RESEARCH ARTICLE
AGROBIOLOGICAL RECORDS
ISSN: 2708-7182 (Print); ISSN: 2708-7190 (Online)
Open Access Journal

THE EFFECT OF SUPPLEMENTING DIFFERENT LEVELS OF PHYTASE ENZYME ON PERFORMANCE, SOME CARCASS PROPERTIES AND ECONOMICS OF BROILER CHICKENS

Madyan Mohammed Ayedh Alshamiri [1,2], Syada Awad Mohamed Ali [1*]
Hyder Osman Abdalla [1] and Hatim Badwi Ahmed [1]

[1]Department of Animal Science, Faculty of Agricultural Sciences, University of Gezira, Sudan
[2]Department of Poultry Research, Agricultural Research and Extension Authority, Taiz, Yemen

**Corresponding author*: saydamhmmd@yahoo.com; saydamhmmd@gmail.com

ABSTRACT

Plant origin feeds contain some important nutrients that are not available to poultry due to their inability to analyze them and benefit from them. An experiment was fulfilled to study the performance of broiler chicken using supplemented diets with four levels of phytase enzyme 0.0 FTU/kg feed (T1), 500 FTU/kg feed (T2), 1000 FTU/kg feed (T3) and 1500 FTU/kg feed (T4). A completely randomized design (CRD) using four treatments, with three replicates each with 12 Ross 308 male chicks, was performed. Results indicated significant ($P\leq0.05$) differences in feed intake (FI), body weight (BW) and feed conversion ratio (FCR). The highest feed consumption was recorded with (T1), where (T4) recorded the highest body weight and best FCR followed by (T3, T2 and T1) respectively. There were significant ($P\leq0.05$) differences in carcasses, gastrointestinal tract (GIT) and the associated parts weights, and some GIT organs lengths. However, other parts including heads, necks, shanks and abdominal fat weights were non-significantly ($P>0.05$) different. There were no significant ($P>0.05$) differences in individual sensory evaluation attributes (taste, flavor, color and tenderness), but there were significant differences in overall sensory evaluation. There were no significant differences in the mortality rates among treatments. However, there were significant ($P\leq0.05$) differences in the economics appraisal were (T4) recorded the least cost and the highest revenue. It reveals that using the (1500FTU/kg) level of phytase enzyme had performance parameters and economic appraisal. It could be concluded that supplementing broiler chicken diets with (1500FTU/kg) is good for production performance and returns.

Keywords: Broilers; Phytase; Performance; Carcass characteristics; Sensory attributes; Economics appraisal

Article History (2020-1038) || Received: 25 Oct 2020 || Revised: 21 Nov 2020 || Accepted: 25 Nov 2020 || Published Online: 05 Dec 2020

1. INTRODUCTION

Feed cost in any system of poultry production compromises the highest expense that accounts for up to 70% of total production costs. Reducing feed cost is the principal reason for using feed enzymes (Barletta 2011) and supplementing the feed with phytase releases phytate-bound minerals, proteins and starch. Adding that phytases reduces the risk of pollution of watercourses from excessive phosphorus excreted by both pigs and poultry. Rezaei et al. (2007) concluded that phytase supplementation improved the body weight gain of broilers. Poultry diets are mainly composed of seed-based components and contain the great amount of phosphorus in the phytic acid form. Phosphorus is an important mineral in the growing and development of poultry. It is, therefore, necessary to supplement poultry with the adequate amount of phosphorus. However, this phytic acid often forms the complex with other cations such as calcium and proteins which hinder the efficiency of absorption. Defiance or deficiency in phosphorus, therefore, hinder poultry growth which can further lead to birds losing appetites, becoming weak and die (Haque et al. 2012). Therefore, phytase enzyme supplement is added to commercial poultry diets to overcome this issue because the highest portion of poultry diets consists of plant derived ingredients and high levels of phytic acid are found. Phosphorus (P) in phytic acid is of very importance because it has high amount of P accounts to (28.2%), and poultry usage to phytate P is poor (Ravindran et al. 2006). Phytase is an enzyme that initiates phosphate removal of from phytate and it has been widely used in animal feeding specifically in the poultry industry to increase phosphorus intake and minimize pollution of environment (Daniel et al. 2018). Phytase is an enzyme that can hydrolyze phytate into inorganic P (Selle et al. 2007), and because there is insufficient quantity or lack of intestinal secretion to phytase, large amounts of P are excreted in manure and feces causing environmental problems, especially in areas of intensive poultry enterprises.

ISSN: 2708-7182 (Print); ISSN: 2708-7190 (Online)
Open Access Journal

Supplementation of phytase to poultry diets improved poultry immune systems and increased weight (Daniel et al. 2018). Adding phytase to young turkey had beneficial effects on their growth performance and tibia mineralization but had no effects on the carcass traits (Ciurescu et al. 2020). Phytase added to growing ducks significantly improved body weight gain and feed conversion ratio (Attia et al. 2019). Super dosing of phytase (1500FTU/kg of feed) increased the best utilization of nutrients resulted in improving performance and improved profitability compared to non-supplemented group (Raut et al. 2018). Fatufe et al. (2019) found that adding phytase or protease separately or combined to broiler chickens fed suboptimal crude protein diets, resulted in improving nutrient digestibility, chicken performance and carcass cut parts.

The present experiment was carried out to study the effects of supplementing broiler chickens diets with different levels of phytase enzyme on performance, gastrointestinal tract (GIT), some carcass characteristics and economic appraisal.

2. MATERIALS AND METHODS

This experiment was conducted in a commercial farm (Albashair farm), south Wed Mdani Town, Gezira State, Sudan) where broiler chicks (Ross 308) one day of age were brought from a local hatchery. They were reared together for one week during which they were offered a pre-starter broiler diet. Broiler male chicks (n=144) were randomly grouped into four experimental diets (four treatments with three replicates), in a completely randomized design, of 12 chicks in each replicate. The chicks were distributed randomly into 12 experimental pens allotted inside a deep litter floor poultry house with an available area of 1.5m^2 of each experimental pen. The environment was controlled and the chicks were reared under standard management conditions. The diets of the experiment were then formulated with reference to that recommended by the National Research Council (NRC 1994) for nutrient requirements for broiler chicks. These diets (Table 1) were prepared for both phases of production (starter and finisher). The birds were then offered a balanced broiler starter diet during the period of 2nd - 3rd week of age, a finisher diet was offered from 4th – 6th week of age; both diets were offered on *ad libitum* basis.

Four levels of the enzyme phytase were added to each dietary treatment T1 (control, 0.0FTU/kg feed), T2 (500FTU/kg feed), T3 (1000FTU/kg feed) and T4 (1500FTU/kg feed), respectively. One phytase unit (FTU) was defined as the amount of enzyme that releases 1µmol of inorganic orthophosphate from a sodium phytate substrate per minute at pH 5.5 and 37°C (AOAC 2000). Daily feed was offered and at the end of the week feed withdrawals were weighed to be deducted from the amount of feed offered on that week for each replicate. Live BW (g) was taken weekly and eventually average body weight gain was calculated. Furthermore, FCR was calculated weekly and as an overall at the end of the experiment, The Mortality of birds was recorded and the mortality rate was calculated weekly basis and as an overall at the end of the experiment.

Feed troughs were removed at night eight hours before slaughter but they had access to water. After six weeks (experimental termination), three birds randomly selected from each replicate were weighted and slaughtered humanely in Islamic tradition (Ali et al. 2011). After slaughtering, the birds were immersed in hot water 60°C for two minutes to help in feathers scalding. Evisceration and removal of internal organs was done and they were kept for further studies. The carcasses were cleaned thoroughly weighted and then immersed in ice water for cooling. The carcasses were then left to drip cold water; then kept to cool in a deep freezer for one day. Some were cut to different parts (breasts, legs, thighs and drumsticks) for further investigations for further evaluation of carcass characteristics and sensory evaluation of meat. Heads, neck and shanks weights were also taken after slaughter. The gastrointestinal tract (GIT) organs (crop, proventriculus, gizzard, intestines and caeca) weights and lengths as well as the associated organs (heart, liver and spleen) weights were taken. Some chemical and physical attributes of meat was carried out. Sensory (taste, flavor, color and tenderness) evaluation of meat was done using the sensory description technique with trained panelist. The total production costs and returns were calculated in Sudanese pounds to get the total revenue through subtracting the total costs from the total returns.

2.1. Statistical analysis

The experimental data was statistically analyzed using the completely randomized design (CRD), using the general linear model (ANOVA) . Differences between the experimental averages were calculated using multiple range tests as described by Duncan (1955) at $P<0.05$. The program (SAS 2003) was used for statistical analysis.
Data analyses of variance were subjected to with the following Equation:

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

Where:

Y_{ij} = observation.

μ = population average.

T_i = diet effect (i = 1 to 4).

ε_{ij} = residual error.

ISSN: 2708-7182 (Print); ISSN: 2708-7190 (Online)
Open Access Journal

Table 1: Feed nutrients ingredients and chemical composition of broiler starter and finisher diets

Ingredients	Starter Diets (8-21 days)				Finisher Diets (22-42 days)			
	T1	T2	T3	T4	T1	T2	T3	T4
Feed ingredients of starter and finisher diets								
Sorghum	56.5	57.5	57.5	57.5	58.6	59.4	59.4	59.4
Ground nut cake	36	37	37	37	31	32	32	32
Broiler concentrate*	5	3	3	3	5	3	3	3
Vegetable Oil	0	0	0	0	2.5	2.5	2.5	2.5
L-Lysine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Oyster shell	0.9	0.9	0.9	0.9	1.3	1.5	1.5	1.5
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Colin chloride	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Antioxidant and antifungal	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Di-Calcium phosphate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Phytase FU/Kg	0	500	1000	1500	0	500	1000	1500
Total	100	100	100	100	100	100	100	100
Chemical composition of starter and finisher diets								
CP%	22.3	22.1	22.1	22.1	20.4	20.2	20.2	20.2
E E%	4.9	4.97	4.97	4.97	5.8	5.83	5.83	5.83
C F%	5.8	5.8	5.8	5.8	5.3	5.3	5.3	5.3
Ca%	1.1	0.9	0.9	0.9	1.2	1.1	1.1	1.1
Total P%	0.5	0.41	0.41	0.41	0.5	0.39	0.39	0.39
Lysine%	1	0.9	0.9	0.9	0.93	0.85	0.85	0.85
Methi+Cysti%	0.85	0.76	0.76	0.76	0.8	0.72	0.72	0.72
Methionine %	0.55	0.47	0.47	0.47	0.57	0.45	0.45	0.45
ME kcal/kg **	3097	3121	3121	3121	3218	3235	3235	3235
Phytase U/kg	0	500	1000	1500	0	500	1000	1500

*Super concentrate contains the following: 35% CP, 2% EE, 4% CF, 10% calcium, 4.5% available phosphorus, 5.7% lysine, 4.5% methionine and 4.9% methionine + cystine. Metabolizable energy 2000 kcal/kg, 2.6% Sodium, with added vitamins and minerals: ** Metabolizable energy (ME K cal/kg) was calculated according to the formula derived by Lodhi *et al.* (1976). ME kcal/kg = 32·95 (% crude protein + % ether extract × 2·25 + % available carbohydrate) –29·20: T1=Control (basal diets *ad libitum*); T2=Basal diet supplemented with 500/FU on *ad libitum* basis; T3=Basal diets supplemented with 1000/FU *ad libitum* basis and T4=Basal diets supplemented with 1500/FU *ad libitum* basis.

3. RESULTS

3.1. Broiler performance

Results of supplementing broiler chicken diets with different levels of phytase enzyme on performance are shown in Table 2, significant differences (P≤0.05) were found in feed intake (FI) during the entire experimental period. The control group recorded the highest feed intake and T4 had the lowest feed intake (Table 2). However, the live BW, BWG, were significantly the highest in T4, T3 and T2, respectively where T1 (control) recorded the lowest weights. Weekly were for T4, T3 and T2, significantly (P≤0.05) recorded the best weekly and overall FCR where T1 (control) recorded the worse FCR (Table 2).

3.2. Gastrointestinal Tracts (GIT)

As shown in Table 3 there were non-significant (P≥0.05) difference in weights of crops, gizzards, hearts, small and large intestines and abdominal fat pads (AFP). However, there were significant differences in weights of esophagus, proventriculus, livers and caeca. Non-significant difference between lengths of crops, duodenum, intestines and caeca (Table 3). However, there were significant (P≤0.05) differences in proventriculus lengths.

3.3. Some Carcasses Characteristics and Mortality Rate

Significant differences (P≤0.05) were found in live body weights, hot and cold carcasses, breast, whole leg, thigh, drumstick and wing weights, were the T4 had the best weights (Table 4). However, non-significant (P≥0.05) differences were found in heads necks and shanks weights. Significant differences in the dressing percentages were found (Table 4) as T4 recorded the best results. There were non-significant differences in mortality rate between different treatments (Table 4).

Table (5) shows significant (P≤0.05) differences in the chemical properties of broiler breast meat (DM, EE, ash, Ca and P). There were significant differences in the chemical properties (dry matter, ash, calcium and phosphorus) of tibia bones (Table 6).

Table 2: The Effect of different levels of phytase enzyme on performance of broiler chicken, weekly feed intake, weekly body weight (g), weekly body weight gain (g) and feed conversion ratio

Age (Weeks)	Treatments				C.V %	P value
	T1	T2	T3	T4		
Feed Intake (g)						
Week 1	107±0.025	107±0.03	107±0.02	107±0.01	0	1.0
Week 2	274±1.7a	271±1.4a	259±1b	258±1.1b	0.9	0.01
Week 3	456±1.1a	443±1.7b	442±1.1b	437±1.3c	0.5	0.01
Week 4	715±1.7a	708±1.7b	706±0.5b	697±1.4c	0.3	0.04
Week 5	974±1.2a	972±1.5ab	967±1.5b	957±1.4c	0.3	0.09
Week 6	1106±1.7a	1097±1.7b	1086±1.2c	1081±1.4c	0.2	0.01
Overall	3623±6a	3598±8.2b	3567±4.5c	3538±5c	0.3	0.01
Body Weight (g)						
0	40.0±0.3	40.0±0.3	40±0.3	40.0±0.3	0.0	1.0
Week 1	125±0.3b	126±0.6ab	126± 0.4ab	126.3±0.3a	0.22	0.013
Week 2	333.7±0.3b	334.3±0.3ab	334.6±0.3ab	335.3±0.3a	0.16	0.07
Week 3	645±2.8c	656±2.9b	675±2.8a	677±3.7a	0.8	0.05
Week 4	1081±2.3d	1128±1.4c	1141±2.7b	1157±2.4a	0.34	0.01
Week 5	1595±2.8d	1670±2.8c	1688±3b	1708 ± 2.7a	0.3	0.01
Week6	2115±3.1d	2210±2.8c	2235±2.8b	2260±2.8a	0.23	0.01
Body Weight Gain (g)						
Week 1	85.3±0.3b	86.3±0.3ab	86±0.2ab	86.7±0.3a	0.45	0.03
Week 2	208.3±0.3	208.3±0.3	208.6±0.3	209±0.5	0.2	0.45
Week 3	311.3±2.6c	321.3±2.7b	340.3±2.6a	341.7±3.5a	1.5	0.04
Week 4	435.6±0.7d	472±1.5b	466.3±0.8c	479.7±1.4a	0.4	0.01
Week 5	514.3±0.7d	542.7±1.4c	546.7±0.3b	551.7±0.3a	0.2	0.01
Week 6	519.7±0.3d	540±0.5c	547±1.2b	551.7±0.8a	0.15	0.01
Overall	2154.7±3.2d	2249.7±2.9c	2275.0±3.2b	2299.7±3.1a	0.23	0.01
Feed Conversion Ratio						
Week 1	1.25±0.004a	1.23±0.4ab	1.24±0.02ab	1.2±0.004b	0.3	0.013
Week 2	1.3±0.008a	1.3±0.005a	1.2±0.002b	1.2±0.005b	0.8	0.01
Week 3	1.5±0.008a	1.4±0.006b	1.3±0.006c	1.27±0.009c	1	0.01
Week 4	1.6±0.006a	1.5±0.008b	1.51±0.003b	1.4±0.007c	0.8	0.01
Week 5	1.9±0.002a	1.8±0.002b	1.77±0.002c	1.7±0.001d	0.2	0.01
Week 6	2.1±0.002a	2.0±0.003b	1.98±0.004c	1.9±0.002d	0.3	0.01
Overall	1.7±0.001a	1.6±0.001b	1.59±0.003c	1.57±0.001d	0.9	0.01

Values (mean±SE) showing different alphabets in a row differ significantly (P≤0.05). CV=Coefficient of Variation; T1=Control (basal diets *ad libitum*); T2=Basal diet supplemented with 500/FU on *ad libitum* basis; T3=Basal diets supplemented with 1000/FU *ad libitum* basis and T4=Basal diets supplemented with 1500/FU *ad libitum* basis.

Table 3: The Effect of different levels of phytase enzyme the gastrointestinal (GIT) weights (g) and lengths (cm)

Parameters	Treatments				C.V %	P value
	T1	T2	T3	T4		
Weight (g)						
Esophagus	8.1±0.03b	8.2±0.03b	8.3±0.03ab	8.4±0.03a	0.68	0.016
Proventriculus	7.3±0.06b	7.7±0.1a	7.8±0.1a	7.9±0.1a	1.7	0.011
Gizzard	35±0.9	36±1.1	36±0.9	37±1.4	5.1	0.64
Intestines (Small, Large)	97±2.1	99±2.3	101±1.5	102±0.7	2.8	0.37
Liver	42±0.3b	47±1.7ab	49±0.9a	49±1.2a	4.8	0.042
Heart	10.1±0.3	10.4±0.3	10.1±0.1	10.5±0.1	3	0.53
Crop	7.2±0.3	7±0.3	7.3±0.02	8.1±0.3	6.2	0.14
Caeca	6.1±0.3b	6.7±0.3b	7.1±0.2ab	8.1±0.3a	6.3	0.021
AFP	28.1±0.6	26.2±1.3	25±1.1	26±1.2	8.6	0.62
Lengths (cm)						
Esophagus	19.2±0.03c	19.4±0.03bc	19.7±0.03ab	19.9±0.03a	0.3	0.006
Crop	4.5±0.3	4.1±0.1	4.2±0.02	4.3±0.10	3.3	0.45
Proventriculus	3.7±0.2b	4.0±0.1ab	4.2±0.1a	4.2±0.03a	4.3	0.047
Duodenum	30±0.01	30±0.03	30±0.6	30±0.3	1.3	0.89
Caeca	20±0.3	21±0.7	21±0.3	21±0.9	4.6	0.52
Intestines (Small, Large)	217±1.9	219±0.9	217±1.7	221±1.2	1.2	0.19

Footnote remains the same as that of Table 2.

Table 4: The Effect of different levels of phytase enzyme on some body parts and carcass characteristics and mortality %

Parameters	Treatments				C.V %	P value
	T1	T2	T3	T4		
Live body (g)	2116 ± 1.9d	2214 ± 2c	2239 ± 0.7b	2260 ± 1.4a	0.14	0.001
Carcass Hot (g)	1575 ± 1.8c	1672 ± 2b	1686 ± 2ab	1706 ± 1.2a	0.17	0.001
Carcass Cold (g)	1522 ± 2.3c	1615 ± 2b	1631 ± 0.9ab	1648 ± 1.4a	0.2	0.001
Head (g)	49 ± 0.6	49 ± 1.2	50 ± 0.6	50 ± 0.3	2.3	0.350
Neck (g)	88 ± 0.7	88 ±1.9	89 ± 0.6	93 ± 0.9	1.9	0.130
Shank (g)	86 ± 0.9	86 ± 0.9	89 ± 0.9	90 ± 0.7	1.7	0.061
Breast meat (g)	374.0 ±0.6d	404.3 ±2.3c	422.7 ±1.5b	443.3 ±1.7a	0.65	0.001
Whole leg (g)	218.7 ±0.9c	230.0 ±2.9b	236.7 ±3.3ab	240.7 ±1.5a	1.75	0.034
Thigh (g)	115,0 ± 0.6c	121,3 ± 1.5b	127,0 ± 2a	130,7 ± 1.2a	1.8	0.009
Drumstick (g)	103,7 ± 0.3b	108,7 ± 1.5a	109,6 ± 1.3a	110,0 ± 1.2a	1.7	0.029
Wing (g)	80,7 ± 1.3b	82.0 ± 2.1ab	82.7 ± 1.4ab	85.3 ± 0.3b	3.3	0.044
Dressing %	74.4 ± 0.04b	75.3 ± 0.1a	75.48 ± 0.07a	75.5 ± 0.1a	0.18	0.048
Mortality %	0.9 ± 0.9	0 ± 0	0 ± 0	0.9 ± 0.9	86.6	0.450

Footnote remains the same as that of Table 2.

Table 5: The Effect of different levels of phytase enzyme on some meat chemical properties

Parameters	Treatments				C.V %	P value
	T1	T2	T3	T4		
DM %	30.1±0.2b	31.0±0.4b	34.7±0.7a	35.4±0.5a	3.2	0.016
Ash %	1.2±0.08c	1.4±0.03bc	1.6±0.07ab	1.8±0.06a	6.6	0.0072
Ca%	0.8±0.05b	0.9±0.05b	1.0± 0.05ab	1.2±0.05a	9	0.015
P%	0.37±0.05c	0.47±0.03bc	0.57±0.03b	0.73±0.03a	8.4	0.012

Footnote remains the same as that of Table 2.

Table 6: The Effect of different levels of phytase enzyme on tibia bone chemical properties

Parameters	Treatments				C.V %	P value
	T1	T2	T3	T4		
DM %	88.1±0.06d	89.1± 0.06c	90.2±0.06b	91.3±0.06a	0.2	0.001
Ash %	48.0±0.09d	50.1±0.1c	51.8±0.09b	52.7±0.3a	9.3	0.001
Ca%	16.6±0.09d	17.3±0.06c	18.1±0.06b	19.3±0.06a	6.5	0.001
P%	8.2±0.06c	8.6±0.06b	8.8±0.09b	9.3±0.06a	7.5	0.001

Footnote remains the same as that of Table 2.

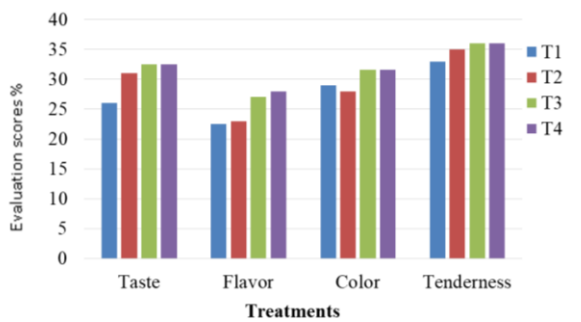

Fig. 1: The effect of different levels of phytase enzyme on the sensory evaluation.

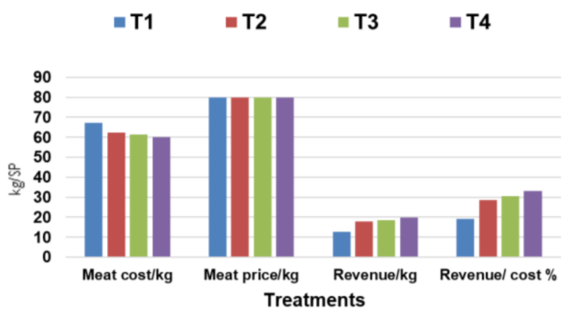

Fig. 2: The effect of different levels of phytase enzyme on the economical appraisal meat/kg (SP: Sudanese Pound)

3.4. Sensory Evaluation

There were non-significant (P≥0.05) differences between the various sensory attributes (taste, flavor, color and tenderness). However, there were significant (P≤0.05) differences for the overall sensory attributes (Fig. 1) were T4 and T3 had the best results.

3.5. Economic Appraisal

Fig. 2 shows the economical appraisal of the experiment on basis of input costs returns and revenue. There were significant (P<0.05) differences between the four treatments and the highest level of phytase (1500FTU/kg feed) had the best revenues.

4. DISCUSSION

4.1. Broiler Performance

This study showed that the different levels of phytase had significantly better performance in feed intake, live BW and FCR (Table 2). These findings agree with some authors (Kliment et al. 2012; Alarasi and Pandey 2017; Sato et al. 2017; Hao et al. 2017; Abdulwahid et al. 2018; Walters et al. 2019; Dersjant-Li et al., 2020) who found similar results. These findings confirm that phytase supplementation has an appreciable effect on broiler performance, and that the level 1500FTU/kg is the best compared to 500FTU/kg (Ali et al. 2017).

The study concluded that super dosing of phytase increased the better utilization of nutrients thereby improved performance than non-supplemented group. Metwally et al. (2020) concluded that birds fed to 1500FTU/kg feed had significantly ($P \leq 0.05$) the highest BW, BWG and FC compared to the control group at second and fifth weeks of age. Several studies had approved an improvement in performance of broilers with phytase supplementation, (Abd El-Hakim and Abd El-Samme 2004) who found that phytase supplementation at 750 U/kg to broiler diets from (7-42) day of age during summer season improved BWG. These findings were in contrast with that of Abudabos (2010) and Abudabos (2012) who reported that at 10 day of age, there were no significant differences in FCR due to enzyme supplementation. This might be due to the fact that the duration was short and the amount of the enzyme was low. These findings didn't agree with that of Motawe et al. (2012) who showed that phytase supplementation didn't affect FI at starter/grower periods. However, Sreeja et al. (2018) investigated the effect of phytase on the broiler growth performance and bone traits when fed a diet with low dietary C and P and 500 FTU/kg of phytase. They didn't find significant ($P<0.05$) differences in broiler performance (BW, BWG, FI, and FCR), during the entire phase, this might be due to low levels the immobilized enzyme and the enzyme purification.

However, the study findings agreed with that of De Souza et al. (2015) who found that supplemented diets with phytase, had best performance. Broilers fed with phytase supplemented diets showed improvement in feed intake, BWG and FCR. They added that phytase enzyme is of benefit to broilers body weight gain. Phytase hydrolyses the phytate and reduction of its anti-nutritional factors that result in improved birds' performance (Shirley and Edward 2003). They added that diets supplemented with phytase increased BWG, making feed to be utilized efficiently.

4.2. Gastrointestinal tract

The results shown in Table 3 are in accord with that of Khursheed et al. (2017), who found that the carcass characteristics of birds fed on mint leaves and super doses of phytase enzyme supplement. There was non-significant difference in the yield characteristics of gizzard, heart, shank, head and liver weights among different treatment groups and the control group. However, this study findings agree with that of Oko et al. (2018) observed slightly improved carcass yield of broiler chickens when supplemented with phytase enzyme. The results of this study coincide with Abdulwahid et al. (2018) and Sabha (2008) who indicated no significant differences in the carcass different parts between the different treatments when adding phytase enzyme to the broiler chicken diets. Hao et al. (2017) when using two levels of (300-500 FTU/kg) of phytase found no significant effect of the relative weight of liver, abdominal fat, and gizzard. These results agree with that of Ahmed et al. (2004) reported that carcass, breast meat, tights and liver weight of chicks were increased in chicks fed with diets supplemented with phytase.

4.3. Some Carcass Characteristics

The findings shown in Table 4 were in line with the findings of Scheideler and Ferket (2000), they concluded that supplementation of phytase to female broiler diets improved BWG. Supplementing heavy male broiler diets with Phytase improved BWG weight gain and low mortality. These results were on accord to that of Akhtaruzzaman (2019), who concluded that phytase enzyme increased body weight by (1.47 ± 0.05) than the control birds. As found in these findings the dressing percentages were the highest in T4 (Table 4) compared with the other groups, these results coincide with that of Akhtaruzzaman (2019), who that the phytase supplemented group had the best dressing percentage. These results were in line with Attia et al. (2014), they found that feed supplemented with phytase improved meat quality and the highest percentages of dressing and total edible parts of broilers. As shown in Table 5 there were significant differences ($P \leq 0.05$) in the chemical properties of broiler meat (DM, EE, ash, Ca and P). Table 6 shows the effect of different levels of phytase enzyme on tibia bone chemical properties. There were significant differences ($P \leq 0.05$) in the chemical properties (dry matter, ash, calcium and phosphorus). These results were in agreement with Walk (2014), who concluded that phytase supplementation improved tibia ash. These findings coincided with the findings of Dersjant-Li et al. (2020), they found that phytase supplementation improved tibia ash sampled at both day 21 and day 42. However, these results were in contrast with that of Metwally et al. (2020) who found non-significant differences in breast, giblets, carcass and dressed percentages relative to BW were affected by optizyme, phytase enzyme levels and their interactions. This might be attributed to the fact that they used two different compounds (optizyme and phytase enzyme).

4.4. Sensory Evaluation

In this study, no significant differences were found in the sensory evaluation of the breast muscle, except for the overall acceptability, these results agree with the findings reported with previous authors (Elshib and Mukhtar 2016). They found that sensory characteristics of the breast muscle did not show a significant difference (P<0.05) between dietary treatments, but showed a significant difference when evaluated as overall. According to (Khursheed et al. 2017) and in his study of the organoleptic evaluation of meat from different levels of phytase; his result was very similar to the results of this study, as there was non-significant difference between the different sensory characteristics such as flavor, juiciness, texture, mouthwash and the general acceptability.

4.5. Economics Appraisal

As presented in Fig. 2 an improvement in the economic appraisal when broiler diets were supplemented with phytase enzyme significantly enhanced the net income per kilogram of meat produced. It was observed that as the levels of phytase enzyme increased, the net profit increased due to decreased cost of production. The highest dosing of phytase (T4) made the highest profit using 1500FTU/kg of feed. The present findings are in agreement with that of Ponnuvel et al. (2013). However, these results confirm that of Sharma et al. (2018) who investigated that enzyme supplementation significantly reduced feed cost per kilogram weight gain and consequently improved cost saving. The observed reduction in feed cost/kg weight gain resulting from enzyme supplementation that enhanced cost saving on the production of the birds might probably be due to reduction in concentrates. Adding to that decreased feed intake, improved feed efficiency and utilization that resulted in better weight gains and final body weights of the broiler chicken. These findings as well agree with that of Rezaei et al. (2007) who concluded that with adding phytase and calculating the cost with adding phytase and using phytase equivalency values in feed formulation, improved production efficiency. They added phytase enhanced growth performance Ca and P retention and reduced production cost.

Conclusion: It can be concluded that using phytase levels up to (1500FTU/kg diet) improved performance in terms of FI, BW and FCR. Enhanced meat quality and quantity and strong bones were obvious in having high dressing percentage and high tibia bones weights and ash percentage. Good economic appraisal in supplementing broiler diets with phytase was achieved.

Author's Contribution: SAMA tailored the idea and planned the research and supervised the research. MMAA was responsible for management of birds, data collection, chemical and physical analysis and drafted the manuscript. HOA and HBA participated in birds management and data collection. MMAA and SAMA performed statistical analysis and interpreted the data and edited the manuscript and all authors approved final version of the manuscript.

ORCID

Madyan Mohammed Ayedh Alshamiri https://orcid.org/0000-0001-8023-391X
Syada Awad Mohamed Ali https://orcid.org/0000-0001-7165-0033
Hyder Osman Abdalla http://orcid.org/0000-0002-6536-2876
Hatim Badwi Ahmed https://orcid.org/0000-0003-1441-9307

REFERENCES

Abd El-Hakim AS and Abd El-Samee MO, 2004. Effect of feeding systems and phytase supplementation on the performance of broiler chicks during summer season. Egyptian Poultry Science 24: 297-310.
Abdulwahid AS, Hasan MO and Abdulwahid ES, 2018. Effect of adding phytase enzyme farmazyme® phytase to ration on some productive and physiological performance of broilers. Annals of Agricultural Sciences Moshtohor 56: 137-142.
Abudabos AM, 2010. Enzyme supplementation of corn-soybean meal diets improves performance in broiler chicken. International Journal of Poultry Science 9: 292-297. https://doi.org/10.3923/ijps.2010.292.297
Abudabos AM, 2012. Effect of enzyme supplementation to normal and low density broiler dets based on corn- soybean meal. Asian Journal of Animal Veterinary Advancement 7: 139-148. https://doi.org/10.3923/ajava.2012. 139.148
Ahmed F, Rahman MS, Ahmed SU and Miah MY, 2004. Performance of broiler on phytase supplemented soybean meal based diet. International Journal of Poultry Science 3: 266-271. https://doi.org/10.3923/ijps.2004.266.271
Akhtaruzzaman MD, 2019. Use of commercial phytase on growth performance of broiler, a thesis submitted to the Department of Animal Nutrition, Genetics and Breeding, Sher-e-Bangla Agricultural University, Dhaka-1207.
Alarasi EMH and Pandey RK, 2017. Efficacy of phytase microbial feed additive on growth performance of broilers chicks. International Journal of Current Microbiology and Applied Sciences 6: 2542-2546. https://doi.org/10.20546/ijcmas.2017.611.299

Ali SAM, Abdalla HO and Mahgoub IM, 2011. Effect of slaughtering method on the keeping quality of broiler chickens' meat. Egyptian Poultry Science 31: 727–736.

Ali SA, Elangovan AV, Shet D, Awachat VB, Ghosh J, Pal DT and Gowda NKS, 2017. Response of super dosing of phytase on growth performance and bone characteristics in broilers fed with low phosphorus and calcium diets. Indian Journal of Animal Nutrition 342: 187-192. https://doi.org/10.5958/2231-6744.2017.00032.9

AOAC, Method 2000.12: Phytase activity in feed: colorimetric enzy-matic method, in Official Methods of Analysis of AOAC International, 17th Ed. Association of Official Analytical Chemists, Arlington, VA (2000). ISBN-10 093558467-6

Attia YA, El-Tahawy WS, Abd Al-Hamid AE, Nizza A, Mohamed A, Al-Harthi AI, El-Kelaway M and Bovera F, 2014. Effect of feed form, pellet diameter and enzymes supplementation on carcass characteristics, meat quality, blood plasma constituents and stress indicators of broilers. Archiv Tierzucht 57 (30): 1-14. https://doi.org/10.7482/0003-9438-57-030

Attia YA, Addeo NF, Abd Al-Hamid AH and Bovera F, 2019. Effects of phytase supplementation to diets with or without zinc addition on growth performance and zinc utilization of White Pekin ducks. Animals 9: 280. https://doi.org/10.3390/ani9050280

Barletta A, 2011. Introduction: Current Market and Expected Developments. In: Enzymes. In: Farm Animal Nutrition, Bedford MR and Partridge GG (eds). 2nd Ed, Chapter 1, CAB International, Wallingford, UK.

Ciurescu G, A. Vasilachi A and Grosu H, 2020. Efficacy of microbial phytase on growth performance, carcass traits, bone mineralization, and blood biochemistry parameters in broiler turkeys fed raw chickpea (*Cicer arietinum L., cv. Burnas*) diets Journal of Applied Poultry Research 29: 171–184. https://doi.org/10.1016/j.japr.2019.10.004

Daniel JD, Nor HAM, Nur IWA, Jennifer E, Sarah AY, Roslinda AM, Vickpasubathysiwa S, Dalia S and Hesham EE, 2018. Current and future applications of phytases in poultry industry: A critical review. Journal of Advances in VetBio Science and Technique 3: 65-74. https://doi.org/10.31797/vetbio.455687

De Souza JPL, Albino LFT, Vaz RGMV and Rodrigues KF, 2015. The effect of dietary phytase on broiler performance and digestive and bone and FV blood biochemistry characteristics. Brazilian Journal of Poultry Science 17: 69-76. https://doi.org/10.1590/1516-635×170169-76

Dersjant-Li Y, Archer G, Stiewert AM, Brown AA, Sobotik EB, Jasek A, Marchal L, Bello A, Sorg RA, Christensen T, Kim HS, Mejldal R, Nikolaev I, Pricelius S, Haaning S, Sørensen JF, de Kreij A and Sewalt V, 2020. Functionality of a next generation biosynthetic bacterial 6-phytase in enhancing phosphorus availability to broilers fed a corn-soybean meal-based diet. Animal Feed Science and Technology 264: Article # 114481. https://doi.org/10.1016/j.anifeedsci.2020.114481

Duncan D 1955. Multiple Range and Multiple F Tests. Biometrics 11: 1-42.

Elshib RMH and Mukhtar MA, 2016. Effect of different levels of Roselle seed supplemented with commercial phytase enzyme on the performance of broiler chickens. World Journal of Pharmacy and Pharmaceutical Sciences 5: 2109-2118. https://doi.org/10.20959/wjpps20166-6976

Fatufe AA, Adesehinwa AOK, Ogunyemi DJ and Akinde DO, 2019. Effect of phytase and protease supplementations on growth performance and carcass characteristics of broiler chickens fed suboptimal levels of crude protein. Nigerian Journal of Animal Science 21: 59-68.

Hao XZ, Yoo JS and Kim I H, 2017. Effect of phytase supplementation on growth performance, nutrient digestibility and meat quality in broilers. Korean Journal of Agricultural Science 11: 449-455. https://doi.org/10.7744/kjoas.20170041

Haque N, Hossain A, Kumar M, Kumar V and Tyagi AK, 2012. Phytase: their biochemistry, physiology and application in poultry. International Journal of Livestock Research 2: 30-41. https://doi.org/10.5455/ijlr.20120407060451

Khursheed A, Banday MT, Khan AA, Adil S, Ganai AM, Sheikh IU and Sofi AH, 2017. Effect of mint leaves with or without enzyme supplementation on blood biochemistry, carcass characteristics and sensory attributes of broiler chicken. Advanced Animal Veterinary Science 5: 449-455. https://doi.org/10.17582/journal.aavs/2017/5.11.449.455

Kliment M, Angelovičová M and Nagy S, 2012. The effect of microbial phytase on broiler chicken production and nutritional quality of meat. Animal Science and Biotechnologies 45: 46-50.

Lodhi G, Singh D and Ichhponani J, 1976. Variation in nutrient content of feeding stuffs rich in protein and reassessment of the chemical method for metabolizable energy estimation for poultry. The Journal of Agricultural Science 86: 293-303. https://doi.org/10.1017/S0021859600054757

Metwally MA, Farghly MFA, Ismail ZSH, Ghonime ME and Mohamed IA, 2020. The effect of different levels of optizyme and phytase enzymes and their interactions on the performance of broiler chickens fed corn and soybean meal: 1-broiler performance, carcass traits, blood constituents and nitrogen retention efficiency. Egyptian Journal of Nutrition and Feeds 23: 123-136. https://doi.org/10.21608/ejnf.2020.95831

Motawe FA, EL-Afifi TM, Hassan HMA, and Attia YA, 2012. Addition of phytase to broiler diets contained different lysine levels. Egyptian Poultry Science 32: 117-130. researchgate.net [PDF]

NRC, 1994. Nutrient Requirements of Poultry. National Academy Press, Washington, DC. http://www.nap.edu/catalog/2114.html

Oko OOK, Ozung PO, Halilu A and Effiom EI, 2018. Growth and carcass characteristics of broiler chickens fed acha-based diet supplemented with phytase® enzyme. Continental Journal of Agricultural Science 12: 12-32. https://doi.org/10.5281/zenodo.1477600

Ponnuvel P, Narayanankutty K, Jalaludeen A and Anitha P, 2013. Economics of phytase enzyme supplementation in low energy-protein layer chicken diet. International Journal of Livestock Production 5: 113-116. https://doi.org/10.5897/IJLP2014.0212

Ravindran V, Wu YB, Thomas DG and Morel PCH, 2006. Influence of whole wheat feeding on the development of gastrointestinal tract and performance of broiler chickens. Australian Journal of Agricultural Research 57: 21–26. https://doi.org/10.1071/AR05098

ISSN: 2708-7182 (Print); ISSN: 2708-7190 (Online)
Open Access Journal

Rezaei M, Borbor S, Zaghari M and Teimouri A, 2007. Effect of phytase supplementation on nutrients availability and performance of broiler chicks. International Journal of Poultry Science 6: 55-58.
Raut S, Dhumal M, Nikam M and Khose K, 2018. Influence of super dosing of phytase enzyme on performance of broiler chicken. International Journal of Livestock Research 8: 220-231. https://doi.org/10.5455/ijlr.20170921044550
Sabha RIA, 2008. Effect of different levels of phytase on broilers performance and body status of phosphorus, M.Sc. Thesis Faculty of Graduate Studies University, Nablus Palestine
Statistical analysis system (SAS) 2003. Statistical analysis system. User's Guide SAS/STA-t version, 8th Ed, SAS, Institute, Inc. New York, USA.
Sato VS, Pinto GV, Amaral CM, Crisci AR, Oliveira WP and Guimarães LH, 2017. The active role of spray-dried phytase produced by rhizopus microspores var *microsporus biofilm* in feeding broiler chickens. Insights Enzyme Research 1: 1-8. https://doi.org/10.21767/2573-4466.100006
Scheideler SE and Ferket PR, 2000. Pytase in broiler rations: effects on carcass yield an incidence of tibial dyschondroplasia. Journal of Applied Poultry Research 9: 468-475. https://doi.org/10.1093/japr/9.4.468
Selle PH and Ravindran V, 2007. Microbial phytase in poultry nutrition: A review. Animal Feed Science Technology 135: 1-41. https://doi.org/10.1016/j.anifeedsci.2006.06.010
Sharma R, Baghel R, Sharma S, Mishra RK, Nayak S and Yadav V, 2018. Effect of varying levels of enzyme supplementation with high levels of paddy replacing maize on the performance and economics of broiler production. Journal of Entomology and Zoology Studies 6: 5-9.
Shirley RB and Edward HM, 2003. Graded levels of phytase past industry standards improves broilers performance. Poultry Science 82: 671-680. https://doi.org/10.1093/ps/82.4.671
Sreeja A, Divya S, Jyotirmoy G, Vaibhav BA, Karthik B, Dintaran P and Arumbackam VE, 2018. Effect of immobilized fungal phytase on growth performance and bone traits of broilers fed with low dietary calcium and phosphorus. Veterinary World 11: 758-764. https://doi.org/10.14202/vetworld.2018.758-764
Walk CL, Santos TT and Bedford MR, 2014. Influence of super doses of a novel microbial phytase on growth performance, tibia ash, and gizzard phytate and inositol in young broilers. Poultry Science 93: 1172-1177. https://doi.org/10.3382/ps.2013-03571
Walters HG, Coelho M, Coufal CD and Lee JT, 2019. Effects of increasing phytase inclusion levels on broiler performance, nutrient digestibility, and bone mineralization in low-phosphorus diets. Journal of Applied Poultry Research 28: 1210-1225. https://doi.org/10.3382/japr/pfz087