of Broiler

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Abstract:
This study was conducted at the poultry farm of the Animal Production Department, College of Agriculture, Al-Muthanna University, from February 1, 2025, to March 8, 2025. 225 one-day-old broiler chicks were used. They were randomly distributed into five treatments with three replicates per treatment. The treatments were as follows: T1: Control (no additives). Treatments T2, T3, T4, and T5, an enzyme mixture (β-xylanase 2000 IU + β-glucanase 100 IU + cellulase 500 IU) was added at levels of 250, 500, 750, and 1000 gm ton of feed, respectively. The results of this study show that the use of soybean hulls enhanced with a mixture of enzymes (β-xylanase, β-glucanase, and cellulase) in broiler chicken diets, led to a significant improvement ($P \leq 0.05$) on some productive performance of broilers.

Keywords: soybean hulls, enzyme mix, productive ferformance, broiler Ross308.

Introduction

The poultry industry is one of the most important animal sectors globally. It plays a vital role in providing a primary source of animal protein. It constitutes a significant percentage of global food production. This contributes to achieving food security and meeting the growing demand for food (Pathai *et al*., 2026).
Nutrition is a fundamental pillar in the poultry industry. It provides all the nutrients birds need for production, growth, and reproduction. It is the primary factor upon which the production process depends. Therefore, it is obtained from balanced feed rations (Al Salman and Al-Gharawi, 2019; Georganas *et al*., 2023). Breeders strive to achieve the highest production rates at the lowest possible cost, by making optimal use of feed materials available in local markets (Al-Gharawi, 2012). To achieve this, poultry feed must contain all the essential nutrients necessary for the ideal growth of birds (Al-Salman and Al-Gharawi, 2023).
Soybeans are a major source of protein in poultry feed, while soybean hulls, a byproduct of seed hulling, are used in feed production as an economical and versatile feed resource. Soybean hulls contain quantities of non-starch polysaccharides, which can contribute to promoting the growth of beneficial bacteria in the gut. However, ey can also increase intestinal viscosity, negatively impacting growth performance and reducing nutrient digestibility (Choct *et al*., 2010).
Due to the lack of enzymes in soybean hulls necessary for the efficient digestion of non-starch polysaccharides, their use in poultry is limited (Liu *et al*., 2017). Therefore, exogenous enzyme supplements can compensate for this deficiency, as enzymes break down non-starch polysaccharides. This reduces the viscosity of digestive fluids and improves the digestibility of nutrients. This makes soybean hulls more viable and cost-effective as feed ingredients (Balasubramanian *et al*., 2018).
Therefore, the study of enzymes has garnered significant attention from researchers, as these additives are incorporated into animal feed to improve the utilization of trace nutrients, enhance poultry performance, and consequently increase productivity (Ebeid *et al*., 2025).
Given the fluctuating prices of ingredients used in animal feed, enzymes play a crucial role in optimizing nutrient utilization more profitably with a low environmental impact. As an additive, they influence livestock production and contribute to the quality of products, such as broiler chickens, meat, and commercial cuts favored by consumers (Silva and Smithard, 2000). Due to the presence of structural polysaccharides in the cell walls of grains used as poultry feed, which hinders nutritional utilization, the use of exogenous enzymes derived from microorganisms such as fungi improves grain breakdown, releasing a greater supply of nutrients to animals. In addition to nutritional benefits, enzymes significantly impact the economics of farmers who incorporate them into their animals' diets (Annison and Choct, 1991).
Fiber-digesting enzymes are added to feed, improving bird nutrition. The main effect is to reduce the anti-nutritional factor in grain fiber. Thus, the enzymes improve digestion and nutrient availability for absorption in the intestine, leading to better animal growth (Walker *et al*., 2024). Non-saccharide (NSP)-digesting enzymes are used in poultry diets to break down non-starch polysaccharides (NSPs) found in plant cell walls, particularly pentose, arabinoxylan, and beta-glucan, releasing nutrients from the grain cell walls. This improves the viscosity of digested starch and increases the absorption of essential

nutrients for chicken meat metabolism, including carbohydrates, proteins, fats, vitamins, and minerals (Nisha, 2022).
This study aims to improve the nutritional value of soybean hulls, using a specialized enzyme mixture for feed on some productive performance of broiler.

Materials And Methods

This study was conducted at the poultry farm of the Animal Production Department, College of Agriculture, Al-Muthanna University, from February 1, 2025, to March 8, 2025. 225 one-day-old broiler chicks were used. They were randomly distributed into five treatments with three replicates per treatment. The treatments were as follows:
T1: (Control Treatment).
T2: The birds were fed a diet containing 250 gm of enzyme mix per ton of diet.
T3: The birds were fed a diet containing 500 gm of enzyme mix per ton of diet.
T4: The birds were fed a diet containing 750 gm of enzyme mix per ton of diet.
T5: The birds were fed a diet containing 1000 gm of enzyme mix per ton of diet.
Three specialized fiber-digesting enzymes are mixed: β-xylanase 2000 IU+β-glucanase 100 IU+cellulase 500 IU. The fiber content of all treatments is 3.5%.

The traits studied:
Productive traits: live body weight (gm), weekly weight gain (gm), weekly feed intake (gm), feed conversion ratio (gm feed consumption/gm weight gain), and production index.

Results And Discussion

Table (1) shows the effect of using enzyme-enriched soybean hulls on the weekly body weight (gm) of broiler. The results indicate a significant effect (P≤0.05) across all treatments of enzyme-enriched soybean hulls compared to the control treatment. During the first week, treatments T3 (adding 500 gm of enzyme mixture/ ton of diet) and T4 (adding 750 gm of enzyme mixture/ton of feed) showed superior results. These two treatments did not differ significantly from each other compared to T2 (adding 250 gm of enzyme mixture/ton of feed). T2 showed a significant increase (P≤0.05) compared to the control treatment (no enzyme mixture). There were no significant differences (P≤0.05) between T4 and T3 on the one hand, and T5 and T2, and treatments T1 and T5 on the other. From week two to week five, T4 showed a significant advantage (P≤0.05) over T3, which in turn was superior to T2. Meanwhile, T5 showed a significant advantage (P≤0.05) over the control treatment. The mean body weight in week five was 1993.33, 2119.33, 2318.33, 2404.33, and 2054.66 gm for treatments T1, T2, T3, T4, and T5, respectively.

Table (1) Effect of using enzyme-enhanced soy husks on body weight rate (gm) of broiler chickens (mean ± standard error).

Treatments	Age (week)				
	1	2	3	4	5
T1	0.99± 149.07 c	1.82±333.30 e	3.84±746.43 e	3.75±1415.33 e	4.09± 1993.33 e
T2	1.61± 155.08 b	1.05±361.63 c	5.65±780.46 c	3.58±1477.36 c	6.35±2119.33 c
T3	0.79± 160.75 a	1.56± 369.80 b	1.46± 809.06 b	4.09±1512.33 b	38.76±2318.33 b
T4	0.82± 163.89 a	0.86± 378.43 a	2.05±822.53 a	6.65±1544.00 a	12.57±2404.33 a
T5	2.06± 152.33 bc	2.20± 350.30 d	4.55±759.1000 d	2.40±1437.66 d	3.17± 2054.66 d
Sig.	*	*	*	*	*

Table (2) Effect of using enzyme-enriched soybean hulls on weekly weight gain (g) of broiler. The results indicate a significant effect (P≤0.05) of all treatments using the enzyme mixture to enhance soybean hulls compared to the control treatment. During the first week of the birds' lives, treatments T4 and T3 showed a significant advantage (P≤0.05). These treatments did not differ significantly from treatment T2, and no significant differences (P≤0.05) were found between treatments T4 and T5, or between treatments T1 and T5. In the second week of broiler life, T4 showed a significant increase (P≤0.05) in weekly weight gain, compared to treatment T2, which also showed a significant increase (P≤0.05), compared to T5, which showed a significant increase (P≤0.05) compared to the control treatment (T1). No significant differences were found between treatments T2 and T3, or between treatments T3 and T4. In the third and fifth weeks of chicken life, treatments T3 and T4 showed a significant increase (P≤0.05) compared to treatments T5 and T2. No significant differences were found between treatments T5 and T2 compared to the control treatment. At the fourth week, T4 showed a significant advantage (P≤0.05) over treatments

T3 and T2. Two treatments, T3 and T2, also showed a significant advantage over treatment T5, while no significant differences were found between treatments T5 and T1. Regarding the overall weight gain, a significant advantage (P≤0.05) was observed for all supplementation treatments compared to the control. The mean cumulative weight gain was 1955.33, 2081.33, 2366.33, and 2016.66 g for treatments T1, T2, T3, T4, and T5, respectively.

Table (2) Effect of using enzyme-enhanced soy husks on weight gain (gm) of broiler (mean ± standard error).

Treatment	Age (week)					Total weight gain
	1	2	3	4	5	
T1	111.07 ± .99 0 c	184.23 ± 0.86d	413.13 ± 3.37b	668.90 ±6.56 c	578.00 ±.57 0b	1955.33 ± 4.09e
T2	117.08 ± 1.61b	206.55 ± 1.37b	418.83±4.6 5b	696.90 ±2.86 b	641.96 ±3.39 b	2081.33 ± 6.35c
T3	122.75 ± .79 0a	209.04 ± 2.33ab	439.26 ± 3.00a	703.26 ±2.76 b	806.00 ± 41.62a	2280.33 ± 38.76b
T4	125.89±.82 0a	214.54 ± 1.56a	444.10 ± 1.25a	721.46±5.23 a	860.33 ± 17.07a	2366.33±12. 57a
T5	114.33 ± 2.06bc	197.97 ± 3.13c	408.80 ± 2.41a	678.56 ±2.34 c	617.00 ±1.00 b	2016.66 ± 3.17d
Sig.	*	*	*	*	*	*

Table (3) Effect of using soybean hulls enhanced with enzyme mixture on the weekly feed intake (gm) of broiler. The table shows the results for the first and second weeks of broiler chicken life, in addition to the cumulative feed intake. A significant increase (P≤0.05) was observed in treatments T4 and T3 compared to treatments T5 and T1, which did not differ significantly from each other. T2 significantly outperformed the control treatment, while no significant differences were found between T5 and T1. In the third week, a significant increase (P≤0.05) was observed in treatment T3 compared to the supplementation treatments T2, T4, and T5. No significant differences were found between the supplementation treatments and the control treatment. In the fourth week, a significant increase (P≤0.05) was observed in the supplementation treatments T2, T3, and T4 compared to the control treatment T5 and the control treatment T1, between which no significant differences were found. In the fifth week of broiler age, a significant increase (P≤0.05) was observed in treatments T4 and T3 compared to the control treatments T5 and T2. The mean total feed intake was 3424.89, 3579.72, 3926.62, 3979.62, and 3499.92 g for treatments T1, T2, T3, T4, and T5, respectively.

Table (3) Effect of using enzyme-enhanced soy husks on weight gain (gm) of broiler (mean ± standard error).

Treatment	Age (week)					Total feed intake
	1	2	3	4	5	
T1	114.92 ± 1.05c	226.66 ± 1.26c	668.57 ± 4.90ab	1223.85 ± 11.76b	1190.87±3.0 5b	3424.89 ± 10.82c
T2	120.32 ± 1.71b	249.31 ± 2.03a	665.40 ± 8.41b	1253.47 ± 3.07a	1291.20 ± 6.91b	3579.72 ± 15.54b
T3	125.66 ± 0.89a	250.71 ± 3.01a	685.76±5.1 0b	1245.47 ± 4.03ab	1619.00±83. 83a	3926.62±86. 11a
T4	128.36 ± 0.78a	254.80 ± 1.79a	663.49 ± 3.65b	1262.05 ± 7.45a	1670.90 ± 29.56a	3979.62±23. 40a
T5	118.02 ± 2.15bc	240.19 ± 3.55b	656.41 ± 5.20b	1228.86 ± 1.98b	1256.41 ± 2.86b	3499.92 ± 5.63bc
Sig.	*	*	*	*	*	*

Table (4) Effect of using enzyme-enriched soybean hulls on feed conversion ratio (gm feed intake/ gm weight gain) of broiler chickens. It is observed that all experimental treatments, based on the results obtained, showed a significant improvement (P≤0.05) compared to the control treatment. In the first and second weeks of the birds' lives, T4 showed a significant improvement (P≤0.05), compared to treatment T3, which showed a significant improvement (P≤0.05) compared to T2, which also showed a significant improvement (P≤0.05), compared to treatment T5, which in turn showed a significant improvement (P≤0.05) compared to the control treatment. In the third and fourth weeks, a significant improvement (P≤0.05) was observed in T4 compared to treatments T3 and T2, and also compared to the control treatment. No significant differences were found between treatments T5 and T1, or between treatments T5 and T2. However, in the fifth week, the cumulative feed conversion ratio (CFR) showed significant improvement in treatment T4 (P≤0.05), compared to treatments T3 and T2, which did not differ significantly from each other. T5, in turn, showed significant improvement (P≤0.05) compared to the control treatment. The mean feed conversion ratio was 1.75, 1.71, 1.72, 1.68, and 1.73 gm feed intake/ gm weight gain for treatments T1, T2, T3, T4, and T5, respectively.

Table (4) Effect of using enzyme-enhanced soy husks on feed conversion ratio (gm feed intake/ gm weight gain) of broiler (mean ± standard error).

Treatment	Age (week)					Total feed intake
	1	2	3	4	5	
T1	±1.03 0.0006 e	±1.23 0.001 e	±1.61 0.001 d	0.001 ±1.82 e	0.004 ±2.06 d	0.0018 ±1.75 d
T2	0.000±1.02 6 c	±1.20 0.002 c	±1.58 0.005 c	0.003 ±1.79 c	0.001 ±2.01 b	0.0022 ±1.71 b
T3	±1.02 0.0006 b	±1.19 0.001 b	±1.56 0.001 b	0.001 ±1.77 b	0.001 ±2.00 b	0.00 83±1.72 b
T4	±1.01 0.0008 a	±1.18 0.001 a	±1.49 0.004 a	0.003 ±1.74 a	0.005 ±1.94 a	± 1.68 0.0012 a
T5	±1.03 0.0006 d	±1.21 0.001 d	±1.60 0.003 dc	0.003 ±1.81 d	0.002 ±2.03 c	0.0019±1.73 c
Sig.	*	*	*	*	*	*

Table (5) shows a significant improvement (P≤0.05) in the production index of broiler chickens due to the treatment using soybean husks enhanced with the enzyme mixture. T4 showed a significant improvement (P≤0.05) over the control treatment and the other supplementary treatments. T3 outperformed treatment T2, which in turn significantly outperformed treatment T5, which itself outperformed the control treatment. The mean production index was 325.15, 352.06, 384.68, 408.47, and 338.25 for treatments T1, T2, T3, T4, and T5, respectively.

Table (4) Effect of using enzyme-enhanced soy husks on production index of broiler (mean ± standard error).

Treatment	Production index
T1	0.32 ±325.15 e
T2	0 .60±352.06 c
T3	4.54 ±384.68 b
T4	1.92 ±408.47 a
T5	0 .51±338.25 d
Sig.	*

The study results indicate that using soybean hulls enhanced with multiple enzymes (β-xylanase, β-glucanase, and cellulase), resulted in a significant improvement (P≤0.05) in the productive traits of broiler chickens compared to the control treatment without the added enzymes. Treatments T3 and T4 achieved the highest rates in final body weight, weekly weight gain, feed conversion ratio, and overall production index. This improvement is attributed to the effective role of the added enzymes in breaking down the non-starch polysaccharides (NSPs) present in soybean hulls. This led to improved nutrient digestion and increased energy and protein utilization. This improvement is linked to hydrolytic enzymes such as xylanase, beta-glucanase, and cellulase, which break down plant cell walls composed of cellulose and hemicellulose, thus releasing nutrients trapped within plant cells (Cowieson and Bedford, 2009).
It contributes to reducing the viscosity of intestinal contents, which increases absorption efficiency and improves the balance of the intestinal microbial ecosystem (Chen *et al.*, 2023). The results indicated that the effect of enzymes is cumulative and continuous. The superiority of enzyme treatments was most evident during the second to fifth weeks of the rearing period. This demonstrates that the increased effectiveness of enzymes becomes more pronounced as the digestive system develops and the bird's nutritional requirements increase (Erdaw *et al.*, 2016).
The increase in feed consumption may be attributed to the improved flavor and palatability of feed enhanced with enzyme mixtures. The breakdown of certain complex compounds leads to the production

of simple sugars and short-chain oligosaccharides. These act as flavor enhancers, thereby increasing birds' appetite for feed (Velázquez-De Lucio *et al*., 2021). These oligosaccharides also contribute to improving the balance of the intestinal microbiome, by stimulating the growth of beneficial bacteria that produce short-chain fatty acids.This, in turn, improves nutrient absorption and increases the energy efficiency of the feed (Liu *et al*., 2017).

The increased body weight gain may be attributed to the fact that the enzymes added to the soybean hulls in the feed improved digestibility. This, in turn, increased feed utilization and reduced acid loss. This, in turn, increased the digestibility coefficient and consequently the body weight gain. The weight gain may also be attributed to the enzyme mixture's ability to effectively increase the digestibility coefficient. This, in turn, increases nutrient availability, which positively impacts weight gain rates (Kim *et al*., 2024).

The reason for increased feed consumption is attributed to the fact that enzymes accelerate digestion and increase its rate, thus leading to faster intestinal emptying. This, in turn, affects receptors in the small intestine, which then send signals to the hypothalamus centers responsible for hunger and satiety, prompting the chickens to eat more feed and thus increasing the amount of feed consumed (Moita and Kim, 2022).

The improvement in feed conversion ratio is attributed to increased feed consumption and enzyme activity. This activity affects the availability of nutrients in the feed rations, resulting in an increased digestibility coefficient, which in turn improves nutrient utilization. Consequently, this leads to higher weight gain due to the improved feed conversion efficiency compared to the control group (Hajati *et al*., 2009).

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