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Impact of Supplementing Xylanase and Glucanase Enzymes to Broilers Diet Contained Rice Bran on Growth Performance, Nutrients Digestion and Economic Evaluation During Fattening Period

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ABSTRACT

Three hundred and fifty-seven (357) unsexed broiler chicks (Arbor Acer), that were one day old, were weighed and split into seven equal experimental groups, each with three replicates (17 chicks per replicate), to examine the effects of supplementing mixture enzymes of xylanase plus glucanase as natugrain® TS (NE) to broiler diets containing different levels of rice bran (RB) on the growth performance, nutrient digestibility's and carcass traits, as well as economic efficiency during the fattening period (42 days). The groups were arranged as follows: the first fed a control diet (NC) without RB and non-supplemented with NE and set as a negative control group, while the second and third were fed an NC diet plus 1.0 and 2.0 g NE/kg, respectively; the fourth and fifth contained 7.5% RB plus 1.0 and 2.0 g NE/kg, respectively, while the sixth and seventh groups were fed a diet containing 15.0% RB plus 1.0 and 2.0 g NE/kg, respectively, during the starter, grower and finisher periods. The obtained results showed that all studied growth traits were significantly ($P<0.05$) improved by feeding the RB diet as compared with the control. Nutrient digestion and feeding value were significantly lowered by using RB in broiler diet. Relative weights of both eviscerated carcass and total edible parts were significantly ($P<0.05$) improved by using RB in broiler diet at 40 days of age. Both net revenue and economic efficiency were significantly higher by feeding RB diet plus NE addition at 40 days of age. From the obtained results, feeding dietary rice bran (up to 15.0%) with a mixture of enzymes of xylanase and glucanase (1.0 or 2.0 g/kg diet) could be used to improve growth performance, carcass traits and nutrient digestibility coefficients, as well as economic efficiency for broiler chicks during the fattening period.

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INTRODUCTION

Finding ways to lower feed costs is crucial to attaining sustainable profitability in broiler production, as they make up about 70% of overall production costs. Among other strategies to reduce feed costs. Agricultural by-products and alternative feed sources have emerged as crucial alternatives for farm animal nutrition in the wake of the recent conflict between Russia and Ukraine, the COVID-19 pandemic, and climate change (**Hashem *et al.*, 2021; Attia *et al.*, 2024**). Rice bran (RB), a by-product of local agriculture, can be a good solution because of its high nutrient content, making it useful for poultry feed (**Hafez and Attia, 2020; Attia *et al.*, 2023**). However, use of RB in poultry nutrition is limited by several factors, including its high fiber and fat content and the presence of antinutritional agents like phytic acid. When layer and broiler hens are fed diets including RB, certain procedures and techniques, like fermentation, enzyme supplementation, and the utilization of the fermented product, can enhance the quality of the bran and, consequently, the performance of the birds (**Wizna *et al.*, 2012**).

According to availability and nutritional effects, RB can be used as a substitute by-product in poultry production schemes to reduce the number of raw materials used for human feeding. This avoids the need for materials like corn that drastically affect their prices (**Chakraborty *et al.*, 2018**). The RB has a lower carbohydrate content than maize but has higher protein levels (around 13%), fatty acids (13%), and metabolizable energy (2980 Kcal/kg) **(NRC, 1994)**; thus, chickens could be fed this inexpensive energy source made from agro-industrial waste (**Cicero and**

Derosa, 2005; **Shaheen *et al.*, 2015)**. Additionally, oryzanols, tocopherols, tocotrienols, and phytosterols—all of which are micronutrients that contain antioxidants like vitamin E—are abundant in rice bran (**Sharma *et al.*, 2015**). The percentage of RB in broiler diets should be lowered to less than 12.5% because it may reduce the nutrients' digestibility when used in place of 25 or 50% of yellow corn due to its high fiber content, which in turn may have a negative impact on the birds' growth (**Abdul-Abass and Almrsomi, 2014; Alshukri *et al.*, 2016**). **Parakash (1996)** showed that dietary fiber is largely made of non-starch polysaccharides (NSPs), which include non-cellulosic, cellulose polymers, and pectic. He added that the protein amino acid composition of RB is generally better than that of other cereal grains due to its high lysine content (4.31%) and the limiting amino acids being threonine and isoleucine.

However, insoluble NSP could physically block enzymes, making it more difficult for proteins and carbohydrates to be digested effectively (**Morgan *et al.*, 2023**). Growth performance and nutrient digestibility can be enhanced by reducing intestinal viscosity and the cell-wall encapsulating effect in poultry diets by including NSP-degrading enzymes (**Chesson, 2001**). The current study aimed to evaluate the effects of supplementing the mixture of xylanase and β-glucanase enzymes (Natugrain TS compound) in broiler diets containing RB inclusion on growth performance, nutrient digestibility, physiological status, carcass traits and economic efficiency (EEF) during the fattening period.

MATERIALS AND METHODS

Ethical approval

The experimental procedures were approved and undertaken in accordance with the guidelines of the experimental animal care committee ethics of Damietta University, Egypt and **Marr (2015).**

Experimental design

This experiment carried out in a private farm near of Kafr Saad, Damietta Governorate in collaboration with Faculty of Agriculture, Damietta University, Egypt, during the period of September to October 2024. Three hundred and fifty-seven (357) unsexed commercial broiler chicks (Arbor Acer), that were one day old were weighed and split into seven equal experimental groups, each with three replicates (17 chicks per replicate). The study conducted to study the effects of supplementing mixture enzymes of xylanase plus glucanase as **Natugrain® TS** (NE) to broilers diets contained different levels of RB on the growth performance, nutrients digestibility's and carcass traits as well as economic efficiency during fattening period**.** The experimental diets (starter, grower and finisher) were formulated approximately iso- energetic and iso- nitrogenous to meet the broiler requirements according to **NRC (1994).** Chicks fed a starter diet from hatch day up to 14th day, the grower diet from 14 day up 28 days, then the finisher diet from 28 day up to 40 days of age. The experimental groups were arranged as follows: the first group fed a control diet (NC) that formulated without any rice bran level and non-supplemented with enzymes and set as a negative control group, while the second group was fed the NC diet that supplemented with 1.0 g NE/kg, the third was fed the NC diet with 2.0 g NE/kg, the forth was fed diet contained 7.5 % RB with 1.0 g NE/kg , the fifth was fed diet contained 7.5% RB with 2.0 g NE/kg, the sixth was fed diet contained 15.0 %RB with 1.0 g NE/kg and the seventh group was fed diet contained 15.0 %RB with 2.0 g NE/kg diet. The composition and calculated analysis of studied dietary treatments are shown in **(Table 1)** for each growth period.

Bird management

Chicks were reared with *ad libitum* access to feed and water. During the experiment period, the birds were raised at a standard ambient temperature (from 30°C to 24°C by dropping 3°C/week) with a relative humidity of 60–70%. They were exposed to light for 23 hours and darkness for 1 hour each day. The litter was wood shavings. Infectious bronchitis (IB) and Newcastle disease (ND) vaccinations were given to the birds during their first week of life, while the Gumboro disease vaccine was given to them in drinking water during their second week.

Obtained data and estimating parameters

- **Growth performance traits**

Live body weight (LBW, g) of chickens were recorded for each replicate at 1 and 40 days of age. Body weight gain (BWG, g), feed consumption (FC, g), and feed conversion ratio (FCR, g/g) were recorded weekly for each replicate during the experimental period.

- **Nutrients digestibility and nitrogen retention**

At 35 d of age three chicks per each treatment was selected on the basis of the average body weight. Each bird was kept separately in a metabolic cage (60 cm long × 50 cm wide × 60 cm high) and fed their respective experimental diets, the adaptation period was two days. For three days, the excreta were quantitatively collected, and the amount of feed consumption was noted. The excreta were then dried for 48 hours at 65 ºC in a forced oven, then it's thoroughly crushed and placed in plastic bags for storage. The proximate analysis of experimental diet and the excreta were carried out according to the official methods **(AOAC, 2023)**. Digestion coefficients determined using the formula: Digestion coefficient% = [(Nutrient consumption (g) – Fecal nutrient content (g)) / Nutrient consumption (g)] × 100. Nitrogen retention (NR) was calculated from the following formula, NR = (N content of dry matter of dry feed – N content of dried excreta) × 100/N content of dry feed.

- ### Carcass evaluations

At the end of 40 d of age, three chicks from each treatment were taken and weighted then slaughtered. The eviscerated carcass, liver, heart and gizzard, as well as abdominal fat were weighted then expressed as relative to their live body weight to calculate their relative weight percentages.

Economic evaluation

Economic parameters were calculated at the end of the studied period according to the price of feed ingredients and live body weight sales at investigation time. Economic efficiency (EEF, %) = (Net return LE/Total feed cost LE) × 100. Where net return= Total return- the cost of feeding.

Statistical analysis

Data obtained were statistically analyzed using the General linear model of **SAS (2004).** Differences among treatment means were estimated by Duncan's multiple range test **(Duncan, 1955).**

Table 1: The composition and calculated analysis of the testing diets.

Ingredients, %	Starter diets			Grower diets			Finisher diets		
	Rice bran %			Rice bran %			Rice bran %		
	0.0	7.5	15.0	0.0	7.5	15.0	0.0	7.5	15.0
Corn	55.9	49.45	43.15	61.4	55.3	48.5	66.5	60.0	53.6
Soybean (46%)	40.1	39.05	38.05	34.6	33.8	32.6	29.5	28.5	27.5
Rice bran	0.0	7.5	15.0	0.0	7.5	15.0	0.0	7.5	15.0
Di Cal phosphate	1.5	1.5	1.4	1.6	1.5	1.5	1.6	1.6	1.5
Limestone	1.5	1.5	1.4	1.4	0.9	1.4	1.4	1.4	1.4
Men. Vit. Premix	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Salt	0.30	0.3	0.3	0.3	0.3	0.3	0.30	0.3	0.3
Bicarbonate sodium	0.10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Lysine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	100	100	100	100	100	100	100	100	100
Calculated analysis									
CP, %	22.99	22.97	22.97	20.89	20.87	20.87	18.94	18.92	18.92
ME kcal/kg	2877	2828	2800	2927	2900	2835	2974	2926	2885
C. fat	2.53	3.32	4.12	2.68	3.47	4.27	2.82	3.62	4.41
Ca, %	0.98	0.98	0.93	0.95	0.96	0.95	0.94	0.95	0.94
Phosphorus, %	0.42	0.43	0.43	0.43	0.44	0.44	0.42	0.44	0.44
CF	2.89	3.52	4.16	2.80	3.43	4.07	2.71	3.35	3.98
Av. Methionine	0.42	0.42	0.42	0.40	0.40	0.40	0.37	0.37	0.37
Av. Lysin	1.32	1.33	1.34	1.20	1.20	1.21	1.06	1.08	1.08
Na.	0.17	0.18	0.18	0.17	0.18	0.18	0.17	0.18	0.18
Cost of one kg, LE	19.425	18.725	18.580	18.073	17.928	17.783	17.348	17.203	17.058

- Each 3 kg of the Vit and Min. premix contains: Vit. A 10 MIU, Vit. D 2 MIU, Vit E 10 g, Vit. K 2 g, Thiamin 1 g, Riboflavin 5 g, Pyridoxine 1.5 g, Niacin 30 g, Vit. B12 10 mg, Pantothenic acid 10 g, Folic acid 1.5 g, Biotin 50 mg, Choline chloride 250 g, Manganese 60 g, Zinc 50 g, Iron 30 g, Copper 10 g, Iodine 1g, Selenium 0. 10 g, Cobalt 0.10 g. and carrier $CaCO_3$ to 3000g according **to NRC (1994).**
- Price of one kg (LE) at time of experiment for different ingredients: yellow corn, 12.0; Soy bean meal, 26.5; Di-calcium Phosphate, 25.0; limestone, 0.35; Vit. & Min. premix, 90.0; Nacl,1.5, Lysine, 85.0; Methio., 250.0; rice bran, 12.00, and sodium bicarbonate, 150.0 and; as well as manufacture process, 500.0 LE/ton.

RESULTS

Growth performance

A significant improvement was shown in studied growth performance traits for broiler chicks fed diets containing rice bran (RB) plus natugrain® enzyme (NE) addition (Table 2). At 40 days of age, chicks fed a different RB diet plus NE supplementation had significantly higher LBW than those fed the negative control diet with or without NE addition. Chicks fed a 15.0% RB diet with 1.0 and 2.0 g NE/kg diet recorded the heavier LBW than the other treatment groups at 40 days of age. Chicks fed diet contained 7.5 and 15.0% RB% with both NE levels recorded a significant improvement in body weight gain (BWG) than those fed the negative control diet with or without NE supplementation at the period of 1- 40 days of age **(Table 2).** Feeding on 15.0% RB diet plus 2.0 g NE/kg resulted a superior BWG than those fed the other treatment groups at the whole experimental period (1-40 days of age).

Chicks fed all RB diets consumed significantly more feed than those fed the control diet supplemented with 1.0 g NE/kg during the period of 1-40 days of age **(Table 2).** Chicks fed a 15.0% RB diet plus 2.0 g NE/kg recorded a higher amount of feed consumed than other treatment groups at the whole period (1-40 days of age).

A significant improvement in FCR was induced for chicks fed on different RB diets compared with those fed the negative control diet with or without NE supplementation at 1-40 days of age; moreover, chicks fed on the 15.0% RB diet plus 1.0 or 2.0 g NE/kg recorded a better FCR than those in the other groups at the period of 1-40 days of age **(Table 2).**

Table 2: Growth performance traits for broilers fed the testing diets.

Treatments[1]	Traits[2]				
	LBW, g/chick		BWG, g	FC, g	FCR (g FC/ g. BWG)
	1-d	40-day	1-40	1-40	1-40
0.0 % RB+ 0.0 g/NE (NC)	42.22	1664.9[d]	1622.7[d]	2525.2[c]	1.56[ab]
0.0% RB+ 1.0g/NE/kg	42.61	1678.3[d]	1635.7[d]	2670.7[c]	1.63[a]
0.0% RB+ 2.0g/NE/kg	43.71	2015.6[c]	1971.9[c]	3201.0[b]	1.63[a]
7.50% RB+ 1.0g/NE/kg	43.56	2230.9[b]	2187.4[b]	3327.2[b]	1.52[bc]
7.50% RB+ 2.0g/NE/kg	42.67	2314.0[b]	2271.4[b]	3385.7[b]	1.49[c]
15.0% RB+ 1.0g/NE/kg	42.44	2380.0[ab]	2337.6[ab]	3457.8[b]	1.48[c]
15.0% RB+ 2.0g/NE/kg	42.38	2563.9[a]	2521.5[a]	3740.5[a]	1.48[c]
SEM[3]	0.20	75.04	75.02	93.88	0.035
P-value	0.273	0.001	0.001	0.001	0.021
Significant[4]	NS	**	**	**	*

[a,b,c, d]**:** indicates there are major differences between each item with different superscripts in the same column ($P \leq 0.05$). [1]RB: rice bran; NC= negative control (no enzyme-supplement), NE= Natugrain enzyme supplement. [2]LBW= live body weight; BWG= body weight gain; FC= feed consumption' FCR= feed conversion ratio. [3]SEM: standard errors mean. [4]NS: non-significant, *: significant at $P \leq 0.05$, **: significant at $P \leq 0.01$

Nutrient digestion

Significant differences were observed among experimental groups in nutrients digestibility coefficients and feeding value for broiler chicks by dietary RB and NE addition (Table 3). Chicks fed the negative control diet supplemented with 1.0 or 2.0 g NE/kg levels had higher crude protein (CP) and crude fiber (CF) digestibility than those fed the negative control and RB groups. However, chicks fed an NC diet with or without NE addition recorded a significant improvement in EE and NFE digestibility when compared with different RB groups **(Table 3).** Moreover, TDN and ME (kcal/kg) showed significantly reduced values compared to the negative control group, regardless of NE addition.

Table 3: Nutrients digestibility (%) and nutritive value for broilers fed testing diets.

Treatments[1]	Traits					
	Nutrients digestibility (%)[2]				Nutritive value[3]	
	CP	CF	EE	NFE	TDN	ME (kcal/kg)
0.0 % RB+ 0.0 g/NE (NC)	79.95 ^{c}	64.80 ^{b}	89.40 ^{a}	89.37 ^{a}	83.02 ^{b}	3470.12 ^{b}
0.0% RB+ 1.0g/NE/kg	81.45 ^{b}	70.12 ^{a}	89.82 ^{a}	90.24 ^{a}	84.46 ^{a}	3530.56 ^{a}
0.0% RB+ 2.0g/NE/kg	83.48 ^{a}	71.20 ^{a}	87.61 ^{b}	90.35 ^{a}	84.41 ^{a}	3528.50 ^{a}
7.50% RB+ 1.0g/NE/kg	79.44 ^{c}	53.51 ^{e}	81.77 ^{d}	85.75 ^{d}	81.49 ^{c}	3406.48 ^{c}
7.50% RB+ 2.0g/NE/kg	80.02 ^{c}	59.90 ^{d}	81.85 ^{d}	86.67 ^{c}	83.31 ^{b}	3482.26 ^{b}
15.0% RB+ 1.0g/NE/kg	75.25 ^{e}	55.15 ^{e}	85.98 ^{c}	86.84 ^{c}	81.54 ^{c}	3408.44 ^{c}
15.0% RB+ 2.0g/NE/kg	76.94 ^{d}	62.24 ^{c}	88.55 ^{b}	87.09 ^{c}	81.90 ^{c}	3423.49 ^{c}
SEM[3]	0.57	1.43	0.71	0.39	0.27	11.30
P-value	0.001	0.001	0.001	0.001	0.001	0.001
Significant[4]	**	**	**	**	**	**

Carcass traits

Significant differences were observed among the experimental groups in the relative weight of the eviscerated carcass and total edible parts; however, total giblets and abdominal fat were unaffected by the experimental diets given to broiler chicks at 40 days of age **(Table 4).** Relative weight (LBW) of eviscerated carcass and total edible parts were significantly improved for chicks fed a diet containing 15.0% RB with 1.0 or 2.0 g NE/kg than those fed the negative control diet, while chicks fed the 7.5% RB diet recorded an insignificant increase in both eviscerated carcass and total edible parts than the negative control with or without NE addition at 40 days of age. Chicks fed a 15.0% RB diet plus 1.0 or 2.0 g NE/kg diet recorded better eviscerated carcass, gizzard and total edible parts weights than those fed the negative control diet with or without NE addition at 40 days of age.

Table 4: Relative weights (%) of some carcass parameters for broilers fed testing diets.

Treatments[1]	Carcass parameters, %			
	Eviscerated Carcass	Total giblets	Total edible parts	Abdominal fat
0.0 % RB+ 0.0 g/NE (NC)	72.08^{c}	3.75	75.83^{b}	0.75
0.0% RB+ 1.0g/NE/kg	73.02^{c}	3.74	76.76^{b}	0.76
0.0% RB+ 2.0g/NE/kg	72.21^{b}	3.69	75.91^{b}	0.75
7.50% RB+ 1.0g/NE/kg	76.63^{ab}	3.92	80.54^{a}	0.91
7.50% RB+ 2.0g/NE/kg	76.22^{ab}	3.98	80.20^{a}	1.28
15.0% RB+ 1.0g/NE/kg	80.08^{ab}	3.94	84.02^{a}	1.04
15.0% RB+ 2.0g/NE/kg	80.58^{a}	3.95	84.53^{a}	1.38
SEM[2]	1.023	0.089	1.062	0.939
P-value	0.071	0.972	0.078	0.375
Significant[3]	*	NS	*	NS

Economic evaluation

Significant differences were observed among the experimental groups in all studied economic evaluation parameters and economic efficiency, which were significantly affected for broiler chicks fed a diet containing different RB and NE levels at 40 days of age **(Table 5).** Chicks fed 7.50 and 15.0% RB diets plus 1.0 and 2.0 g NE/kg had significantly higher total costs and total sales than other groups and the negative control, while chicks that were fed the negative control diet plus 2.0 g NE/kg recorded a significant increase in total sales compared to the negative control once at 40 days of age. On the other hand, EE value was significantly improved for chicks fed a diet containing RB than the negative control with or without NE supplementation at 40 days of age. Finally, all RB levels in the diet recorded the best EE value. This improvement could be due to their higher body weights and better feed conversion ratio, which reflect the compensation of increasing total feeding costs compared to the control group.

Table 5: Economic evaluation parameters for broilers fed testing diets at 40 days of age.

Treatments	Feeding cost, LE			Total cost, LE[4]	Total sales, LE[5]	Net revenue, LE[6]	EE[7]
	Feed cost[1]	NE cost[2]	Total				
0.0 % RB+ 0.0 g/NE (NC)	45.64[c]	0.00[f]	45.64[c]	85.64[d]	116.55[d]	30.90[d]	0.356[bc]
0.0% RB+ 1.0g/NE/kg	48.30[c]	0.16[e]	48.46[c]	88.46[d]	117.48[d]	29.02[d]	0.328[c]
0.0% RB+ 2.0g/NE/kg	57.66[b]	0.30[c]	57.96[b]	97.96[b]	141.09[c]	43.13[c]	0.443[b]
7.50% RB+ 1.0g/NE/kg	59.17[b]	0.20[d]	59.37[b]	99.37[b]	156.17[b]	56.79[b]	0.572[a]
7.50% RB+ 2.0g/NE/kg	60.25[b]	0.41[b]	60.66[b]	100.66[b]	161.98[b]	61.33[ab]	0.609[a]
15.0% RB+ 1.0g/NE/kg	61.11[b]	0.21[d]	61.38[b]	101.38[b]	166.60[ab]	65.22[ab]	0.643[a]
15.0% RB+ 2.0g/NE/kg	66.09[a]	0.45[a]	66.54[a]	106.54[a]	179.47[a]	72.94[a]	0.685[a]
SEM	1.58	0.032	1.59	1.59	5.25	3.76	0.032
P-value	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Significant	**	**	**	**	**	**	**

SEM: standard errors mean, NC= negative control (no enzyme-supplement), NE= Natugrain enzyme supplement, RB: rice bran.
a,b,c,: indicates there are major differences between each item with different superscripts in the same column (P ≤ 0.05), NS: non-significant, *: significant at P≤ 0.05, **: significant at P ≤ 0.01 , 1- Feed cost = feed consumption (starter, grower, finisher) diet price , 2- One kg of NE enzyme = 60.0 L, 3- Rearing cost per chick = chick price (30 LE) + rearing incubation (10 LE), 4-Total cost per chick = total feeding cost +rearing cost, 5- Total sales per chick= LBW(kg) × 70.0 LE , 6- Net revenue per chick = total sales – total cost , 7- EE = net revenue / total cost.

DISCUSSION

In order to achieve sustainable profitability while improving production performance and food quality, this article investigates the possibilities of alternative sustainable poultry feeding techniques, with a particular emphasis on the possible recycling of agro-byproducts. The present study has revealed that chicks fed a 15.0% RB diet with 1.0 and 2.0 g NE/kg diet recorded the best LBW, BWG and FCR than the other treatment groups at 40 days of age (Table 2). Because rice bran is composed of seeds or kernels, pericarp particles, seed coat, aleurone, germ, and fine, starchy endosperm, it may be rich in B vitamins, tocopherols, and nutrient density and profiles of amino acids and fatty acids, which may account for these improvements in RB groups (**Han *et al.*, 2015)**. Additionally, the high concentrations of oryzanols, tocopherols, vitamin E, ferulic acid, phytic acid, lecithin, and inositol in the broiler diet may benefit the birds' performance by increasing the absorption and digestion of lipoproteins and a significant quantity of essential fatty acids (**Jo and Choi, 2010**).

Also, supplementing natugrain TS enzymes to the RB diet could improve final body weight gain (**Choct *et al.*, 2004**) as a result of the presence of xylanase in natugrain TS enzymes, which could attribute to an improvement of feed digestion, the enhancement of nutrient absorption, and the regulation of metabolic hormones in response to the addition of the enzyme, which in turn could have an effect on body health and immunity (**Gao *et al.*, 2007**). These findings also agreed with **Yasin *et al.*, (2012) and Parveen *et al.*, (2013),** who reported that the natural antioxidant in RB diet of chickens, like α-tocopherol, resulted in higher broiler body weight. According to **Aderibigbe *et al.*, (2018)**, broilers' live weight and body weight gain rose when they were fed rice husk (RH) rather than maize and supplemented with 100 ppm of the xylanase enzyme. Additionally, **AL-Doori and Allaw (2021)** discovered that bronze turkeys' live body weight and weight gain increased when they were fed RB (15 and 20%) with or without enzyme supplementation (0.5 g/kg). **Inayah *et al.*, (2022)** concluded that broiler body weight gain was boosted by dietary xylanase enzyme supplementation. Moreover, the presence of rice bran up to 10% in broiler diets improved BWG for broilers at 1 to 5 weeks of age (**Attia *et al.*, 2023).** In contrast, **Deniz *et al.*, (2007)** reported a significant reduction in broiler body weights and body weight gains by using rice bran inclusion in their diets because of attenuated feed intake. **Medgu *et al.*, (2011)** found that broilers fed starter and finisher diets containing 10% and 20% RB had lower performance. Also**, Ani *et al.*, (2013)** reported that average daily weight gain was significantly (P<0.05) depressed at the level of inclusion of 20% rice milling waste with enzyme supplementation.

However, **Al-Tayyar and Almrsomi (2022)** demonstrated that using 5.0 or 7.5% RB in a broiler diet did not have a significant effect on marketing LBW and BWG. The increase in feed conversion (FC) observed in chicks provided with diets containing 7.5% or 15.0% rice bran (RB) in the present study may be attributed to their gradual adaptation to the anti-nutritional factors present in RB over time. Additionally, the enhancement in body weight gain (BWG) and the elevated dietary fiber content in these formulations led to a notable rise in feed intake. It is plausible that chicks receiving diets with higher levels of RB, which are characterized by increased fiber and reduced energy, consumed larger quantities of feed to meet their energy requirements, as birds typically prioritize consumption to fulfill their energy needs **(Alewi *et al.,* 2022)**. These results are comparable to those of **AL-Doori and Allaw (2021)**, who found that supplementing the diet of bronze turkeys with 20% rice bran and 0.5 g/kg enzymes boosted FC. On the other hand, **Deniz *et al.,* (2007)** found that the higher amount of RB in the broiler diets significantly decreased FC. **Aderibigbe *et al.,* (2018)** demonstrated that FC decreased when maize was substituted with rice husk (RH), regardless of levels supplemented with 100 ppm xylanase enzyme.

Al-Tayyar and Almrsomi (2022) found that using 5.0 or 7.5% RB in a broiler diet did not have a significant effect on accumulative feed consumption. In the current study, a significant improvement in FCR for chicks fed on different RB diets compared to those fed the negative control diet with or without NE supplementation improvement in FCR could be related to rice bran NSP that can have a positive impact on broiler gastrointestinal health and performance, which plays a role as a source of substrates for probiotic bacteria species (**Singh and Kim, 2021)**. Or, RB was a rich source of flavonoids, which could increase the height of intestinal villi in the duodenum of broiler chickens without inducing any changes in the composition of gut microflora (**Hong *et al.,* 2012**; **Surai, 2014**), resulting in a significant increase in the surface area of the small intestine available for nutrient absorption and modifying its structure (length and width of villi, crypt depth) in broilers (**Kamboh *et al.,* 2015**).

Additionally, by lengthening the villi and the intestinal surface absorptive area, enzyme supplementation may improve food absorption (**Chen *et al.,* 2019**). Furthermore, xylanase can boost immunity directly or through fermentation metabolites that are created in response to beneficial microbiota's increased colonization of the GIT (**Jha *et al.,* 2019**). These results are consistent with **Cowieson *et al.,* (2010**) who concluded that supplementing maize/soy-based diets with both glucanase and xylanase displayed improvement in feed conversion ratio (FCR) and ileal nutrient digestibility. **Aderibigbe *et al.,* (2018)** revealed that the replacement of maize with rice husk (RH) independent of levels treated with 100 ppm xylanase enzyme induced a reduction in FC and better FCR. Additionally, **Fan *et al.,* (2020)** revealed that the presence of rice bran in broiler finisher diets increased gut health and subsequently FCR. In the current study, the significant (P<0.05) higher increase in CP and CF digestibility in chicks fed the negative control diet supplemented with 1.0 or 2.0 g NE/kg levels than those in the negative control and RB groups may be due to the higher fermentation activity of intestinal bacteria, increased intestinal epithelial absorption capacity, and improvements in enzymatic nutrient digestion. Or, the application of exogenous enzymes in fibrous diets has been found to increase nutrient utilization and subsequently improve the growth performance of broilers (**Singh *et al.,* 2017; Bedford, 2018**). Also, the addition of β-glucanase and xylanase to broiler diets results in higher nutrient digestion because they may have reduced digesta viscosity caused by soluble NSP and enhance the accessibility of gastrointestinal enzymes to the cell contents of the grain **(Moftakharzadeh *et al.,* 2019)**. These findings are similar to **Wu *et al.,* (2017)** who found that digestibility of nutrients for broiler diets significantly improved with enzyme supplementation. **Zhou *et al.,* (2009)** discovered that, in comparison to diets with higher energy levels given to broiler chicks, xylanase, amylase, and protease might enhance the amount of ME available from corn-soy diets with lower energy contents.

In the current study, the increase in weights of eviscerated carcass, gizzard and total edible parts for chicks fed a 15.0% RB diet plus 1.0 or 2.0 g NE/kg diet compared to those fed the negative control diet with or without NE addition may be due to increasing dietary fiber gradually when RB increased in the diet and the percentage of saturated fatty acids being less in rice bran oil compared to mono- and polyunsaturated fatty acids, which resulted in increasing the fat deposition in adipose tissue. Also, higher weights of total edible parts in RB groups with NE enzyme addition may be due to better live body weights in these groups. These results are confirmed by those obtained by **El-Ghamry *et al.,* (2005)** who found that the weight of the gizzard increased when the amount of RB was increased. This could be because the high amount of crude fiber in rice bran caused the gizzard to swell, which in turn raised the weight of the gizzard. Similarly, **Sarica *et al.,* (2005)** and **Barekatain *et al.,* (2013)** found that xylanase addition to broiler diets didn't affect heart and liver relative weights. **El-Sanhoury et al., (2017)** demonstrated that the addition of the enzyme had no effect on internal organs. In contrast, **Anitha *et al.*, (2007)** discovered that rice bran oil had no effect on the weights of the eviscerated carcass and broiler giblets. Additionally, **Awad *et al.*, (2009)** demonstrated that feeding RB diets to Domyati ducklings during their growth period (12 weeks of age) had no discernible effect on the relative weights of dressed carcass, giblets, edible components, and abdominal fat.

The best EEF parameters that were observed in chicks fed a diet containing different RB and NE levels at 40 days of age in the current study are fully in agreement with the findings of **Alewi *et al.*, (2022)** who concluded that rations having treated defatted rice bran in their formulation were more economical (reduced feed cost/kg weight) than those containing maize. Also, **Awad *et al.*, (2009)** found that net return/duckling and EEF values were significantly improved for growing Domyati ducklings fed different RB levels in their diets during the growth stage from hatch to 12 weeks of age. **Donkoh and Zanu (2010)** have noted that adding agro-industrial wastes provides a significant economic benefit by lowering feed costs and raising net profits without compromising egg production performance. Utilizing agro-industrial byproducts lowers the cost per kilogram of diet.

CONCLUSION

From the obtained results, feeding dietary rice bran (up to 15.0%) plus natugrain TS enzymes (1.0 or 2.0 g/kg diet) could be used to improve growth performance, carcass traits and nutrient digestibility coefficients, as well as economic efficiency for broiler chicks during the fattening period.

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Data availability statement

Not applicable. The information that underpins the conclusions of this research can be obtained from the corresponding author upon a reasonable request.

Conflict of Interest

The authors declare that they have no conflict of interest.

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