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RESEARCH ARTICLE

Impact of Replacement Maize with Graded Levels of Indomie Waste Meal on Performance, Carcass Traits, Cost and Blood Parameters of Broiler Chickens

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Abstract

A six week feeding study was carried out to assess the effects of graded levels of indomie waste meal (IWM) as a substitute for maize in the diet of broiler chickens on growth performance, carcass traits, cost efficiency, digestive enzymes activities, and serum biochemical parameters. One hundred and twenty male one day-old Cobb 500 broiler chicks were used. The birds were weighted and assigned to equal six treatment groups as following: T1 (0% IWM), T2 (20% IWM), T3 (40% IWM), T4 (60% IWM), T5 (80% IWM), and T6 (100% IWM) in a completely randomized design. Each treatment had five replicates and each replicate contains four chicks. The Results of growth performance showed that the body weight gain was significantly highest ($P < 0.05$) in birds fed 60% IWM (2663 g / bird). The feed intake decreased gradually as IWM increased in the diet. Feed conversion ratio was significantly lowest ($P < 0.05$) in birds fed 60% IWM (1.65). It was revealed that the relative weight of gizzard, liver, intestine, and abdominal fat were significantly ($P < 0.05$) affected by the dietary inclusion of IWM. The highest recorded value of abdominal fat percent was (3.36) in group fed 100% IWM. The lowest recorded value of liver % was (1.91) in group fed 60% IWM. Cost and return analysis revealed that the feed cost decreased because IWM increased in the diet. Total return and net profit were significantly highest in birds fed 60% IWM. Also there was an improvement in the pancreatic digestive enzymes activities with dietary inclusion of IWM. There were significant increase in amylase and lipase activities while significant decrease in protease activity. There was a significant increase in the total cholesterol as dietary IWM increased. Based on the study's findings, indomie waste meal was recommended to substitute maize up to 60% level in the broiler chickens diet.

Keywords: Indomie, Broilers, Performance, Cost, Digestive enzymes.

Introduction

The poultry industry has experienced remarkable improvements in productivity due to the high importance given to nutrition and management practices [1]. Approximately 70-80% of poultry production inputs have been attributed to feeding cost, so good quality feed should be available at a reasonable price to make poultry production more profitable [2]. Hence, the broilers can only perform economically well if they consume, on daily basis, the proper amount of energy, protein, vitamins, and minerals [3].

In recent years, there has been a constant increase in the cost of conventional feed ingredients like maize, groundnut cake, soybean meal, and fish meal [4]. Maize constituted the highest proportion of most compounded ration for livestock especially non-ruminant animals taking about 40-60% of such diets [5]. Any effort to substitute maize with cheaper feed ingredients is likely to reduce the total cost of production significantly [6, 7].

Various human food-based industrial wastes have been exploited for livestock feeding to replace maize. Food waste products such as biscuit waste meal, sorgum sprout, cocoa pod meal, burnt maize meal, macro cassava flakes, wheat and corn flour dust, and indomie noodle waste meal have been incorporated into the feed of monogastric to replace maize [8].

Indomie noodle was first commercialized in Japan in 1958; their popularity was rapid, spreading worldwide. They have since become one of the food products that are consumed by people of all socioeconomic levels in both urban and rural areas of the country [9]. Indomie noodle is strips or strands cut from a sheet of dough made from wheat flour, starch, water, refined palm oil, salt or kansui (an alkaline salt mixture of sodium carbonate, potassium carbonate, and sodium phosphate), tertiary butyl hydroquinone antioxidant and other ingredients (guar gum, tartrazine, and spices) that improves the texture and flavor of noodles. Tertiary butyl hydroquinone was created to help with stabilization of various vegetable oils, fats, and foods against oxidative deterioration; as a result, food storage life is extended [10]. Flour of hard wheat (*Triticumaestivum L.*) is the most important ingredients [11]. Alkaline salts can assist strengthen the structure and, as a result, improve the end product's hardness. [12]. The increased temperature used in feed processing may have helped to reduce the negative effects of non-starch polysaccharides (NSP) found in wheat by-products. The waste generated during the packaging of the noodles is sold to the livestock industry as indomie waste, which has several advantages over other non-conventional feed components in that it is produced for human consumption and is packaged hygienically, eliminating the possibility of contamination. Indomie waste has high energy content with no anti-nutritional components [13].

It has been found that the proximate composition of indomie waste meal is comparable to that of maize as it contains 3799 metabolizable energy (ME) Kcal/Kg, 89% dry matter, 8.57% crude protein (CP) and, 17.14% ether extract while that of maize is 3315 ME Kcal/Kg, 91.8% dry matter, 8.9% CP, and 4% fat [14].

Indomie waste meal is a suitable energy source, when compared with maize, it requires no extra processing before being consumed, and it has a consistent and affordable price. With the recent rise in consumption and acceptance of indomie noodles as a quick snack in the country, as well as the corresponding rise in producers and production, a lot is being thrown away as waste [15].

The purpose of this research was to evaluate the performance characteristics, carcass traits, pancreatic digestive enzymes activities, economic efficiency, and serum biochemical parameters of broiler chickens fed varied levels of indomie waste meal as a maize substitute.

Materials and methods

Birds, housing, diets, and experimental design

This research was carried out at the Experimental Research Animal Unit, Faculty of Veterinary Medicine, Zagazig University, Egypt. The protocol of this study was approved by the Institutional Animal Care and Use Committee-Zagazig University with approval number ZU-IACUC/2/F/98/2021. One hundred and twenty male one day old chicks (Cobb 500 broiler) were purchased from a producer of commercial chicks. Chicks were weight at the start of the experiment. They were randomly assigned to six groups with five replicates each contain four birds in completely randomized design. Six treatments: T1, T2, T3, T4, T5, and T6 were formulated to contain 0, 20, 40, 60, 80, and 100% indomie waste meal as replacement for maize in broiler chickens diets, respectively. Usual health and vaccination protocols were done against Newcastle (at the 4^{th} and 14^{th} days) and Gumboro diseases (at 7^{th} and 22^{th} day). The ingredient composition (%) of the experimental diets is presented in Table 1.

Table 1. Ingredient composition (%) of the experimental diets used in the starter, grower and finisher stage.

Ingredient	Experimental diets																	
	Starter						Grower						Finisher					
	ntrol	20% IWM	40% IWM	60% IWM	80% IWM	100% IWM	Control	20% IWM	40% IWM	60% IWM	80% IWM	100% IWM	control	20% IWM	40% IWM	60% IWM	80% IWM	100% IWM
Yellow corn	56	44.8	33.6	22.4	11.2	0	58	46.4	34.8	23.2	11.6	0	63.6	50.88	38.16	25.44	12.72	0
Indomie waste meal	0	11.2	22.4	33.6	44.8	56	0	11.6	23.2	34.8	46.4	58	0	12.72	25.44	38.16	50.88	63.6
Soybean meal, 46%	30.98	33.7	35.65	38.09	37.63	37.59	33.89	33.65	33.4	33.1	33	32.57	28.45	28.2	28	27.65	27.4	27.1
Corn gluten, 60%	5.78	3.4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soybean oil	2.3	2	1.5	1.1	0.6	0	3.79	3.25	2.66	2.12	1.5	1	3.9	3.25	2.65	2	1.39	0.77
Calcium carbonate	0.74	0.73	0.72	0.71	0.71	0.7	0.41	0.4	0.4	0.4	0.4	0.4	0.36	0.36	0.36	0.36	0.36	0.36
Calcium phosphate	2.58	2.58	2.58	2.58	2.58	2.58	2.4	2.4	2.4	2.4	2.4	2.4	2.15	2.15	2.15	2.15	2.15	2.15
Common salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Sodium bicarbonate	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Premix*	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
L-Lysine HCL, 78%	0.38	0.33	0.29	0.24	0.24	0.24	0.23	0.23	0.24	0.25	0.25	0.26	0.27	0.27	0.27	0.27	0.27	0.27
DL-Methioinine, 98%	0.14	0.15	0.15	0.17	0.17	0.[17]	0.19	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.18
L-Threonine, 98.5%	0.11	0.12	0.12	0.12	0.13	0.12	0.1	0.09	0.09	0.09	0.09	0.09	0.1	0.09	0.09	0.09	0.09	0.09
Choline chloride, 60%	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Antimycotoxin	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Anticoccidial	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Zeolites	0	0	0	0	0.95	1.61	0.00	0.80	1.63	2.46	3.18	4.10	0.00	0.91	1.71	2.71	3.57	4.49
Chemical composition %																		
ME (kcal/kg diet)	2975.05	2975.65	2976.45	2975.75	2975.53	2975.19	3025.13	3027.59	3026.20	3028.10	3026.91	3029.47	3102.53	3100.46	3104.17	3100.22	3101.97	3101.73
Crude protein	22.01	21.94	22.08	22.09	22	22.09	20	20	20.01	20.01	20.08	20.01	18.01	18.01	18.05	18.02	18.03	18.03
Calcium	1	1	1	1	1	1	0.84	0.84	0.84	0.84	0.84	0.84	0.76	0.76	0.76	0.76	0.76	0.77
Available Phosphrus	0.45	0.45	0.45	0.45	0.45	0.45	0.42	0.42	0.42	0.42	0.42	0.42	0.38	0.38	0.38	0.38	0.38	0.38
D. Lysine HCL	1.22	1.22	1.22	1.22	1.22	1.22	1.11	1.11	1.11	1.12	1.12	1.11	1.02	1.02	1.02	1.01	1.01	1.00
D. Methioinine	0.46	0.46	0.45	0.46	0.46	0.46	0.45	0.45	0.45	0.46	0.46	0.46	0.42	0.42	0.42	0.42	0.43	0.43
D. Threonine	0.83	0.83	0.83	0.83	0.83	0.83	0.73	0.72	0.72	0.73	0.73	0.73	0.67	0.66	0.66	0.66	0.67	0.67

[1]Muvco premix: Each 2.5kg contain vit. A (10, 000000 IU), vit. D3 (2, 000000 IU), vit. E (10 g), vit.k3 (1000 mg), vit. B1 (1000 mg), vit. B2 (5 g), vit. B6 (1.5 g), pantothenic acid (10 g), vit. B12 (10 mg), niacin (30 g), folic acid (1000 mg), biotin (50 g), fe (30 g), Mn (60 g), Cu (4 g), I (300 mg), Co (100mg), Se (100 mg) and Zn (50 g**)**. IWM: indomie waste meal.

Control: fed basal diet, 20%: fed basal diet with 20% IWM and 80% maize, 40%: fed basal diet with 40%IWM and 60% maize, 60%: fed basal diet with 60%IWM and 40% maize, 80%: fed basal diet with 80I WM and 20% maize and 100%: fed basal diet with 100% IWM.

The chemical composition of IWM (3799metabolizable energy (ME) Kcal/Kg, 88% dry matter, 8.50% crude protein (CP) and, 17.14% ether extract) while that of maize (3320 ME Kcal/Kg, 91% dry matter, 7.50% CP and, 3.70% fat).

Growth performance

The birds were weighed individually on the first day of life to determine the average initial body weight, and then again at the end of starter, grower, and finisher period to determine the average body weight (BW) of the birds in each group. BW, BWG (body weight gain) and FI (feed intake) were calculated. FCR (feed conversion ratio) was calculated according to Wanger *et al* [16].

Carcass characteristics study

On the final day of the feeding trial, the birds were starved of food overnight, but drinking water was provided. The dressed weights of the plucked bird were estimated after they were eviscerated. The relative weights of organs like gizzard, liver, spleen, intestine, abdominal fat, and bursa were estimated.

Sample collection and enzyme analysis

A pancreatic sampling procedure that was used in this study was described by Uni *et al.* [17]. The pancreas was homogenized in ice cold phosphate-saline buffer and centrifuged for 15 min at 3,000 rpm. To test the activity of different digestive enzymes, the supernatant was collected into multiple Eppendorf tubes and kept at -70°C.

The amylase activity was measured using the method of Somogyi [18]. During 30 minutes of incubation at 38°C, one enzyme unit was defined as the amount of amylase producing reducing sugars corresponding to 1 mg of glucose per mg of pancreas. In this experiment, the substrate was corn starch. The activity of lipase was determined using the method described by Tietz and Fiereck [19]. The amount (mL) of 0.05 M NaOH necessary to neutralize the fatty acid generated after 6 h incubation with 3 mL of lipase substrate at 38°C per milligram of pancreas was defined as the lipase activity unit. In this experiment, the substrate was olive oil. Protease activity was detected using the method described by Lynn and Clevette-Radford [20]. The protease activity unit was defined as the mg of azocasein breakdown per mg of pancreas after a 2 h incubation period at 38°C.

Economic importance

Collective efficiency measures including total return, total costs, variable costs, and net profit were calculated [21- 23]. Also, the performance index (PI) was estimated [24].

Serum parameters

At the end of experiment (42 days), five birds were randomly selected from each group and slaughtered for collection of blood samples. Each blood sample was collected into clean centrifuge tube without anticoagulant for separation of serum, kept in the refrigerator over the night, and then centrifuged at 3000 rpm for 15 min to separate the serum. The obtained sera were stored at -20°C until used for biochemical analysis.

Serum glucose, total cholesterol, triglyceride, high density lipoprotein concentration, low density lipoprotein, total protein (TP), albumin, and globulin were measured as previously described [25-32]. In addition, we determined the levels of blood urea nitrogen, creatinine, and uric acid as previously stated [33]. Serum aspartate-aminotransferase (AST) and alanine-aminotransferase (ALT) were determined as previously described [34].

Statistical analysis

The data were analyzed by SPSS version 25 (Armonk, NY: IBM Corp). The results were reported as Mean ± SE. Data were screened and Shapiro-Wilk test was applied to test normality assumption. Levene’s test also was run to evaluate homogeneity of variance. Welch’s ANOVA was run for variables violate homogeneity condition. The differences among groups were tested using a one-way ANOVA. The significant results which were followed by Tukey's honesty significant difference test, with a P value < 0.05 being considered statistically significant.

Results

Growth performance

The results of the overall performance revealed that there was a significant difference ($P < 0.05$) between birds fed control diet and others fed graded levels of IWM diet (Table 2). The obtained results showed a significant ($P < 0.05$) higher final BW (2708 g/bird) and total average BW gain (2663 g /bird) in group fed diet contain 60% IWM (T4). The BW of T1, T2, and T3 showed non-significant differences ($P > 0.05$) with that of the control group. Meanwhile T5 and T6 recorded the lowest significant differences. There was a significant ($P < 0.05$) decrease in the feed intake as the level of IWM increased in the diet from 0% to 100%. The highest FI was observed in the control group (4660 g /bird) and T2 group (4659 g /bird) and the least observed with birds fed 60% IWM (4383g/bird). The obtained result revealed that the best FCR (1.65) was found in the group fed 60% IWM if compared to the control and other groups.

Carcass quality traits

As displayed in Table 3, there were non-significant differences ($P > 0.05$) on weight percentages of dressing, spleen, heart, bursa relative to live BW among all experimental groups as compared to the control group. But, there were significant differences ($P < 0.05$) on weight percentages of liver, gizzard, intestine, and abdominal fat. There was significant increase in the abdominal fat% as indomie waste increased in the diet. The highest recorded value of abdominal fat % was (3.36) in the group fed 100% IWM. The lowest recorded value of liver % was (1.91) in the group fed 60% IWM. There were non-significant differences ($P > 0.05$) between T2 and control groups for gizzard%.

Digestive enzyme activity

As depicted in Table 4, there was a significant difference ($P < 0.05$) between digestive enzyme activities in the control and other groups. There were non-significant differences ($P > 0.05$) between amylase activities in T2, T3 groups in comparison with the control group. However, non-significant differences were observed between T4, T5, and T6 groups. These groups showed the highest significant differences ($P < 0.05$) compared to the control group. The lipase activity increased significantly as the level of IWM increased in the diet. The protease activity decreased significantly as IWM increased in the diet from 0 to 100%.

Table 2. Overall performance of broiler (Cobb 500) fed graded levels of indomie waste meal

Trait studied	Experimental diets + groups					
	(T1)	(T2)	(T3)	(T4)	(T5)	(T6)
Final body weight (g)	2636.67±10.93^{ab}	2623.89±38.06^{ab}	2613.33±13.47^{ab}	2708.33±26.58^{a}	2600.56±7.78^{b}	2606.11±18.42^{b}
Absolute weight gain (g)	2592.33±11.21^{ab}	2578.89±38.18^{ab}	2568.42±13.46^{ab}	2663.25±26.51^{a}	2555.89±7.67^{b}	2561.03±18.24^{b}
Total feed consumption (g)	4660.17±21.67^{a}	4659.92±8.12^{a}	4492.92±10.64^{b}	4383.75±29.29^{c}	4491.33±31.37^{b}	4513.75±23.58^{b}
Feed conversion ratio	1.80±.003^{a}	1.81±.03^{a}	1.75±.01^{a}	1.65±.01^{b}	1.76±.01^{a}	1.76±.01^{a}

Values are expressed as mean ± SE. ^{abc}Means within same row with different superscript are statistically different at $P < 0.05$ according to Tukey's Honesty significant difference test.

Table 3. Carcass traits relative to the live weight of broiler (Cobb 500) fed graded levels of indomie waste meal

Trait studied	Experimental diets + groups					
	(T1)	(T2)	(T3)	(T4)	(T5)	(T6)
live body weight (g)	2720±10.80	2658.75±24.86	2712±30.86	2750±73.40	2642.5±14.79	2627.5±85.96
Dressing%	78.02±2.11	74.31±1.38	77.34±1.49	71.50±3.5	71.68±.57	47.32±.96
Liver%	2.26±.15^{ab}	2.23±.19^{ab}	2.24±.15^{ab}	1.91±.10^{b}	2.80±.21^{a}	2.38±.18^{ab}
Gizzard%	2.71±.07^{a}	2.83±.19^{a}	2.47±.12^{ab}	2.07±.08^{bc}	2.09±.07^{bc}	1.88±.12^{c}
Intestine%	5.41±.30^{ab}	5.54±.30^{a}	5.36±.45^{ab}	4.50±.20^{ab}	4.08±.35^{b}	5.28±.18^{ab}
Spleen%	.19±.17	.22±.04	.14±.02	.18±.03	.12±.01	.14±.02
Heart%	.53±.06	.59±.03	.54±.03	.56±.05	.45±.06	.57±.03
Abdominal fat%	1.54±.18^{c}	2.26±.23^{bc}	2.27±.30^{bc}	2.26±.32^{bc}	3.02±.16^{ab}	3.36±.15^{a}
Bursa%	0.23±.03	0.29±.04	0.20±.03	0.26±.04	0.24±.02	0.17±.03

Values are expressed as mean ± SE ^{abc}Means within same row with different superscript are statistically different at $P < 0.05$ according to Tukey's Honesty significant difference test.

Table 4. Pancreatic digestive enzymes activity of broiler (Cobb 500) fed graded levels of indomie waste meal

Trait studied	Experimental diets + groups					
	(T1)	(T2)	(T3)	(T4)	(T5)	(T6)
Amylase (u/l)	550±45.23^{b}	499.23±19.74^{b}	327±30.65^{b}	989.90±94.39^{a}	1284±169.64^{a}	1250±127.48^{a}
Lipase(u/l)	8.24±0.65^{e}	15.16±1.12^{d}	23.67±1.48^{c}	30.07±1.44^{b}	31.24±1.15^{b}	37.11±0.68^{a}
Protease (ng/mg)	466.50±32.66^{a}	337±2.55^{b}	257±4.42^{c}	188±4.42^{d}	123±2.55^{e}	80±5.40^{f}

Values are expressed as mean ± SE. ^{abc}Means within same row with different superscript are statistically different at $P < 0.05$ according to Tukey's Honesty significant difference test.

Economic importance

The total costs decreased significantly ($P < 0.05$) as IWM increased in the diet. There were significant differences ($P < 0.05$) in the total return among groups. Birds fed 60% IWM showed the highest return value (77.83 L.E) if compared with the other groups. There was a significant ($P < 0.05$) increase in the net profit recorded for T4, T5, and T6 groups when compared with the other groups (Table 5).

Serum parameters measured

Lipid profile

The serum cholesterol levels were increasing with increasing the dietary inclusion level of IWM. It were significantly higher ($P < 0.05$) in birds fed 100% IWM (312 mg/dL), followed by (291 mg/ dL) in birds fed 80% IWM, and the lowest level was recorded in the control group (188 mg/ dL). There were non-significant differences ($P > 0.05$) between T2, T3, and T4 groups. The serum triglyceride level increased significantly ($P < 0.05$) as the amount of IWM in the diet increased. The highest value (308.75 mg/ dL) recorded with 100% IWM while the lowest value 85.76 mg/ dL was noted in the control group and there were non-significant differences ($P > 0.05$) between T1, T2, T3, and T4 groups. HDL recorded non-significant difference ($P > 0.05$) between the control group and T2, T3, and T4 groups. There was a significant decrease ($P < 0.05$) in HDL in the groups that were fed 80 and 100% IWM (38.65 and 34.68 mg/ dL). LDL showed significant increase (*P* < 0.05) in groups fed 80 and 100% IWM (219.54 and 251.90 mg/ dL, respectively), but there were non-significant differences (*P* > 0.05) between control and other groups (Table 6).

Protein profile

The results of TP showed no significant difference between control (5.08 g/dl) and T2 (4.71) groups, also there were non-significant differences among T2, T3, and T4 groups (4.71, 4.21, and 4.22 g/dL, respectively). Meanwhile, there was significant decrease (*P* < 0.05) in T5, T6 (2.58 g/dL) than the control group. This trend of results was also recorded in albumin levels between different groups. Globulin showed significant decrease (*P* < 0.05) between groups and the lowest values were observed in T5 and T6 groups (1.49 g/dl).

The other biochemical parameters including ALT, AST, glucose, creatinine, uric acid, and urea showed significant difference (*P* < 0.05) between groups and highest values were noted in groups fed 80 and 100% IWM.

Table 5. Economic efficiency of broiler (Cobb 500) fed graded levels of indomie waste meal

Trait studied	Experimental diets + groups					
	(T1)	(T2)	(T3)	(T4)	(T5)	(T6)
Final body weight (kg)	$2.64±.01^{ab}$	$2.62±.03^{ab}$	$2.61±.01^{ab}$	$2.70±.02^{a}$	$2.60±.01^{b}$	$2.61±.02^{b}$
costs of one Kg feed (L.E)	$12.53±.03^{a}$	$12±.20^{b}$	$11.05±.07^{c}$	$9.85±.08^{d}$	$9.96±.06^{d}$	$9.43±.04^{e}$
Total costs (L.E)	$52.49±.15^{a}$	$50.92±.05^{b}$	$48.37±.06^{c}$	$46.23±.18^{d}$	$45.46±.18^{e}$	$44.16±.13^{f}$
Total return (L.E)	$75.83±.31^{ab}$	$75.46±1.07^{ab}$	$75.17±.38^{ab}$	$77.83±.74^{a}$	$74.82±.21^{b}$	$74.97±.52^{b}$
Net profit (L.E)	$23.34±.18^{c}$	$24.54±1.11^{bc}$	$26.80±.40^{b}$	$31.60±.67^{a}$	$29.36±.20^{a}$	$30.82±.42^{a}$
Economic efficiency (%)	$44.46±.28^{d}$	$48.21±2.25^{d}$	$55.41±.85^{c}$	$68.36±1.39^{ab}$	$64.59±.58^{b}$	$69.79±.81^{a}$
Performance index (%)	$146.67±.71^{b}$	$145.29±4.54^{b}$	$149.40±1.67^{b}$	$164.56±2.84^{a}$	$148±.99^{b}$	$147.87±1.52^{b}$

Values are expressed as mean ± SE. ^{abc}Means within same row with different superscript are statistically different at *P* < 0.05 according to Tukey's Honesty significant difference test.

Table 6. Some serum biochemical parameters of broiler (Cobb 500) fed graded levels of indomie waste meal

Trait studied	Experimental diets + groups					
	(T1)	(T2)	(T3)	(T4)	(T5)	(T6)
Total cholesterol (mg/dl)	$188.98±7.40^{c}$	$213.58±5.94^{bc}$	$220.48±6.77^{bc}$	$230.25±8.61^{b}$	$291.50±3.67^{a}$	$312.15±9.93^{a}$
Triglyceride (mg/dl)	$85.76±2.24^{c}$	$92.53±4.54^{c}$	$91.87±0.79^{c}$	$101.20±2.44^{bc}$	$118.40±8.09^{b}$	$308.75±6.09^{a}$
HDL (mg/dl)	$48.47±1.13^{a}$	$51.67±1.07^{a}$	$51.68±1.64^{a}$	$53.65±2.88^{a}$	$38.65±0.65^{b}$	$34.68±1.86^{b}$
LDL (mg/dl)	$92.40±1.95^{c}$	$107.22±4.47^{c}$	$111.56±4.04^{c}$	$112.40±5.74^{c}$	$219.54±7.67^{b}$	$251.90±9.73^{a}$
Total protein (g/dl)	$5.08±0.10^{a}$	$4.71±0.10^{ab}$	$4.21±0.16^{b}$	$4.22±0.29^{b}$	$2.58±0.06^{c}$	$2.58±0.18^{c}$
Albumin (g/dl)	$3.68±0.05^{a}$	$3.27±0.04^{ab}$	$3.49±0.20^{a}$	$2.98±0.16^{b}$	$2.01±0.01^{c}$	$1.98±0.05^{c}$
Globulin (g/dl)	$3.85±0.04^{a}$	$2.70±0.24^{b}$	$2.53±0.30^{b}$	$2.92±0.02^{b}$	$1.49±0.02^{c}$	$1.49±0.04^{c}$
ALT (u/l)	$13.78±1.31^{e}$	$21.78±0.76^{d}$	$43.61±1.19^{c}$	$48.69±0.54^{bc}$	$51.31±0.87^{ab}$	$56.4±2.19^{a}$
AST (u/l)	$180.33±10.95^{d}$	$214.23±5.59^{cd}$	$255.13±15.39^{bcd}$	$285.35±36.81^{abc}$	$351.5±31.49^{ab}$	$376.48±13.66^{a}$
Creatinine (mg/dl)	$0.32±0.01^{d}$	$0.34±0.01^{d}$	$1.30±0.09^{c}$	$1.75±0.03^{b}$	$2.95±0.06^{a}$	$2.75±0.08^{a}$
Urea (mg/dl)	$16.93±1.15^{e}$	$18.44±1.01^{de}$	$26.55±1.79^{cd}$	$30.75±2.78^{c}$	$46±2.68^{b}$	$64±1.58^{a}$
Uric acid (mg/dl)	$4.72±0.05^{bc}$	$4.6±0.11^{bc}$	$4.29±0.10^{c}$	$5.29±0.08^{b}$	$7.15±0.16^{a}$	$7.61±0.30^{a}$
Glucose (mg/dl)	$189.18±3.77^{c}$	$185.13±13.72^{c}$	$299.23±12.01^{b}$	$322.63±3.67^{ab}$	$334.15±3.69^{ab}$	$348.83±2.78^{a}$

Values are expressed as mean ± SE. ^{abc}Means within same row with different superscript are statistically different at *P* < 0.05 according to Tukey's Honesty significant difference test

Discussion

Our results revealed that birds fed 60% IWM showed significant increase in the final BW and average BW gain and a significant improved FCR. This may be due to better feed utilization. This result was in agreement with the finding of Ogbonna [35] and Akinmutimi [7] who reported that the lower the feed to gain ratio, the better the feed conversion ratio. The feed consumption decreased as the level of IWM increased in the diet and this is because the high energy level of IWM and it is well known that birds eat to satisfy their energy need [36]. These findings were supported by those from previous studies [15, 37] that IWM could replace maize with 50% without any adverse effect on performance of the bird. Meanwhile, Akinola and Ekine [38] reported that birds fed 25% indomie waste meal had better performance.

The obtained results revealed that non-significant differences were found in weight percentages of dressing, spleen, heart, and bursa relative to the live body weight between all experimental groups in comparison with the control one. The mean percent of gizzard ranged from 1.88 (T6) to 2.71% (T1). These results were in agreement with the findings previously reported [37]. The lowest mean percent value of liver was recorded in T4 group (1.91%). There was a significant increase in the abdominal fat % as indomie waste increased in the diet. The group fed 100% IWM has the highest value of abdominal fat percent (3.36%). This could be attributed to the high calories of IWM.

The pancreas is the major organ responsible for amylase, protease, and lipase production and release. A meal bolus stimulates the release of these vital enzymes as it goes through the digestive tract, allowing for the effective breakdown of carbs, proteins, and lipids into smaller particles that can be absorbed later in the digestive process and utilized throughout the body [39]. Our results showed that there was a significant increase in the amylase and lipase activities and a significant decrease in the protease activity as indomie waste meal increased in the diet. The explanation of these findings is the composition of IWM that characterized by high carbohydrates and fats. As there were limited studies in this point, the aim of this step was to ensure that indomie waste had no anti-nutritional factors that may affect on the digestive process.

It was known that the replacement will be more effective whenever the price of maize per kilogram is higher than that of indomie waste. At the time of the experiment, the price of indomie is 3 L.E per kilogram of ton while that of maize is 4.68 L.E per kilogram of ton. Similarly, McNab and Shannon [40] and Nworgu and Egbunike [41] reported that there is a need for a dietary formulation that may be employed as an alternate, non-competitive, readily available, and inexpensive element in chicken diets to partially replace conventional energy and protein feed stuffs.

There was significant ($P < 0.05$) decrease in the feed cost and total cost (TC) recorded as IWM increase in the diet from 0-100%. There was a remarkable increase in the economic efficiency; the group fed 100% IWM recorded the highest economic efficiency value. This in agreement with Akinola and Ekine [38] who studied the numerical value of the feed cost/treatments and showed that the 100% indomie waste inclusion was the least expensive, while the control diet was the most expensive feed. This could be attributed to the cheaper cost of indomie waste compared to maize. However, Omoikhoje *et al* [13] indicated that the inclusions of IWM in the diet up to 50% reduce cost and increase the return. Also, Omole *et al* [42] reported that the diet contained 75% IWM had the lowest cost/weight gain and this was declared by several authors when conventional feed ingredients were substituted by less expensive unconventional feed ingredients [43- 45].

The serum cholesterol level was increasing with the level of IWM inclusion in the diet with the highest value for the 100% IWM and the least value for the control group. This is attributed to the high energy value of IWM. This result is similar to the findings that were found in previous studies [8, 46 and 47], while Alabi and Ayoola [37] recommended using of IWM at 50% to control the cholesterol level of the serum. Reports have shown that serum triglycerides of birds are strongly affected by nutrition, heredity, age, sex, and environmental conditions [48].

Triglyceride levels were non-significantly different between the control and other groups up to 60% followed by 80% IWM. All these values were within the normal range of less than 150 mg/dL. The highest value was recorded with 100% IWM. While, Yakubu *et al* [46] showed that birds fed diet contained 75% IWM have the highest value of triglyceride. The high level of triglyceride indicates an increase in low density lipoproteins. Higher value of HDL is good as birds fed diet contain 60% IWM showed the highest numerical value (53.65 mg/dL). There were non-significant differences between the control group and T2, T3, and T4 groups, indicating the normal level of HDL. The low levels of HDL in T5 and T6 groups that fell below the normal /undesirable range (< 40 mg/dL) indicates the risk of heart disease. Therefore, it was recommended that indomie waste meal can replace maize up to 60%. Similar values of LDL of birds were recorded in the control group and T2, T3, and T4 groups that were near the optimum range (100- 129 mg/dL) but the highest values were recorded with T5, T6 groups.

Our results of protein profile revealed a non-significant difference (P>0.05) between T2 and the control group. The explanation of these results about protein is the composition of IWM that characterized by high carbohydrates, fat and low protein. Omole *et al*. [42] revealed that the similarity in serum albumin, creatinine, urea, and total protein implied that there was normal protein metabolism. As a result there was a significant increase (P < 0.05) in liver enzymes AST and ALT in a level dependent manner with increasing IWM in the diet. But, Akinola and Etuk [49] mentioned that the uniformity in the levels of AST and ALT showed that there was no liver damage caused by toxicity of dietary substances. Creatinine, urea, uric acid, and glucose showed non-significant differences between T2 compared to the control group.

Conclusion

The overall findings of this study clearly show that inclusion of indomie waste meal up to 60% in the diet had no negative impact on the health of the birds. Attention should be taken while incorporating IWM above this amount to avoid any adverse effect.

Conflict of interest

None of the authors have any conflict of interest to declare.

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الملخص العربي

تأثير استبدال الذرة بمستويات متدرجة من وجبة نفايات إندومي على الأداء ، وصفات الذبيحة ، والتكلفة ، ومعايير الدم لدجاج اللاحم

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تم إجراء دراسة تغذية مدتها ستة أسابيع لتقييم آثار المستويات المتدرجة لوجبة نفايات الإندومي (IWM) كبديل للذرة في غذاء الدجاج اللاحم على أداء النمو ، وخصائص الذبيحة ، وكفاءة التكلفة ، وأنشطة الإنزيمات الهضمية ، و المعاملات البيوكيميائية في الدم. تم استخدام مائة وعشرون ذكرًا من كتكوت اللاحم كوب 500 يبلغ من العمر يومًا واحدًا. تم وزن الطيور وتوزيعها على ست مجموعات معالجة متساوية على النحو التالى: المجموعة الاولى (0% وجبة نفايات الاندومى) ، المجموعة الثانية (20% وجبة نفايات الاندومى)،المجموعة الثالثة (40% وجبة نفايات الاندومى)، المجموعة الرابعة (60% وجبة نفايات الاندومى)، المجموعة الخامسة (80% وجبة نفايات الاندومى)و المجموعة السادسة (100% وجبة نفايات الاندومى) بتصميم عشوائي تمامًا. كل مجموعة تحتوي على خمس مكررات وكل مكرر يحتوي على أربعة فراخ. أظهرت نتائج أداء النمو أن زيادة وزن الجسم كانت أعلى معنويا (P <0.05) في الطيور التي تغذت على 60٪ وجبة نفايات الاندومى (2663جم / طائر). انخفض تناول العلف تدريجياً مع زيادة وجبة نفايات الاندومى في النظام الغذائي. كانت نسبة التحويل الغذائي(1.65) أقل معنوياً (P <0.05) في الطيور التي تغذت 60٪ وجبة نفايات الاندومى. تبين أن الوزن النسبي للقوانص والكبد والأمعاء ودهون البطن تأثر معنويا (P <0.05) بالتضمين الغذائي لوجبة نفايات الاندومى. أعلى قيمة مسجلة للدهون البطنية كانت (3.36) في المجموعة التي تم تغذيتها بنسبة 100٪وجبة نفايات الاندومى . أقل قيمة مسجلة للكبد كانت (1.91) في المجموعة التي تمت تغذيتها بنسبة 60٪ وجبة نفايات الاندومى . أظهر تحليل التكلفة والعائد أن تكلفة العلف انخفضت بسبب زيادة وجبة نفايات الاندومى في النظام الغذائي. كان إجمالي العائد وصافي الربح أعلى معنوياً في الطيور التي تمت تغذيتها بنسبة 60٪ وجبة نفايات الاندومى . أيضا كان هناك تحسن في أنشطة أنزيمات الجهاز الهضمي البنكرياس مع إدراج النظام الغذائي وجبة نفايات الاندومى .كانت هناك زيادة معنوية في أنشطة الأميليز والليباز مع انخفاض معنوي في نشاط الأنزيم البروتيني. كانت هناك زيادة كبيرة في الكوليسترول الكلي مع زيادة وجبة نفايات الاندومى الغذائية. بناءً على نتائج الدراسة ، يوصى باستخدام وجبة مخلفات الإندومي لتحل محل الذرة بنسبة تصل إلى 60٪ في النظام الغذائي للدجاج اللاحم.