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Effect of Toasting Time of Full-Fat Soyabean in Diets on Performance and Cost-Benefit of Broiler Chickens

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ABSTRACT

This study evaluated the effect of the toasting time of full-fat soyabean (FFSB) used in diets on the performance of broiler chickens, with emphasis on growth performance, carcass characteristics, and cost-benefit. One hundred and fifty (150) broiler chickens were fed diets containing full-fat soyabean, which was toasted at a constant temperature of 130 ℃ at different time durations 30,35,40, and 45 minutes, represented as T2, T3, T4, and T5, respectively. Each treatment had 3 replicates, and each replicate had 10 birds assigned in a completely randomized design (CRD). Feed and water were supplied ad libitum, and the trial lasted for 8 weeks. Results for growth performance showed that toasting time significantly influenced nutrient availability and absorption, which in turn affected the performance of broiler chickens. Birds fed diets containing FFSB toasted for 40 minutes(T4) exhibited superior weight gain (1573.00g), improved FCR (2.54), and better carcass traits, such as percentage breast (24.20 %), when compared to those fed T2, T3, and T5 diets. The treatments had an increasing effect on some carcass parts, such as the breast and thigh muscle). The cost-benefit analysis showed T4 with the highest profit (₦2869.20) accrued with birds fed T4, as well as return to naira invested (RNI) of ₦0.54 and a benefit-cost ratio (BCR) greater than one (1) (₦1.54). The optimal toasting condition was determined to be 40 minutes at 130 ℃, which achieved the best balance between deactivating antinutritional factors (ANF) and nutrient preservation. These findings highlight the importance of precise thermal processing of FFSB before use in broiler chicken diets and suggest that careful control of toasting conditions can maximize growth performance, carcass yield, and enhance economic benefits. It is therefore concluded that FFSB should be toasted for 40 minutes to give optimal balance between deactivating ANF and denaturing of amino acids, which will increase growth performance and enhance cost-benefit.

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INTRODUCTION

The poultry enterprise remains a significant contributor to Nigeria's GDP. It is an important sector of the economy that provides employment and supports the livelihoods of an estimated 65% of Nigerians (Endacott *et al*., 2021). Broiler production plays a significant role in this industry, with global annual output expected to reach 105.26 million metric tons in 2023 and a growth rate of 1.73 % from 2019 to 2023 (Research and Markets, 2019). The main goal of broiler production is to produce meat and meat-based products (Maharjan *et al*., 2021). According to Ahaotu *et al*. (2017), modern poultry production was introduced in Nigeria in the late 1950s when it became clear that cattle expansion could not meet the increasing demand for meat. In 2022, the poultry bird population was 249 million,

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compared to 300 million in Egypt, the leading country in Africa (Statista, 2023).

Poultry feed alone makes up about 70 % of the total production cost (Etuah *et al*., 2021). Erratic changes in feed material prices often force feed manufacturers to alter formulas to maintain reasonable gross margins (Edache *et al*., 2018). Over time, this has caused significant financial losses to farmers, hindering the poultry industry (Dutta *et al*., 2020). This is because high-quality feeds are essential for poultry production to stay competitive and keep growing to meet the demand for animal protein (Ravindran, 2013).

Soyabean is the principal protein source for monogastric animals. It accounts for two-thirds of the world's total protein feedstuffs, including all other major oil meals and fish meal (Oil World, 2010). It is widely accepted that raw soyabean (SB) cannot be used in broiler diets because it contains various anti-nutritional factors, such as trypsin and protease inhibitors, which negatively affect the overall growth performance of birds (Ebrahimi-Mahmoudabad and Taghinejad-Roudbaneh, 2011). To maximize protein quality while effectively inactivating the anti-nutritional factors in full-fat soyabean, the meal must be processed at optimal heating temperatures (Ari *et al.,* 2017).

Given the nutritional significance of soyabean in non-ruminant diets, this study investigates how including toasted full-fat soyabean for various durations (30,35,40, and 45 minutes) at a constant temperature of 130 °C affects the growth performance and cost-benefit of broiler chickens. The goal of this study is to determine the exact duration of toasting full-fat soyabean to help maintain a balance between the reduction of anti-nutritional factors and the denaturing of amino acids in soyabean.

METHODOLOGY

Study Area

The experiment was conducted at a poultry house located at JI 145 Owner's Occupier Housing Estate, at Latitude 7.8◦ N and Longitude 6.8◦ E, along Jeo Nyam Street, Makurdi, Benue State. The climate is classified as a tropical wet and dry (savanna) climate, with an average rainfall of approximately 1,217mm, and the annual humidity is around 77 % -80 %.

Experimental Birds and Management

A total of one hundred and fifty (150) day-old chicks, CHI meat strain birds purchased from Ibadan, were used for the experiment. Chicks were kept under similar hygienic and environmental conditions and vaccinated against Gumboro and Newcastle disease; antibiotics and multivitamins were administered to the birds in their right quantity. The drinkers and feeders were kept clean daily. The entire building was neatly swept and dirt thrown far from the poultry pen, the foot dip was replaced often, and disinfectant was added to the water. The birds were fed *ad libitum*. Water was provided *ad libitum* throughout the experimental period. Dry litter, proper ventilation and about 23 hours lights was provided; careful monitoring of chicks' behaviour was ensured to avoid huddling.

Experimental Design

The study was conducted using a Completely Randomized Design (CRD). The 150 broiler chickens were randomly assigned to five (5) dietary groups of thirty (30) birds each, which were replicated into three groups with ten (10) birds per replicate.

Preparation of Test Ingredient

Soyabean, which served as the major protein source, was properly cleaned to remove dirt. A locally constructed digital oven with four chambers and a 20 x 28 iron tray was used to toast the already cleaned soyabeans to a crisp at a constant temperature of 130 °C; the oven was first preheated to a temperature of 140 °C; a 10 °C increment was done to manage toasting errors before the introduction of 2kg of soyabean per tray into the oven.

Soyabean was toasted at varying times according to treatments: Treatments 2, 3, 4, and 5 (T2, T3, T4, and T5) were toasted for 30, 35, 40, and 45 minutes, respectively. After toasting, they were air-dried, then ground into fine grits and bagged. The quantity of ingredients remained

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constant from T2-T5;(maize 53 %, FFSB 31 %, Rice bran 7 %, Blood meal 6 %, Bone meal 2.5 %, Salt 0.25 % and Vitamin premix 0.25 %). Metabolizable Eneregy kcal/kg (T1;2900.50, T2-T5; 3164.00) Crude protein (T1; 21.75 %, T2-T5; 21.66 %).

Micro and macro ingredients were mixed in adequate proportion to meet the nutrient requirements of the broiler chickens; The compounded feeds were properly stored after bagging in an airy space to avoid mold. Five experimental diets were compounded, which were designated as T1, serving as the control, and contained maize (60 %) and soyabean meal (24 %) as the main protein source without toasted full-fat soyabean. Diet 2, designated T2; Diet 3 as T3; Diet 4 as T4; Diet 5 as T5, containing full-fat soyabean toasted for 30, 35, 40, and 45 minutes at 130°C, respectively.

Data Collection

Data on feed intake, body weight gain, and feed conversion ratio were collected. Feed intake was determined by taking the difference between the feed quantity offered and the leftover. Body weight gain was determined by taking the difference between the initial body weight and the final weight. The feed conversion ratio was calculated by dividing the body weight gain by total feed intake. Carcass analysis was carried out using three (3) birds selected at random from each replicate. The birds were starved of feed for 12 hours, after which they were weighed individually, slaughtered, plucked, and eviscerated. Dressing percentage was determined using the relationship: Dressing % = Carcass weight/Live weight X 100. Total cost of production was calculated based on the prevailing price of feed ingredients at the time of the experiment. Profit was calculated as revenue less cost.

Statistical Analysis

All data collected were subjected to one-way Analysis of Variance (ANOVA) using the Statistical Package for the Social Sciences (SPSS) version 22.3. Duncan's multiple range test was used to separate means.

RESULT AND DISCUSSION

Growth performance

The result in Table 1 showed that there were no significant ($p>0.05$) differences in the initial body weight (IBW) among treatment groups (T1–T5), implying that all birds started with similar weights (approximately 34.99 g –36.24 g). The lack of significant variation in initial body weights of broiler chicks is crucial for a well-designed study. It shows that all treatment groups began the experiment with a comparable population of chicks, ensuring fairness.

Methodologically, this is important because it confirms that any subsequent differences in growth are due to the dietary treatments, such as different soyabean toasting times, rather than initial weight differences. Significant differences were observed in final body weight (FBW), total weight gain (TWG), daily weight gain (DWG), and feed conversion ratio (FCR) ($p < 0.05$). Birds in T4 recorded the highest (1573.00 g) performance across the treatment groups in final body weight. Maidala *et al*. (2019) observed significantly higher final body weights in broilers fed thermally processed soyabean diets (toasted) compared to raw or inadequately processed forms.

Table 1: Performance of Broiler Chickens Fed Diets containing Full-Fat Soyabean Toasted at Different Time Durations (0-56 days)

Parameter (g)	T1 (Control)	T2 (30min)	T3 (35min)	T4 (40min)	T5 (45min)	SEM	P-Value	LS
IBW	35.33	34.99	35.66	36.24	35.46	0.201	0.417	NS
FBW	1430.00^{b}	1202.00^{c}	1251.33^{c}	1573.00^{a}	1183.33^{c}	42.448	0.000	*
TFI	3978.00	3966.46	3946.23	3908.23	4026.67	15.269	0.151	NS

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Parameter (g)	T1 (Control)	T2 (30min)	T3 (35min)	T4 (40min)	T5 (45min)	SEM	P-Value	LS
ADFI	71.04	70.82	70.46	69.78	71.89	0.272	0.151	NS
TWG	1394.67^{b}	1167.00^{c}	1215.67^{c}	1536.75^{a}	1146.86^{bc}	42.361	0.000	*
ADWG	49.80^{b}	41.67^{c}	43.41^{c}	54.88^{a}	40.99^{c}	1.512	0.000	*
FCR	2.85^{b}	3.46^{a}	3.24^{a}	2.54^{c}	3.51^{a}	0.106	0.000	*

abc = means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error of Mean. IBW: Initial Body Weight, FBW: Final Body Weight, TFI: Total Feed Intake, ADFI: Average Daily Feed Intake, TWG: Total Weight Gain, ADWG: Average Daily Weight Gain, FCR: Feed Conversion Ratio.

Carcass characteristics

The analysis of the carcass characteristics in Table 2 reveals that the live weight (LVW) and plucked weight (PLKWT) of birds in treatments T2(1113.67g), T3(1178.00g), and T5(1106.33g) were comparable. However, these groups differed from the control group T1(1363.33g) and treatment T4(1490.00g), which recorded the highest weights. Similarly, the eviscerated weight (EVISWT) of birds in T1 (1176.67g) and T4 (1256.67g) was similar and notably higher than that in T2, T3, and T5. Interestingly, the dressed weight (DWT) for birds in T4 (1154.67g) was the highest among all treatments. The birds fed T4 exhibited a higher breast meat yield of 24.20 %. he results agree with recent literature highlighting the impact of dietary composition on meat yield and quality traits in poultry, according to Edward (2000) and Ojedapo (2013). These findings emphasize the importance of dietary factors in determining carcass traits and overall meat yield in poultry production systems (Oluwadele *et al.,* 2025).

Table 2: Carcass Characteristics of Broiler Chickens Fed Diets Containing Full-Fat Soyabean Toasted at Different Time Durations

Parameter	T1 (Control)	T2 (30min)	T3 (35min)	T4 (40min)	T5 (45min)	SEM	P-Value
Live weight(g)	1430.00^{b}	1185.33^{c}	1251.33^{c}	1573.00^{a}	1183.33^{c}	43.563	0.000
Plucked Weight(g)	1363.33^{b}	1113.67^{c}	1178.00^{c}	1490.00^{a}	1106.33^{c}	43.019	0.000
Eviscerated Weight(g)	1176.67^{a}	945.33^{b}	1003.00^{b}	1256.67^{a}	936.67^{b}	36.41	0.000
Dressed weight(g)	1003.00^{b}	856.33^{b}	908.00^{bc}	1154.67^{a}	851.00^{c}	34.746	0.003
Relative weight: Dressing %	70.00	72.23	72.54	73.56	71.92	0.970	0.880
Head %	4.17	4.00	3.83	3.61	4.11	0.857	0.231
Neck %	8.52	7.47	8.30	7.86	7.88	0.184	0.460
Wings %	12.76^{c}	12.39^{c}	17.97^{ab}	16.70^{b}	19.52^{a}	0.787	0.000
Breast %	19.62^{b}	16.88^{bc}	19.92^{b}	24.20^{a}	15.31^{c}	0.892	0.001
Back %	15.18^{b}	14.62^{b}	15.38^{b}	16.56^{b}	19.03^{a}	0.507	0.014
Thigh %	17.32^{a}	14.67^{c}	15.25^{bc}	16.84^{ab}	15.85^{ab}	0.330	0.030
Drum Stick %	13.71	14.24	13.85	14.18	13.82	0.200	0.925
Shank %	7.20^{a}	6.39^{ab}	6.66^{ab}	5.22^{c}	5.96^{bc}	0.209	0.007

abc; means in the same row with different superscripts are significantly different (P<0.05).
SEM: Standard Error of Mean, Dressing percentage (calculated as a percentage of Live weight).

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Cost-Benefit Analysis

The results of the economic analyses is presented in Table 3. This study found that broiler chickens fed diets containing full-fat soyabean toasted for 40 minutes (T4) produced superior economic outcomes (highest profit, BCR, and return to naira invested), while sub-optimal roast times (35 min in T3) were least favorable. -It is worth of note that a benefit cost ratio (BCR) which is greater than one (1) signifies viability of an enterprise. However, all treatment recorded BCR greater than one (1) implying that, no losses will be incurred when these treatments are used in broiler chicken production. Return to naira was highest with birds served full-fat soyabean toasted for 40 minutes (0.54) this implies that, for every ₦1.00k invested, 0.54k will be gained in return.

Table 3: Cost-Benefit Analysis of Broiler Chickens Fed Diets Containing Full-Fat Soyabean Toasted at Different Time Duration

Expenditure (₦)	**T1**	**T2**	**T3**	**T4**	**T5**
	(Control)	(30min)	(35min)	(40min)	(45min)
Cost of birds at day old	1000	1000	1000	1000	1000
Cost of feed consumed(1-8 weeks)	3600	4288.2	5034.4	3880.8	2900.8
Cost of transportation	150	150	150	150	150
Cost of medication	200	200	200	200	200
Miscellaneous	100	100	100	100	100
TVC	5050	5738.2	6484.4	5330.8	4350.8
Sales of birds(₦/kg)	7500	7000	7000	8000	6000
Sales of chick dropping(₦/kg)	200	200	200	200	200
TR	7700	7200	7200	8200	6200
Profit: TR -TVC	2650	1461.8	715.6	2869.2	1849.2
BCR = TR/TVC	1.52	1.25	1.11	1.54	1.43
RNI = Profit/TVC	0.52	0.25	0.11	0.54	0.43

Benefit cost ratio, RNI -Return to naira invested, TR- Total revenue, TVC– Total Variable Cost

CONCLUSION AND RECOMMENDATION

Based on the findings of this study, broiler chickens fed diet T4, containing full-fat soyabeans toasted at 40 minutes at a temperature of 130 °C is superior in performance and profitable than other diets. Therefore, diet T4 is recommended for broiler chicken producers in the study area.

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