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EFFECT OF REPLACING MAIZE WITH SOLID WASTE PRODUCT OF SUGAR INDUSTRY ON GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY AND ECONOMICS OF PRODUCTION OF BROILER CHICKENS

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ABSTRACT

This Research was conducted to evaluate the effect of replacing maize with solid waste product of sugar industry on growth performance, nutrient digestibility and economics of production of broilers chickens. The experimental diets were formulated such that SWAPSI replaced maize at 0% (control), 20%, 40%, 60% and 80% serving as T, T2, T3, T4 and T5 respectively. The diets were compounded to be 2800 and 3000kcal/kg ME and 23 and 20%CP for both starter and finisher phases respectively. Four hundred day old chicks were distributed randomly among five diets, with 80 birds per diet that were replicated 5 times, each with 16 birds in a completely randomized design. Data were collected on growth performance, nutrient digestibility, and economics of production. These data were analyzed using the One-Way Analysis of Variance (ANOVA) in the SPSS statistical software. The results show that animals fed T1 and T2 had the highest growth performance at both phases, with better feed conversion ratio compared to T3, T4 and T5. Chickens fed T1 and T2 exhibited the highest crude protein content digestibility for both phases.. Cost of feed per kilogram weight gain was higher at T5 (₦3003.63/bird) than the other treatments. Birds fed diet containing 20% SWAPSI gave higher gross margin of ₦2011.87. The inclusion of SWAPSI from 20-80% decreases all values because SWAPSI increase in the diet without causing damage to the birds. It also decreased total costs while improving gross margins by 20%. SWAPSI meal is recommended at 20% for maximum growth and economic rewards.

Key words: Growth Performance, Digestibility, Economics, Production, Broiler

INTRODUCTION

The consumption of animal protein is essential in meeting the nutritional protein requirement of man (De Vries-Ten Have *et al.,* 2020). The intake of animal protein at present in Nigeria is about 4.82g per caput per day as against the minimum requirement of 35g as recommended by FAO. Livestock provides major sources of income for disadvantaged populations in developing countries and also provides a major entry point to fight against rural poverty (Smith *et al*., 2013). The unprecedented increase in the cost of conventional ingredients used in compounding livestock feeds has necessitated intensive studies into the use of agro-based industrial by-products (Thani *et al*., 2018).

The solid waste products from the sugar industry, such as bagasse and press mud, have the potential to be used as alternative feed ingredients in broiler chicken diets (Raza *et al.*, 2021). Replacing a portion of the maize in broiler diets with these sugar industry byproducts could provide several benefits. Studies have shown that partially replacing maize with sugar industry waste products can maintain or even improve the growth rate and feed conversion efficiency of broiler chickens. The fiber and nutrient content of these byproducts can positively influence the birds' gut health and nutrient utilization (Raza *et al.*, 2021). The fiber, protein, and mineral content of sugar industry wastes may enhance nutrient digestibility in broilers when used to replace maize. Proper processing and formulation can optimize the nutritional value of these alternative ingredients (Ibrahim and Workneh, 2023). Using locally available sugar industry byproducts as feed can reduce the reliance on imported maize, potentially lowering feed costs and improving the overall economics of broiler production (Krishnaveni *et al*., 2020). This can make broiler farming more profitable for smallholder farmers.

It is against this background that this research was employed to evaluate the effect of replacing maize with solid waste products of sugar industry (SWAPSI) on the growth performance, nutrient digestibility and economics of production of broiler chickens**.**

MATERIALS AND METHODS

Location of the study

The experiment was conducted at the Livestock Complex of the Department of Animal Science, College of Agricultural Science and Technology (COAST), situated on Doma Road, Tudun-Amba, Lafia, Nasarawa State. The farm is located in the Southern Guinea Savannah Zone, in the middle belt of Nigeria, at coordinates Latitude 8°35'N and Longitude 8°33'E. The area experiences an average minimum temperature of 23°C and a maximum temperature of 36.9°C. The average monthly relative humidity is around 74%. The annual average rainfall measured 823 mm during the experimental period with an average monthly temperature of 35.06°C. Temperature, humidity, and precipitation data were sourced from the Weather Station of the Faculty of Agriculture, Nasarawa State University, Keffi, Shabu Lafia Campus (Faculty Weather Station, 2022).

Sources of experimental feed ingredients and processing

Solid waste product of sugar industry (SWAPSI was sourced from Dangote Sugar Processing Industry in Numan Local Government Area of Adamawa State. The

SWAPSI collected, were sun dried for 2 -3 days to reduce the moisture content and avoid the growth of fungus and rancidity. The SWAPSI was grinded to produced SWAPSI meal. Other ingredients were purchased from Global Feedmill, Karu, Nasarawa State, Nigeria.

Experimental design and management of experimental birds

The experiment was carried out in a Completely Randomized Design (CRD). A total of 400-day old broilers chicks were used for the experiment. Prior to arrival, the pen was clean and disinfected. Upon arrival birds were administered anti stress and supplementary heat was provided for a period of 3weeks.The birds were randomly allocated to the five dietary treatments at 80 birds per treatment and 16 birds per replicate. All the birds were given equal weight of dietary treatments daily; while water was provided *ad libitum. S*tandard routine management practices were adopted as described by Oluyemi and Roberts (2000).

Proximate composition of SWAPSI

Proximate composition such as crude protein, dry matter, ether extract, crude fiber and nitrogen free extract of SWAPSI were determined using the procedure outlined by AOAC (2002).

Table 1: Proximate composition of SWAPSI meal

Parameters (%)	Values
Crude protein	7.16
Ether extract	5.62
Crude fibre	21.06
Ash	4.12
Moisture	4.13
*NFE	57.91
**Energy (kcal/kg, ME)	2778.51

*(AOAC, 2010) calculated using NFE = 100- sum of (CP + EE + CF + ash + M),
** (Pauzenga, 1985) as calculated.

Experimental diets for broiler starter phase (Day old – 28 days)

The SWAPSI replaced maize varying level which was used as treatments. These include: 0% Control (T_1), 20% (T_2), 40% (T_3), 60% (T_4), and 80% (T_5) inclusion. The treatments were compounded to suit the nutrient requirements of broiler chicks. Other ingredients were included at the recommended levels to meet the nutrient requirements of the birds. The diet composition is shown in Tables 2 and 3. The requirement for poultry feeds was achieved using the following recommendation by NRC (2007).

Data collection

The experiment lasted for 8 weeks and data on growth performance, nutrient digestibility, and economics of production were taken and recorded at both starter and finisher phases.

Growth performance (starter and finisher phases)

The growth performance of the starter chicks were assessed using the following parameters as described by Sani *et al.* (2021).

Weekly body weight: This was obtained by weighing the birds every 7 days using weighing scale.

Body weight gain: This was measured by the difference between the final weight and the initial weight of the animal.

Feed intake: The birds were allocated a weighed amount of feed daily and their corresponding left over weighed and recorded. Daily feed intake was measured as the difference between the amount of feed fed and the leftover.

Feed conversion ratio: - This was calculated as the ratio of feed intake to body weight gain.

$$\text{FCR} = \frac{\text{feed intake (g)}}{\text{Body weight gain (g)}}$$

Protein efficiency ratio (PER): - This was determined as the ratio of gain in body weight to the protein consumed.

Protein intake: This was calculated as feed intake x percentage protein in the diets.

Nutrient digestibility (starter and finisher phases)

The experiment involved two birds per treatment, placed in digestibility cages for five days. Feeders and drinkers were improvised, and a 5-day faecal collection period was adopted, with daily weighing and oven-drying. The faecal samples collected daily from each replicate were bulked, ground, and thoroughly mixed to create a homogenous mixture at the end of the collection period. Samples of the faeces were taken for proximate analysis according to the method outlined by AOAC (2002). Nutrient digestibility was determined using the formula:

Apparent nutrient digestibility coefficient =

$$\frac{\text{Nutrients in feed} - \text{nutrients in faeces}}{\text{Nutrients in feed}} \; x\ 100$$

Finisher phase (28 – 56days old)

At the end of the 4th week of feeding experiment, the birds were re-randomized and re-allotted to 5 treatment diets as in the case of the starter phase and finisher diets used for the feeding experiment and this was done to enhance the reliability and validity of experimental results.

Economics of production (starter and finisher phases)

The parameters of economics of production using SWAPSI for the starter phase include the following using the formulae as earlier reported by Alu *et al.* (2013):

Cost of feed per kilogram (N/kg): This was computed as the cost of the feed ingredient multiplied by the prevailing marketing price.

Cost of feed per unit weight gain: This was computed as the cost of feed consumed divided by a unit weight gain.

Cost of production: Cost of production is a sum total of all variable and fixed costs The cost of production was estimated as the product of cost per kilogram weight gain and mean total weight gain.

Statistical analysis

All data collected from growth performance, nutrient digestibility and economics of production were analyzed using a one-way analysis of variance (ANOVA) utilizing the General Linear Model in IBM SPSS version 20. Means with significant different were compared using Duncan's Multiple Range Test (DMRT) at a 95% confidence interval.

The following statistical model was employed:

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

Y_{ij} = individual observation

μ = population mean

T_i = Treatment effect

e_{ij} = Error effect

Table 2: Gross and chemical compositions of experimental diets for broiler Starter

Ingredients	**T1 0%**	**T2 20%**	**T3 40%**	**T4 60%**	**T5 80%**
Processed SWAPSI	0.00	8.00	16.00	24.00	32.00
Maize	40.00	32.00	24.00	16.00	8.00
Rice offal	17.00	15.00	15.70	16.00	14.00
Fish meal	6.50	6.00	5.00	6.00	5.00
Groundnut cake	28.50	32.00	33.00	24.00	29.00
Blood meal	1.50	0.50	0.50	5.00	3.00
Bone meal	2.00	2.00	1.00	3.00	2.00
Methionine	0.25	0.25	0.20	0.25	0.25
Lysine	0.25	0.25	0.20	0.25	0.25
**Premix	0.25	0.25	0.20	0.25	0.25
Common Salt	0.25	0.25	0.20	0.25	0.25
Palm oil	3.50	3.50	4.00	5.00	6.00
Probiotic[a]	+	+	+	+	+
Toxin binder[b]	+	+	+	+	+
Acidifier[c]	+	+	+	+	+
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated chemical and energy composition					
Energy (kcal/kg, ME)	2834.53	2801.71	2822.98	2803.30	2831.88
Crude protein (%)	23.25	23.43	23.24	23.15	23.17
Crude fibre (%)	4.83	4.35	4.85	4.46	4.85
Ether extract (%)	9.13	9.42	9.79	10.47	10.74
Ash (%)	6.51	6.42	6.77	5.25	5.00
Calcium (%)	1.22	1.83	1.00	1.81	1.47
Phosphorus (%)	0.84	1.13	0.54	0.81	0.66
Lysine (%)	1.24	1.27	1.38	1.64	1.54
Methionine (%)	0.62	0.63	0.88	0.95	0.92

**Premix supplied the following per 100kg of diet: vitamin A15,000 I.U, vitamin D3 300,000 I.U.,vitamin E 3,000 I.U., vitamin K 2.50mg, vitamin B_1 (thiamin) 200mg, Riboflavin (B_2) 600mg, pyridoxine (B_6), Niacin 40.0mg, vitamin B_{12} 2mg, Pantothenic acid 10.0mg, folic acid 100mg, Biotin 8mg, choline chloride 50mg, anti-oxidant 12.5mg, manganese 96mg, zinc 6mg, Iron 24mg, Copper 0.6mg, Iodine 0.14mg, Selenium 24mg, cobalt 214mg. Using Feedwin software version 1.01; + 50g/100kg added in the diets; a=probiotics provided Tanins 5.00g, Zeolite (HSCAS) 600.00g, Mannanolioosaccharides + Beta-glucans 350.00g, Calcium lactate 20.00g; b=toxin binder supplied Vitamins, Pro-vitamins, Betainne, Cynaraseolymus, Anti choke extrac, Toxin binder, Anti caking agent, Coagulantetits, Sodium, Calcium, Allumino silicate, Mycoplasma 2.5kg/MT; c=acidifier supplied the following Mycobinder, Levures 8.00%, Centre brute 1.00%, Protein brute 3.50%, Mg 0.60%, Materes 9.00%, Na 0.24%, Lysine 0.20%, CP 4.50%, CF 1.90%, Crude Fat 0.50% Crude Ash 77.00%, Methionine 0.05%, Cellulose brute 0.05%, Ca 5.06%.

Table 3: Gross and chemical compositions of experimental diets for broiler finisher

Ingredients	**T_1 0%**	**T_2 20%**	**T_3 40%**	**T_4 60%**	**T_5 80%**
SWAPSI	0.00	11.00	22.00	33.00	44.00
Maize	55.00	44.00	33.00	22.00	11.00
Rice offal	15.00	14.00	12.00	10.00	12.00
Groundnut cake	16.00	15.00	17.00	15.00	13.50
Bone meal	2.00	2.00	2.50	3.00	1.20
Blood meal	3.00	4.00	4.00	5.00	5.00
Methionine	0.25	0.25	0.25	0.20	0.20
Lysine	0.25	0.25	0.25	0.20	0.20
*Premix	0.25	0.25	0.25	0.20	0.20
Salt	0.25	0.25	0.25	0.20	0.20
Palm oil	3.00	4.00	5.50	6.00	6.00
Fish meal	5.00	5.00	3.00	5.20	6.50
Probiotics[a]	+	+	+	+	+
Toxin binder[b]	+	+	+	+	+
Acidifier[c]	+	+	+	+	+
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated chemical and energy composition					
Energy (kcal/kg, ME)	3027.34	3026.26	3034.74	3021.07	3012.65
Crude protein (%)	20.27	20.37	20.21	20.54	20.28
Crude fibre (%)	5.70	5.35	5.96	5.10	5.86
Ether extract (%)	8.04	9.12	9.72	9.29	9.56
Ash (%)	4.49	4.65	4.58	4.55	5.24
Calcium (%)	1.27	1.32	1.49	1.80	1.24
Phosphorus (%)	0.63	0.63	0.64	0.76	0.56
Lysine (%)	1.37	1.42	1.36	1.44	1.47
Methionine **(%)**	0.92	0.92	0.87	0.85	0.87

**Premix supplied the following per 100kg of diet: vitamin A15,000 I.U, vitamin D3 300,000 I.U.,vitamin E 3,000 I.U., vitamin K 2.50mg, vitamin B_1 (thiamin) 200mg, Riboflavin (B_2) 600mg, pyridoxine (B_6), Niacin 40.0mg, vitamin B_{12} 2mg, Pantothenic acid 10.0mg, folic acid 100mg, Biotin 8mg, choline chloride 50mg, anti-oxidant 12.5mg, manganese 96mg, zinc 6mg, Iron 24mg, Copper 0.6mg, Iodine 0.14mg, Selenium 24mg, cobalt 214mg. Using Feedwin software version 1.01; + 50g/100kg added in the diets; a=probiotics provided Tanins 5.00g, Zeolite (HSCAS) 600.00g, Mannanolioosaccharides + Beta-glucans 350.00g, Calcium lactate 20.00g; b=toxin binder supplied Vitamins, Pro-vitamins, Betainne, Cynaraseolymus, Anti choke extrac, Toxin binder, Anti caking agent, Coagulantetits, Sodium, Calcium, Allumino silicate, Mycoplasma 2.5kg/MT; c=acidifier supplied the following Mycobinder, Levures 8.00%, Centre brute 1.00%, Protein brute 3.50%, Mg 0.60%, Materes 9.00%, Na 0.24%, Lysine 0.20%, CP 4.50%, CF 1.90%, Crude Fat 0.50% Crude Ash 77.00%, Methionine 0.05%, Cellulose brute 0.05%, Ca 5.06%.

RESULTS AND DISCUSSION

The result for the effects of replacing maize with SWAPSI meal-based diets on growth parameters of broiler chicks is presented in Table 4. The result shows significant difference (P<0.05) in all the parameters except for initial weight of the chicks. Birds fed 0 and 20% SWAPSI had higher final weight, total weight gain, average weight gain/day, feed intake, protein intake, protein and energy efficiency ratio with better feed conversion ratio compared with 40, 60 and 80% SWAPSI included diets.

The improvements in birds fed 0 and 20% SWAPSI were an indication that birds fed 20% SWAPSI meal compete with birds fed 0% SWAPSI favourably. This observation is in agreement with Adedeji *et al.* (2021) who studied the effect of feeding graded levels of whole sugarcane waste in the diets of broilers and reported significant effects on final weight, daily feed intake, weight gain and feed to gain ratio. This also consistent with Nwosu *et al.* (2019) who stated that there was significant difference on the feed intake, weight gain and feed conversion ratio (FCR) of the broiler birds fed total sugarcane waste at different inclusion levels. However, the poor feed conversion ratio observed on birds fed 40, 60 and 80% SWAPSI included diets might be due to the fact that the birds were not able to convert SWAPSI meal in to flesh.

Table 4: Effects of replacing maize with SWAPSI meal-based diets on growth parameters of broiler chicks

Parameters	Replacement value of SWAPSI						
	T1 (0%)	**T2 (20%)**	**T3 (40%)**	**T4 (60%)**	**T5 (80%)**	**SEM**	**LOS**
Initial weight (g/bird)	47.13	45.43	48.53	46.60	46.80	1.63	NS
Final weight (g/bird)	707.80[a]	685.44[a]	486.28[b]	426.24[c]	317.40[d]	28.44	*
Weight gain (g/bird)	660.67[a]	640.01[a]	437.75[b]	379.64[b]	270.60[d]	27.61	*
Av. DWG (g/bird/day)	23.59[a]	22.86[a]	15.63[b]	13.56[c]	9.67[d]	0.98	*
Feed intake (g/bird)	45.99[a]	47.38[a]	36.30[c]	40.62[b]	36.37[c]	1.16	*
Feed conversion ratio	1.97[c]	2.08[c]	2.33[c]	3.02[b]	3.82[a]	0.20	*
Protein intake (g/bird)	10.58[a]	10.90[a]	8.35[c]	9.34[b]	8.36[c]	0.26	*
Protein efficiency ratio	1.03[a]	0.99[a]	0.68[b]	0.59[c]	0.42[d]	0.04	*
Energy efficiency ratio	23.59[a]	22.86[a]	15.63[b]	13.56[c]	9.67[d]	0.98	*

[abcd] = Means with the same letter are not significantly difference, Av = average, SEM = standard error of means, LOS= level of significant, Ns = Not significant, * = significant, P-value = 0.05, DWG = daily weight gain.

Table 5 shows the effects of replacing maize with SWAPSI meal-based diets on nutrient digestibility of broiler chicks. There was significant difference ($P<0.05$) across nutrient digestibility of broiler chicks. Dry matter digestibility depressed across the treatments from T1 to T5. Chicks fed 0 and 20% had higher crude protein (72.51 and 69.79% respectively) compared to 40, 60 and 80% SWAPSI (54.67, 44.70 and 44.89% respectively). Birds fed on 0 and 20% SWAPSI had higher crude fat digestibility than those fed 60 and 80% SWAPSI. Birds fed 40% had similar crude fibre digestibility with T1, T2 and T4 respectively. Birds fed on 0 and 20% SWAPSI had lower crude fibre digestibility than 40, 60 and 80% SWAPSI birds. Ash digestibility was better at 0% (47.86 %), 40% (46.95 %) and 80% (47.59%) compared with lower values at 60% (43.31%) and 20% (39.10%). Nitrogen free extract digestibility depressed across the treatments containing SWAPSI included diets from T1 to T5. T1 (0%) had better value of 56.51% compared to T2, 20% (53.34%) and other treatments diets.

The reduction in the dry matter digestibility could be due to the zero inclusion of SWAPSI in the diets. However, higher crude protein for birds fed on 0 and 20% SWAPSI compared to birds fed 40, 60 and 80% SWAPSI is an indication that higher inclusion of fibrous feed ingredients in chicks diet depressed digestion of nutrients. This is also in relation to low level of dry matter and crude protein in sugarcane. This observation is in agreement with the statement of Cruz *et al.* (2014) who suggested that, sugarcane is characterized by having low levels of dry matter, mineral, crude protein, and high fiber content. Similarly, Teixeira *et al.* (2021) studied the effect of crushed sugarcane on free-range chicken lines and reported similar statement. Similarly, The lower crude fibre digestibility in birds fed 0 and 20% SWAPSI agrees with the report of Nwosu *et al.* (2020) who studied nutrient digestibility of broiler birds fed sugarcane scrapping bark and reported no significant effect on digestibility coefficient of all the parameters measured except crude fibre and ash.

Table 5: Effects of replacing maize with SWAPSI meal-based diets on nutrient digestibility by broiler chicks

Parameters (%)	Replacement value of SWAPSI						
	T1 (0%)	**T2 (20%)**	**T3 (40%)**	**T4 (60%)**	**T5 (80%)**	**SEM**	**LOS**
Dry matter	93.89[a]	86.88[b]	81.75[c]	77.61[d]	68.56[c]	2.86	*
Crude protein	72.51[a]	69.79[a]	54.67[b]	44.70[c]	44.89[c]	4.02	*
Crude fat	35.07[a]	35.02[a]	32.60[ab]	28.51[b]	26.76[c]	1.33	*
Crude fibre	39.10[c]	39.11[c]	43.31[b]	46.95[a]	47.86[a]	1.25	*
Ash	47.86[a]	39.10[c]	46.95[a]	43.31[b]	47.59[a]	1.12	*
Nitrogen free extract	56.51[a]	53.34[b]	46.55[b]	42.79[c]	44.45[b]	1.78	*

abcd = Means with the same letter are not significantly different, Av = average, SEM = standard error of means, LOS= level of significant, Ns = Not significant, * = significant, P-value = 0.05

The results for the effects of replacing maize with SWAPSI meal-based diets on economics of production of broiler chicks are presented in Table 6. There was reduction in the cost of feed consumed and cost of production for birds fed SWAPSI meal based diets from 0 to 80% (₦546.73 to 326.81 /bird). However, there was improved revenue at T1 (₦1557.16) and T2 (₦1507.97) than other SWAPSI included diets. Similarly, T2 gave better gross margin (₦359.86) than T1 (₦350.68). T3 to T4 had poor gross margin (40.03, 19.84 and 11.72) Naira, respectively.

The reduction in the cost of feed consumed and cost of production for birds fed SWAPSI meal based diets from 0 to 80% which resulted to improved revenue and gross margin agrees with Alu *et al.* (2012) who reported that dietary fibre significantly improved daily feed intake, protein efficiency ratio and cost benefit parameters with reduction in feed conversion ratio.

Table 6: Effects of replacing maize with SWAPSI meal-based diets on economics of production of broiler chicks

	Replacement value of SWAPSI						
Parameters	**T1 (0%)**	**T2 (20%)**	**T3 (40%)**	**T4 (60%)**	**T5 (80%)**	**SEM**	**LOS**
CF(₦/ kg)	424.57	368.12	364.09	341.31	320.92	-	NA
CFC (₦/bird)	546.73[a]	488.36[b]	370.03[c]	388.14[c]	326.81[d]	11.86	*
CF/kg WG (₦/bird)	835.05[c]	764.36[c]	848.91[c]	1032.35[b]	1225.47[a]	69.82	*
CP (₦/bird)	1206.48[a]	1148.11[b]	1029.78[c]	1047.89[c]	986.56[d]	11.86	*
Revenue (₦)	1557.16[a]	1507.97[a]	1069.82[b]	1067.73[c]	998.28[d]	62.56	*
Gross margin (₦)	350.68[a]	359.86[a]	40.03[b]	19.84[c]	11.72[d]	64.79	*

abcd = Means with the same letter are not significantly difference, Av = average, SEM = standard error of means, LOS= level of significant, Ns = Not significant, * = significant, P-value = 0.05, CF= cost of feed per kg, CFC = cost of feed consumed, WG = weight gain, CP = cost of production.

Table 7 indicated the effects of replacing maize with SWAPSI on growth performance of broiler finisher chickens. There was significant difference (P<0.05) in all the growth performance parameters except for the initial body weight which ranged from 487.28- 559.92 g/bird. Birds fed on 0% SWAPSI gave higher values across all parameters followed by 20% SWAPSI (T2). However, feed conversion ratio values were similar throughout except for T5 with the poor FCR.

The significant improvement in all the growth performance parameters observed on birds fed on 0% SWAPSI followed by 20% SWAPSI (T2) was an indication that fibrous feed ingredients can compete favorably with normal diets. This suggests that dietary fibre significantly improved performance of birds' most especially daily feed intake and energy or protein intake. This agrees with Alu *et al.* (2022) who studied the growth response, nutrient digestibility and cost benefits of rabbits fed solid waste product of sugar industry and reported increase in the feed intake and protein intake of rabbits fed SWAPSI meal based-diets. However, feed conversion ratio values were similar throughout except for birds fed T5 with the poor FCR.

Table 7: Effects of replacing maize with SWAPSI on growth performance of broiler finisher chickens

	Replacement value of SWAPSI						
Parameters	**T1 (0%)**	**T2 (20%)**	**T3 (40%)**	**T4 (60%)**	**T5 (80%)**	**SEM**	**LOS**
Initial weight (g/bird)	559.92	487.28	514.00	506.36	545.60	108.96	NS
Final weight (g/bird)	1921.20[a]	1596.00[b]	1368.00[c]	1156.00[d]	952.40[e]	76.99	*
Weight gain (g/bird)	1361.28[a]	1098.72[ab]	854.00[bc]	649.64[cd]	406.80[d]	129.56	*
Av. WG/day (g/bird)	48.61[a]	39.24[ab]	30.50[bc]	23.20[cd]	14.53[d]	4.63	*
Feed intake (g/bird)	91.01[a]	88.05[ab]	74.19[c]	77.18[bc]	88.85[a]	5.26	*
Feed conversion ratio	1.88[c]	2.36[c]	2.43[c]	4.18[b]	7.13[a]	1.19	*
Protein intake (g/bird)	18.20[a]	17.61[ab]	14.84[c]	15.44[bc]	17.77[a]	1.05	*
Protein efficiency ratio	2.43[a]	1.96[ab]	1.52[bc]	1.16[cd]	0.73[d]	0.23	*
Energy efficiency ratio	43.91[a]	35.44[ab]	27.55[bc]	20.96[cd]	13.12[d]	4.18	*

abcd = Means with the same letter are not significantly different, Av = average, SEM = standard error of means, LOS= level of significant, Ns = Not significant, * = significant, P-value = 0.05, WG = weight gain.

The result for the effects of replacing maize with SWAPSI meal-based diets on nutrients digestibility of broiler finisher chickens is presented in Table 8. There was significant (P<0.05) differences across all the nutrient digestibility parameters. Higher significant values were found at 0% SWAPSI (T1) diet followed by T2 (20% SWAPSI) for dry matter, , fat and nitrogen free extract than other treatments diets. However, crude fibre was higher at T5 (65.11%) compared with T1 (45.86%). T2, T3 and T4 were statistically similar for crude fibre only.

The higher dry matter, crude protein, fat, ash and nitrogen free extract for birds fed 0% SWAPSI (T1) diet followed by T2 (20% SWAPSI) is probably due to zero to low inclusion of SWAPSI which make the birds to digest most of their nutrients. However, the higher crude fibre digestibility by 80% SWAPSI compared with 0% could be associated with SWAPSI inclusion at different levels to replaced maize. This is because crude fiber is a functional component of normal digestive organ function that supports proper digestion of nutrient. This is in tandem with Nwosu *et al.* (2020) who studied nutrient digestibility of broiler birds fed sugarcane scrapping bark and reported no significant effect on digestibility efficiency of all the parameters measured except crude fibre and ash retention. The current study also disagreed with Alu *et al.* (2022) who reported that SWAPSI inclusion improved digestibility of nutrients significantly as the level of SWAPSI increased in the diets of rabbits.

Table 8: Effects of replacing maize with SWAPSI meal-based diets on nutrients digestibility of broiler finisher chickens

Parameters (%)	Replacement value of SWAPSI						
	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)	T5 (80%)	SEM	LOS
Dry matter	90.89[a]	86.88[b]	81.75[c]	77.61[d]	68.56[c]	2.86	*
Crude protein	71.51[a]	69.79 [a]	54.67[b]	44.70[c]	44.89[c]	4.02	*
Crude fat	33.07[a]	32.60 [b]	26.76[c]	25.51[c]	26.02[c]	1.33	*
Crude fibre	45.86[c]	48.95[b]	50.31[b]	59.10[b]	65.11[a]	1.25	*
Ash	43.86[a]	42.93[a]	31.95[b]	33.31[b]	32.59[b]	1.12	*
NFE	55.51[a]	51.34[b]	43.55[b]	41.79 [c]	40.45[b]	1.78	*

abcd = Means with the same letter are not significantly different, Av = average, SEM = standard error of means, LOS= level of significant, Ns = Not significant, * = significant, P-value = 0.05, NFE = Nitrogen-free extract

The result for the effects of replacing maize with SWAPSI on economics of production of broiler finisher chickens is presented in Table 9. There was significant (P<0.05) reduction in the cost of feed consumed (CFC) cost of production (CP) and revenue of production. Birds fed diets containing 0% SWAPSI had higher CFC (₦1336.77/bird), CP (₦2226.77/bird) and Revenue (₦4230.64/bird) compared with SWAPSI included diets. Cost of feed per kilogram weight gain was higher at T5 (3003.63 ₦/bird) than the control and other treatments. Birds fed diet containing 20% SWAPSI gave higher gross margin of ₦2011.87 followed by 0% with ₦2008.87 compared with other treatments with lower values (₦1145.54, 689.55 and 148.87).

The significant reduction in the cost of feed consumed, cost of production and revenue of production for birds fed diets containing SWAPSI implies that at the inclusion of SWAPSI in the experiment the cost of feed reduces. Feed cost per kg weight gain was lower at 0% inclusion level compared to SWAPSI fed birds, Cost of feed per kilogram weight gain was higher at T5 (₦/bird 3003.63) than the control and other treatments, this is because the feed intake was lower due to the nature of feed consumed, which was due to the fibrous nature of feed and dustiness, the birds were not able to digest and utilize the feed well like in the control diet. However, birds fed diet containing 20% SWAPSI gave higher gross margin of ₦2011.87/bird followed by 0% with ₦2008.87/bird compared with other treatments with lower values (1145.54, 689.55 and ₦148.87/bird). This suggests better inclusion of SWAPSI at 20% to broiler finisher chickens. This observations were similar to Adeniji and Okiri (2021) who reported higher cost of feed per kg by 0% without the inclusion of sugarcane scrapping rumen content mixture (SCSRCM) but also stated that, addition of sugarcane scrapping rumen content mixture in the experimental diet, the cost of feed reduced, thereby suggested that 15% of SCSRCM can be used to replace conventional fiber sources in grower birds diet for cost-efficient productivity.

Table 9: Effects of replacing maize with SWAPSI on economics of production of broiler finisher chickens

	Replacement value of SWAPSI						
Parameters	**T1 (0%)**	**T2 (20%)**	**T3 (40%)**	**T4 (60%)**	**T5 (80%)**	**SEM**	**LOS**
CF/ ₦ kg	524.57	468.12	464.09	441.31	420.92	-	NA
CFC (₦/bird)	1336.77^{a}	1154.04^{b}	964.06^{c}	953.65^{c}	1047.23^{bc}	67.51	*
CF/kg WG (₦/bird)	987.78^{b}	1107.59^{b}	1130.72^{b}	1844.94^{b}	3002.63^{a}	511.21	*
CP (₦/bird)	2226.77^{a}	2211.77^{b}	1864.06^{c}	1853.65^{c}	1947.23^{bc}	67.51	*
Revenue (₦)	4230.64^{a}	4223.64^{b}	3009.60^{c}	2543.20^{d}	2095.28^{e}	169.38	*
Gross margin (₦)	2003.87^{a}	2011.87^{a}	1145.54^{b}	689.55^{c}	148.05^{d}	184.87	*

abcd = Means with the same letter are not significantly difference, Av = average, SEM = standard error of means, LOS= level of significant, Ns = Not significant, * = significant, P-value = 0.05, CF= cost of feed per kg, CFC = cost of feed consumed, WG = weight gain, CP = cost of production.

CONCLUSION AND RECOMMENDATIONS

From the results of this study it can be concluded that SWAPSI meal had the potential for use as a source of carbohydrates in the diet of broiler chickens. The results also indicated that dietary feed containing 20% SWAPSI improved weight gain, protein intake, protein efficiency ratio, energy efficiency ratio, and had better feed conversion ratio at starter and finisher phase. Digestibility of nutrient was better in 20% SWAPSI diet having higher crude protein for starter and finisher phase. But a higher value of crude fibre is observed in 80% SWAPSI diet. Inclusion of SWAPSI meal in broiler chickens production is recommended at 20% for optimum performance and economic returns to production.

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REFERENCES

Adedeji, M.O., Habiba, Z., Duweni, T. and Adeniji, A.A. (2021). Effect of Feeding Graded Levels of Whole Sugarcane Waste with or without Fishmeal and Grass. *Medicon Agriculture and Environmental Sciences,* 1(3): 16-22.

Adeniji, A. and Okiri, H.G. (2021). Effect of Replacing Wheat Offal with Sugarcane Scrapings Rumen Content Mixture (SCSRCM) on the Performance of Growing Pullets, *Electronic Research Journal of Engineering, Computer and Applied Sciences* 3:2709-3700..

Alu, S. E. Kaankuka, F. G. and Oluremi, O. I. A. (2010). The interactive effects of dietary fibre and Nutrasexyla(R) enzyme supplementation on carcass characteristics of grower pigs. *International journal of food and Agricultural Research*, 1(7): 205-212.

Alu, S. E. Kaankuka, F. G. Bello, M. and Salau, E. S. (2013). Growth parameters and economic analysis of broiler finisher birds' production fed sugarcane (*Saccharum officinarum*) scrapping meal (SCSM)-based diets. *Journal of Life and physical sciences. ActaSATECH*, 4(2): 51-60.

Alu, S. E., Kaankuka, F. G., Carew, S. N. and Tuleun, C.D. (2012). Effects Of Maxigrain® Supplementation Of Sugarcane Scrapping Meal-Based Diets On The Growth Rate, Nutrient Digestibility And Cost Implication Of Japanese Quail (Cortunix Cortunix Japonica) Chicks, *International Journal of Engineering Research and Technology (IJERT)*, 1 (9): 2278-0181.

Alu, S.E. (2013). Economic analysis of production and growth response of broiler chickens fed sugarcane (*Saccharum officinarum*) scrapping meal (SCSM)-based diets. Nigerian Poultry Science Journal, © *World"s Poultry Science Association-Nigerian Branch*, 10: 1-6.

Alu, S.E., Ari, M.M., Swomen, F.E., Abdullahi, H.R. and Ushie, F.T. (2022). Growth response, nutrient digestibility and cost benefits of rabbits fed solid waste product of sugar industry, *Production Agricultural Technology Journal*, 18 (1):37-45.

Association of official analytical chemists. (2002). 15th ed. Williams Tryd Press. Richmond Virginia, U.S.A.

Cruz, L. R., Geraseev, L. C., Carmo, T. D., Santos, L. D. T., Barbosa, E. A., Costa, G. A. and Santos, A., Jr. (2014). Características agronômicas e composição bromatológica de variedades de cana-de-açúcar. *Bioscience Journal*, 30(6): 1779-1786.

De Vries-Ten Have, J., Owolabi, A., Steijns, J., Kudla, U. and Melse-Boonstra, A. (2020): Protein intake adequacy among Nigerian infants, children, adolescents and women and protein quality of commonly consumed foods. *Nutrition research reviews*, *33*(1), 102–120. https://doi.org/10.1017/S0954422419000222.

Duncan, D. B. (1997). Multiple Ranges and Multiple F Test. Biometric, 11: 1-42.

Ibrahim, T.S.T., Workneh, T.S. The environmental impact of the sugar industry waste in Sudan. *Environmental Monitoring Assessment*, 195:870. https://doi.org/10.1007/s10661-023-11401-8.

Krishnaveni, A., Chinnasamy, S., Elumalai, J. and Muthaiyan, P. (2020). Sugar Industry Wastes as Wealth of Organic Carbon for Soil. IntechOpen. doi: 10.5772/intechopen.90661.

National Research Council (NRC) (2007): Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids. National Academic Science, Washington, DC P 384. https://doi.org/10.17226/11654

Nwosu G. C., Adeniji A. A. and Adeniji A. A. (2020). Nutrient Digestibility of Broiler Birds Fed Sugarcane Scrapping Bark Fermented with Rumen Liquor for 4 and 8 Days at Different Grade Levels, *Journal of Biotechnology Research*, 6(1): 1-6.

Nwosu, G.C. Adeniji A.A. and Agubosi O.C.P. (2019). Effects of feeding sugarcane (*saccharum officinarum*) bark scraping fermented with rumen liquor on performance of broiler chickens, *Research in: Agricultural & Veterinary Sciences*, 3(3): 134-143.

Oluyemi, J. A and Robert, F. A. (2000).Poultry production in warm wet climates, 2nd edition, published by Macmillan publishers limited, London.

Pauzenga, U. (1985). Feeding parent stock. Zootechnician International. 22-24.

Raza, Q.U.A., Bashir, M.A., Rehim, A., Sial, M.U., Ali Raza, H.M., Atif, H.M., Brito, A.F. and Geng, Y. (2021). Sugarcane Industrial Byproducts as Challenges to Environmental Safety and Their Remedies: A Review. *Water*, 13: 3495. https://doi.org/10.3390/w13243495.

Sani, A., Uba, S., Omoniyi, K.I. and Mikail, A.H. (2021). Physico-chemical characterization of uvaria chamae oil and quality assessment of biodiesel produced from Uvaria Chamae. *FUDMA Journal of Sciences* (FJS), 7 (1): 261-266

Smith, J., Sones, K., Grace, D., MacMillan, S., Tarawali, S. and Herrero, M. (2013). Beyond milk, meat, and eggs: Role of livestock in food and nutrition security. *Animal Frontiers*, 3(1): 6–13.

Teixeira, A.O., de Resende, V.A. Moreira, L. M. Corassa, A., Brighenti, C. R. G., Gaya, L.G., Valente Júnior, D. T., Teixeira, H. Z., Reis, R. S. (2021). Effect of crushed sugarcane on performance, bone characteristics and intestinal morphology of free-range chicken lines, *Semina: Ciênc. Agrár. Londrina*, 42 (5): 2893-2906.

Tewe, O. O. (1999) Food ingredients and ration formulation for economic gain. Proc. of the 1st August in poultry Management during economic depression. The Nigeria situation. Department of Animal Science, University of Ibadan. PP.103-136.

Thani, R. J., Alu, S. E. and Yakubu, A. (2018). Evaluation of differently processed Kidney bean seeds on nutrient and anti-nutrient compositions: Implications for monogastric animal feeding. *Nigerian Journal of Animal Science*, 20 (1): 134-144.