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The effect of partial replacement of yellow corn by banana peels with and without enzymes on broiler's performance and blood parameters

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Abstract

Six weeks experiment was performed using 288 (one day- old) ROSS chicks in order to evaluate the effect of replacing 15, 30 or 45% of yellow corn with dried banana peels (with and without enzyme) in broilers' diets on their growth performance and blood parameters. The metabolizable energy of banana peels was calculated from a digestibility trial and was found to be 2932 Kcal/Kg. The proximate analysis of dried banana peels showed that they contain 10g/100g (crude protein), 14.91 g/100g (crude fiber), 18.64 g/100g (ash), 0.31 g/100g (calcium) and 0.25 g/100g (phosphorus). The results of the growth experiment showed that the inclusion of banana peels in broilers' diet did not cause significant changes in broilers' performance. The supplementation of enzyme in the diets resulted in an enhancement in broilers' performance parameters numerically with no statistically significant differences. The groups fed on banana peels at the different tested levels with and without enzyme had significantly lower levels of cholesterol and triglycerides as compared to the control groups. The economic study revealed that increasing the replacement level of banana peels resulted in a lower feed cost of the diets. In conclusion, the results of the present study confirmed the use of banana peels in broiler's diet as a promising application in animal feed.

Key words: Banana peels, Blood, Broilers, Carcass, Enzyme, Performance

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Introduction

The need for poultry products is increasing markedly as a consequence of the continuous growing global population. However, the high cost and low availability of conventional poultry feedstuffs frequently demand consideration of by-products, even if efficiency of utilization is low (Negesse et al., 2009). It is important to utilize inexpensive materials not only to sustain the market of animal products but also to search for new sources of animal feed by recycling underutilized wastes (Ulloa et al., 2004).

Agricultural and food processing wastes have been utilized as alternative sources of animal feed production (Sruamsiri, 2007). However, the use of agricultural wastes in feed may be restricted by nutritional aspects (e.g. high fiber content) and presence of antinutritional factors (ANFs) (e.g. polyphenols, tannins, caffeine), which may limit their inclusion at high levels in the feed (Ulloa et al., 2004). Using low-fiber products in animal diets with acceptable production performance, in order to reduce the amount of corn in the diet has been tested in different trials (Blandon, et al., 2013).

Banana (Musaceae) is one of the earliest crops cultivated in the history of human agriculture (Padam et al., 2012). It is the world's second largest fruit crop with an estimated gross production exceeding 139 million tons (FAO, 2010). Significant quantities of banana or plantain peels, equivalent to 40% of the total weight of fresh banana, are generated as a waste product in industries producing banana based products (Nagarajaiah and Prakash, 2011).

Banana peel is a major by-product in pulp industry and it contains various bioactive compounds like polyphenols, carotenoids and others compound that are important in human and animal metabolism (Sundaram et al., 2011; Mohapatra et al., 2010).

Several approaches have been investigated to evaluate the inclusion of this material in animal diets and the respective contributions of nutrients. Banana peels were found to contain a substantial amount of protein, lipid, carbohydrate, fiber and a number of essential minerals such as potassium, sodium, calcium, iron and manganese, which serves as a promising raw material for feed production (Ahnwange, 2008).

Emaga et al. (2007) reported that banana peels are rich in total dietary fiber (40–50 %), protein, and amino acids (8–11%), lipids and fatty acids (2.2 % to 10.9 %). Negesse et al. (2009) stated that banana peels contains (55 g/Kg DM) crude protein, (163 g/Kg DM) ash, (48 g/Kg DM) ether extract, (9.3 MJ/Kg DM) metabolizable energy and its dry matter was (124 g/Kg).

In spite of their high availability and good nutritive value, a few numbers of studies were performed on the inclusion of banana peels in broilers diet. The inclusion levels of banana peels in diets are somewhat limited because of the presence of tannins in the banana peel that makes it difficult to digest (Widjastuti and Hernawan, 2012). Maximum inclusion rates of 7.5% and 10% dried banana peels have been suggested for broiler diets. Dried plantain peelings replacing maize grain resulted in a significant decrease of the weekly weight gains when included at more than 7.5 % in the diet (Tewe, 1983). Oppositely, in another trial, live-weight gain and feed conversion efficiency were significantly higher in chickens fed up to 10% banana peel meal in the diet. Feed intake increased linearly as the level of peels increase to 10%, after which growth decreased (Sabutan, 1996). Omole et al. (2008) reported no significant difference in the weight gain of weaned rabbit fed 15% plantain peels in place of maize.

The aim of this study was to investigate the efficacy of different dietary levels of banana peel and to assess the nutritive quality of banana peels as well as the effect of replacing a portion of the yellow corn in broiler diets by banana peels with and without enzyme on growth performance, blood constituents and carcass traits.

Materials and Methods

Test feedstuff preparation and experimental diets

Banana peels (BP) were obtained from Juice production factories in Egypt. The peels were washed, cut into small pieces and then air dried until constant weight. The dried peels were then grinded and subjected to chemical analysis. A representative sample of the dried banana peels was taken and divided to three portions. The first portion was autoclaved at 120°C for 10 min, the second portion was subjected to heating at 105°C for 120 min and the last portion was soaked in boiling water for 3 min.

The enzyme used in this study was "ALLZYME^{TM} SSF" obtained from Alltech Co. (USA). Each 1000 g of the enzyme contain (Phytase 300 SPU/g, Protease 700 HTU/g, Cellulase 40 CMCU/g, Xylanase 100XU/g, Betaglucanase 200 BGU/g, Amylase 30 FAU/g and pectinase 4000 AJDU/g).

Experimental design and diets formulation

Two hundreds and eighty eight (288) ROSS chicks (one day old) from a commercial hatchery were used in this study. The experiment was divided into 3 treatments with replacement levels of 15, 30 and 45% banana peels (in partial replacement of yellow corn). Each treatment consisted of three replicates. The experimental groups were arranged as follows: (T1) negative control (Control without Enzyme), (T2) positive control (Control + Enzyme), (T3) 15% banana peels without Enzyme, (T4) 30% banana peels without Enzyme, (T5) 45% banana peels without Enzyme, (T6) 15% banana peels + Enzyme, (T7) 30% banana peels + Enzyme and (T8) 45% banana peels + Enzyme.

The experimental diets were formulated according to the NRC (1994) recommendations to meet the nutrient requirements of broilers from day 1 to 28 (grower diet) and from day 29 to 42 (finishing diet). The starter diets contained 23% CP and 3000 kcal ME/Kg and the finisher diet contained 20% CP and 3200 kcal ME/Kg.

Tables 1 and 2 show the formulation and nutrients composition of the experimental and control diets used at the starter and finisher periods.

Table 1. Starter diets composition and analysis (1-28 days of age)

Ingredients	Control (negative)	BP 15%	BP 30%	BP 45%	Control (positive)	BP 15%+E	BP 30%+E	BP 45%+E
Corn 7.5%	56.465	47.996	39.526	31.056	56.425	47.956	39.486	31.016
Soybean (46%)	28.50	28.00	27.50	27.00	28.50	28.00	27.50	27.00
Gluten (60%)	8.31	8.40	8.50	8.50	8.31	8.00	8.90	8.50
BP	-	8.469	16.939	25.409	-	8.469	16.939	25.409
Enzyme	-	-	-	-	0.04	0.04	0.04	0.04
Oil	2.70	3.11	3.51	4.01	2.70	3.51	3.11	4.01
Di-Calcium phosphate (24.5%)	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03
Limestone (39.8%)	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
Vitamin	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Choline chloride (70%)	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
Dl-Methionine	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
L-Lysine	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Total	100	100	100	100	100	100	100	100
Determined Analysis (%)								
Crude protein	23.30	23.40	23.10	23.30	23.30	23.40	23.10	23.30
Calcium	1.10	1.12	1.14	1.12	1.10	1.12	1.14	1.12
Total phosphorus	0.76	0.77	0.76	0.76	0.76	0.77	0.76	0.76
Ether extract	2.95	2.90	3.10	3.32	2.95	2.90	3.10	3.32
Ash	6.40	6.20	6.10	5.80	6.40	6.20	6.10	5.80
Crude fibre	2.52	3.78	5.02	6.20	2.52	3.78	5.02	6.20

(*)Premix supplied per Kg of diet: Vit. (A), 12000 I.U., Vit.(D_3), 2000I.U. ; Vit.(E), 10mg ;Vit.(K_3) , 2mg; Vit.(B_1), 1 mg; Vit.(B_2), 5 mg; Vit.(B_6), 1.5 mg; Vit.(B_{12}), 10 ug; Biotin, 50ug; Choline chloride,500mg; Pantothenic acid , 10 mg; Niacin,30mg; Folic,1mg; Manganese, 60mg; Zinc,50mg; Iron,30mg;Copper,10mg;Iodine,1mg;Selenium,0.1mg and Cobalt,0.1mg (According to NRC,1994).

Table 2. Finisher diets composition and analysis (29-42 days of age)

Ingredients	Control (negative)	BP 15%	BP 30%	BP 45%	Control (positive)	BP 15%+E	BP 30%+E	BP 45%+E
Corn 7.5%	62.50	53.125	43.75	34.375	62.46	53.085	43.71	34.335
Soybean (46%)	24.00	23.50	23.00	22.50	24.00	23.50	23.00	22.50
Gluten (60%)	6.305	6.305	6.305	6.305	6.305	6.305	6.305	6.305
BP	-	9.375	18.75	28.125	-	9.375	18.75	28.125
Enzyme	-	-	-	-	0.04	0.04	0.04	0.04
Oil	3.60	4.10	4.60	5.10	3.60	4.10	4.60	5.10
Di-Calcium phosphate (24.5%)	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82
Limestone (39.8%)	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Vitamin	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Choline chloride (70%)	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
Dl-Methionine	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
L-Lysine	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
Total	100	100	100	100	100	100	100	100
Determined analysis (%)								
Crude protein	20.40	20.20	20.00	20.10	20.40	20.20	20.00	20.10
Calcium	0.90	0.91	0.89	0.90	0.90	0.91	0.89	0.90
Total phosphorus	0.69	0.68	0.68	0.69	0.69	0.68	0.68	0.69
Ether extract	3.50	3.00	3.20	3.35	3.50	3.00	3.20	3.35
Ash	5.40	6.20	6.50	6.60	5.40	6.20	6.50	6.60
Crude fibre	2.51	3.89	5.29	6.60	2.51	3.89	5.29	6.60

(*)Premix supplied per Kg of diet: Vit. (A), 12000 I.U., Vit.(D_3), 2000I.U. ; Vit.(E), 10mg ;Vit.(K_3) , 2mg; Vit.(B_1), 1 mg; Vit.(B_2), 5 mg; Vit.(B_6), 1.5 mg; Vit.(B_{12}), 10 ug; Biotin, 50ug; Choline chloride,500mg; Pantothenic acid , 10 mg; Niacin,30mg; Folic,1mg; Manganese, 60mg; Zinc,50mg; Iron,30mg;Copper,10mg;Iodine,1mg;Selenium,0.1mg and Cobalt,0.1mg (According to NRC,1994).

Every dietary treatment was fed to 12 chicks of each 3 replicates. The average initial live body weights of all replicates were nearly the same at the start of the experiment. Electric heaters were used to keep the required temperature for the brooding period. Light was provided 24 hr daily throughout the experiment. Feed and water were provided *ad-libitum* throughout the 42 days experimental period.

Digestibility trial

A digestion trial was performed using 12 male broiler chicks from 45 to 52 days of age. It consisted of 4 days of adaptation, followed by 72 h feeding with each treatment. Twelve birds (3 Replicates per each diet) were housed in individual cages with wire bottoms. Birds had free access to water throughout the experiment. Excreta were collected for each 24-hour period for days 50, 51 and 52. Any contaminants or feathers were carefully removed, and the excreta were stored in containers at –25°C. Excreta samples were subsequently dried in an oven at 80°C, weighed, ground through a 0.5 mm sieve, and stored in an airlock plastic vessel at 4°C until analysis. The true metabolizable energy (TME) was then calculated according to the following equation:

TME (Kcal/g) = $((GE_f \times X) - (Y_{ef}-Y_{ec}))/X$ (Sibbald, 1976).

Where: GE_f is the gross energy of 1g of test material, X is the amount of test material force fed, Y_{ef} is the gross energy of the excreta of the fed birds, Y_{ec} is the gross energy of the excreta of the control unfed birds.

Chickens performance and carcass traits determination

Feed consumption and chicken's live body weight were recorded at 42^{th} day after fasting overnight and feed conversion ratio (feed/gain) was then calculated. During the experimental period, mortality rate and signs of any apparent health problems were recorded.

At the end of the experimental period (6 weeks of age), a slaughter test for carcass traits was performed on 48 birds including 6 from each of the control groups and 6 birds from each experimental replicate. After the removal of head, viscera, shanks, spleen, gizzard, heart and liver, the rest of the body was weighted to determine the dressed weight. The edible organs (heart, empty gizzard and liver) were then individually weighed. All weights were recorded to the nearest 0.01 g and expressed as percentage of fasted weight.

Chemical and blood analyses

Moisture, CP, crude fiber, and ash were analyzed according to the methods of the Association of Official Analytical Chemists International (AOAC, 2006). Ether extract was determined by extraction in petroleum ether following acidification with 4 N HCl solution (Wiseman et al., 1992). Tannins content of banana peels was determined using Folin-Denis colorimetric method described by Kirk and Sawyer (1998).

Blood plasma was analyzed for cholesterol and triglycerides using kits purchased from the agent of DiaSys Diagnostic System GmbH.

All animal housing, care and experimental procedures were conformed to the requirements of the Institutional Animal Ethics Committee.

Economics of production

The economic efficiency is calculated from the money output and input analysis based upon the differences in both growth rate and feeding cost. The market costs of the ingredients at the time of the experiment were used to calculate the cost of feed. The economic efficiency was calculated as:

(Net Revenue /Total cost) ×100.

Statistical analysis

Data were statistically analyzed using the general linear model for analysis of variance of SAS (SAS, 2004) and the test of significance for the difference between means was computed using Duncan's (Duncan, 1955) multiple range tests.

Results and Discussion

It has been reported that tannins are the major antinutrient usually affecting the utilization of banana peels in monogastrics ration **(**Happi Emaga et al., 2011). The use of plantain peels in poultry has been limited because of possible deleterious effects arising from the presence of tannins. Tannins exist in plantains in two different forms, (a) "free or active tannins" which impart a strong bitter taste and (b) "bound or vegetable tannins" which are insoluble, supposedly inert and which have little or no effect on the palatability (Makkar et al., 2007).

In the present study, tannins content in dry banana peels was found to be 1.2 g/100g. In order to reduce the tannins content of BP, the dried peels were subjected to three different treatments namely autoclaving, oven heating and soaking in boiling water. The tannins content of BP after the different treatments was 1.04, 0.59 and 0.46 g/100g for autoclaving, oven heating and soaking in boiling water, respectively. Thus, it was decided to use banana peels after soaking in boiling water as this treatment showed the lowest tannins content.

According to Onu et al. (2011), the nutritive value of feed ingredients used in feeding poultry should be determined in terms of nutrient content and availability. The proximate chemical composition of banana peels used in the present work is reported in Table 3. Banana peels were found to contain good amount of nutrients and minerals that allows it to be used as alternative feed ingredient for broilers. The results obtained for the proximate composition of banana peels were consistent with the results previously reported by Ironkwe et al. (2012 and 2013). The true metabolizable energy of BP was estimated from the digestibility trial to be 2932 Kcal/Kg.

Table 3. Proximate composition of banana peels

Item (g/100g)	Content in banana peels
Dry matter (DM)	91.03
Crude protein (CP)	10.00
Crude fiber (CF)	14.91
Ether extract (EE)	8.23
Nitrogen free extract (NFE)	39.25
Ash	18.64
Calcium	0.31
Phosphorus	0.25

The results of performance, carcass traits and serum parameters are shown in Table 4. The results showed that there were no significant differences (P > 0.05) for body weight and weight gain between the groups fed BP without enzyme as compared to their relative control group. Similarly, the groups fed BP with enzyme did not differ significantly in their body weight and weight gain values as compared to their respective control group except for the group fed (45% BP+ E) which showed significantly (P < 0.05) lower body weight and weight gain when compared to the positive control group. It can be concluded thus that the inclusion of BP in the broilers diets did not have a negative effect on either body weights or body weight gain. This results could be due to the chemical characteristics of banana peel which contain substantial amounts of protein, fiber, lipids, carbohydrates and some minerals that makes it optimal for animal feed (Padam et al., 2012; Ahnwange, 2008; Sehgal and Sharma, 1993).The groups fed BP+E showed higher numerical values for their body weight and weight gain as compared to their respective groups fed the experimental diets without enzyme.

Table 4. Performance, carcass characteristics and blood measurements of broilers

Parameters	T1	T2	T3	T4	T5	T6	T7	T8
Average body weight	2269^{ab} ±63.17	2281^{a} ±50.71	2211^{ab} ±53.00	2180.67^{ab} ±40.07	2159^{b} ±85.75	2238.33^{ab} ±46.75	2201.33^{ab} ±21.30	2163^{b} ±72.34
Body weight gain	2225^{ab} ±63.17	2237^{a} ±50.71	2167^{ab} ±53.00	2136.67^{ab} ±40.07	2115^{b} ±85.75	2194.33^{ab} ±46.75	2157.33^{ab} ±21.30	2119.33^{b} ±72.34
Feed intake	3735^{a} ±25.70	3746.67^{a} ±17.10	3696.67^{a} ±61.80	3728^{a} ±45.57	3681.67^{a} ±110.90	3705^{a} ±60.60	3740^{a} ±43.50	3694.33^{a} ±116.00
Feed conversion ratio	1.68^{b} ±0.04	1.68^{b} ±0.03	1.71^{ab} ±0.02	1.75^{a} ±0.03	1.74^{a} ±0.02	1.69^{b} ±0.01	1.73^{a} ±0.02	1.74^{a} ±0.01
Dressed weight	82.79^{a} ±0.65	82.39^{ab} ±0.08	81.37^{abc} ±0.48	81.1^{bc} ±0.39	80.56^{c} ±2.56	81.34^{bc} ±0.60	81.27^{bc} ±0.50	80.75^{c} ±2.52
Liver weight	2.29^{a} ±0.40	1.74^{b} ±0.14	1.9^{ab} ±0.07	1.77^{b} ±0.17	1.95^{ab} ±0.25	1.75^{b} ±0.10	1.87^{ab} ±0.15	1.96^{ab} ±0.26
Gizzard weight	2.71^{a} ±0.41	2.57^{a} ±0.28	2.48^{a} ±0.83	2.30^{a} ±0.07	2.32^{a} ±0.06	2.80^{a} ±0.37	2.63^{a} ±0.18	2.63^{a} ±0.13
Heart weight	0.48^{ab} ±0.09	0.49^{ab} ±0.08	0.58^{a} ±0.07	0.47^{ab} ±0.05	0.50^{ab} ±0.03	0.53^{ab} ±0.03	0.48^{ab} ±0.03	0.50^{ab} ±0.03
Abdominal fat	1.53^{a} ±0.66	1.44^{a} ±0.52	1.49^{a} ±0.75	1.68^{a} ±0.39	1.59^{a} ±0.32	1.63^{a} ±0.76	1.52^{a} ±0.54	0.86^{a} ±0.25
Breast weight	17.65^{b} ±0.89	17.68^{ab} ±0.13	17.71^{ab} ±0.65	18.40^{ab} ±0.29	17.96^{ab} ±1.13	17.58^{ab} ±0.76	18.50^{a} ±0.22	18.31^{ab} ±0.55
Drumstick Weight	4.65^{a} ±0.21	4.66^{a} ±0.27	4.10^{a} ±0.35	4.85^{a} ±0.49	4.67^{a} ±0.19	4.15^{a} ±0.27	4.83^{a} ±0.41	4.64^{a} ±0.27
Thigh weight	4.77^{a} ±0.41	4.79^{a} ±0.26	5.12^{a} ±0.77	5.28^{a} ±0.33	5.47^{a} ±0.67	5.1^{a} ±0.66	5.43^{a} ±0.34	5.16^{a} ±0.36
Cholesterol	189.3^{a} ±7.37	188.7^{a} ±1.52	180.7^{c} ±2.08	169.3^{c} ±1.52	151^{d} ±2.00	178.7^{b} ±2.08	170.7^{c} ±3.05	148.3^{d} ±2.51
Triglyceride	117^{a} ±2.00	113.3^{b} ±1.52	107.7^{c} ±1.15	99.3^{e} ±2.08	87^{f} ±2.00	104.3^{d} ±1.15	97.3^{e} ±0.57	83.7^{g} ±3.05

Each value represents the least square mean from 36 broilers per each treatment. Means with different superscripts (a-g) differ significantly (P < 0.05)

No significant differences ($P > 0.05$) were obtained for feed intake values of all experimental groups. This result is in agreement with those reported by Atapattu and Senevirathne (2013) who using increasing levels of banana meal observed non significant changes in feed intake values ($P > 0.05$). The groups fed diets containing 30 and 45% BP with and without enzyme recorded the significantly ($P < 0.05$) highest feed conversion values meaning worst conversion ratios as compared to the control groups.

According to Babatunde (1992) high dietary banana meal reduced the performance of poultry. In contrast, our results showed that the inclusion of BP in broilers' diet did not cause significant changes in broilers' performance which is also in agreement with the findings of Atapattu and Senevirathne (2013).

Regarding the carcass traits results there were no significant differences ($P > 0.05$) in liver, gizzard, heart, breast and drumstick weights and in abdominal fat between all the experimental groups. The dressed weight of broilers fed 15% BP without enzyme did not differ significantly ($P > 0.05$) with respect to control. Whereas increasing the level of BP to 30 and 45% without enzyme resulted in a significant ($P < 0.05$) decrease in broilers' dressed weights. On the other hand, the broilers fed 15 and 30 % BP with enzyme did not show any significant differences in their dressed weights when compared to control group in contrary to the group fed 45% BP with enzyme which recorded significantly lower dressed weight as compared to the control group. The decrease observed in our experiment in dressing weight ($P < 0.05$) may be associated with the form of absorption of lipids from the diet. Since it has been reported that banana peel contains important antioxidant compounds (Kanazawa and Sakakibara, 2000; Someya et al., 2003; Mokbel and Hashinaga, 2005) that can play a fundamental role in how to deposit or convert lipids in muscle or skin.

The improvement in performance parameters of the groups fed the diets with enzyme supplementation could be due to the type of enzyme used in the present study Previous research on poultry have indicated that "Allzyme SSF" improved the body weight gain, feed conversion rate (FCR) and the survival percent (Ben et al., 2010).

Changes such as the serum concentrations of several proteins and metabolites and the activity of certain enzymes can be used as sensitive indicators of metabolism of nutrients and its assimilation. In the present study, the different treated groups fed on BP at the different tested levels with and without enzyme had significantly ($P < 0.05$) lower levels of cholesterol and triglycerides as compared to the control groups. It is known that banana contain secondary compounds like terpenoids, flavonoids and others phenolic compounds with a important physiological activity (Marie-Magdeleine, 2009). It can be hypothesized that changes in serum concentration of metabolites is related with this compounds.

Table 5 gives the economic results of utilizing banana peels in broilers diet in partial replacement of yellow corn. The results show that increasing the replacement level of banana peels resulted in a lower feed cost of the diets. This was expected since the cost of banana peels is much lower than that of yellow corn. Several authors (Onu et al., 2011; Abdel-Moneim, 2013; Kalio et al., 2013) reported similar trend with various by-products used in broilers' diet.

Table 5. Economic efficiency of the experimental diets

	T1	T2	T3	T4	T5	T6	T7	T8
Final live body weight (g)	2269	2281	2211	2181	2159	2238	2201	2163
Price/Kg feed* (L.E)	2.73	2.74	2.43	2.35	2.24	2.44	2.36	2.25
Feed consumed (kg)/ chicken	3.74	3.75	3.70	3.73	3.68	3.71	3.74	3.69
Total cost/ 1Kg chicken (L.E) [a]	13.70	13.77	12.48	12.26	11.75	12.54	12.33	11.81
Total revenue/ chicken (L.E)[b]	31.77	31.93	30. 95	30.53	30.23	31.34	30.82	30.29
Net revenue/ chicken (L.E)	18.07	18.17	18.47	18.27	18.48	18.80	18.49	18.47
Economic efficiency (EE), % [c]	131.93	131.98	147.97	148.99	157.31	149.89	150.02	156.40
Relative EE (%)[e]	100	100	112.16	112.94	119.24	113.57	113.67	118.50

(a) Including initial Chick price. (b) Assuming that the selling price of one Kg live body weight is (14 L.E). (c) Net revenue per unit total cost. (d) Considering the economic efficiency of the control diet is 100%.

The addition of enzyme also enhanced the economic efficiency of the diets as the chickens in the enzyme supplemented groups acquired higher body weights compared to their respective groups fed diets non-supplemented with enzyme.

Conclusion

This study showed that inclusion of banana peel in diets for broilers had potential. The inclusion of BP levels in the diets was not detrimental to growth performance, carcass characteristics and haematological parameters. The feed intake and feed conversion ratio is also an advantage and should result in reduced feed costs. In conclusion, the results of the study confirmed the banana peel have promising application in broiler chicken's feed.

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