Performance Characteristics of Starter Broiler Chicks Fed Dietary Sun-Dried Sweet Orange Peel Meal (SOPM) with and Without Polyzyme®

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Abstract

The study was carried out to evaluate the performance characteristics of starter broiler chicks fed diet containing sun-dried sweet orange peel meal with and without polyzyme®. Fresh sweet orange peel was collected from sweet orange fruits retail sellers and was immediately sun-dried on concrete platforms to attain less than 12 % moisture. It was ground and mixed with other feed ingredients to produce six (6) experimental diets T_1, T_2, T_3, T_4, T_5 and T_6. Two hundred and sixteen (216) unsexed day-old *Abor acer plus* broiler chicks were randomly assigned to the six dietary treatments of 36 chicks each and 12 chicks per replicate. The experimental diets had 2 levels of Polyzyme® (0 % and 0.04 %) and 3 levels of sun-dried sweet orange peel meal (15 %, 20 % and 25 %) and the experimental was fitted into the completely randomized design. Chicks were fed these diets T_1 - 15 % sun-dried sweet orange peel meal + 0 % polyzyme®, T_2 - 20 % sun-dried sweet orange peel meal + 0 % polyzyme®, T_3 - 25 % sun-dried sweet orange peel meal + 0 % polyzyme®, T_4 - 15 % sun-dried sweet orange peel meal + 0.04 % polyzyme®, T_5 - 20 % sun-dried sweet orange peel meal + 0.04 % polyzyme® and T_6 - 25 % sun-dried sweet orange peel meal + 0.04 % polyzyme®. Broiler chicks fed 15 % dietary SOPM with and without polyzyme® had significantly ($P<0.05$) highest final weight, weight gain and feed intake. Experimental diets did not show significant effect ($P>0.05$) on dry matter, crude protein, crude fibre and nitrogen free extract digestibility. There was interaction between polyzyme® and sweet orange peel meal on nitrogen free extract at 15 % and 25 % which was influenced by polyzyme®. There was no detrimental effect of SOPM and polyzyme® production cost. It is therefore concluded from this trial that sun-dried sweet orange peel meal has some nutritional benefits in the diet of broiler chicks and that inclusion level of sun-dried sweet orange peel meal up to 25 % without and with polyzyme® level of 0 % and 0.04 % did not have deleterious effect on broiler chicks growth performance and production cost.

Keywords: Orange, polyzyme®, broiler, chicks, performance.

Introduction

The soaring demand for global corn, for human consumption and industries has led to increase in price of corn and corresponding increase in livestock feed cost and animal products (meat and eggs). This is one of the major limiting factors in poultry production as the cost of feed alone accounts for about 70 – 75 % of the total cost of broiler production (Jurgens *et al.,* 2009). In addition to price, world grain production has also been declined in the past years due to the crops compete for land (Attamangkune, 2007). The use of cereal by-products that are cheap, locally available and have no direct nutritional value to mankind therefore appears to be one of the approaches for solving the feed crises that is having negative effect on livestock industry most especially non ruminant animal production. One of such alternatives is the sweet orange (*Citrus sinensis*) peel. According to Chapman *et al.* (2000), a number of residue materials like peels, rag, seed, etc. are produced when fresh citrus fruits are processed into juice, concentrates and canned fruits in developed countries. In Nigeria, sweet orange is consumed on a wide scale, and the peels are usually considered as wastes which at times are seen littered on the streets and along the road due to the fact that the Nigerian Government and orange retailers have not developed strategic disposal programme. As such, orange peels have become an environmental problem (Oluremi *et al.,* 2007).

Sweet orange fruit peel has been observed to be a source of calorie and protein comparable with maize grain (Oluremi, 2008). Besides Neal *et al.* (1999) reported that dried grape fruit waste materials are good for growing animals based on the nutritive and digestible nutrients contained therein. Thus far, nutritional trials with monogastric animals have shown that the meal of sun-dried sweet orange peels of *Citrus sinensis* can replace up to 20 % of dietary maize in broiler diet (Agu *et al.,* 2010) and 40 % in rabbit (Oluremi *et al.,* 2005), without any adverse effect on their performance. The use of exogenous microbial enzymes to improve the nutritional value of high fiber diets have been well documented (Angelovicova *et al.*, 2005; Raza *et al*., 2009). The utilization of exogenous enzymes has been shown to improve nutrient digestibility, destroy anti-nutritional factors and manipulate gut flora population as well as supplementing endogenous enzymes (Bedford, 1996). Classen and Bedford (1999) reported improved nutrient utilization when poultry birds were fed wheat-based diets supplemented with crude enzyme preparation having high xylanase activity. The Polyzyme® contains xylanase, phytase, cellulase, β – glucanase, pectinases, α – amylase, protease, α – galactosidase, β – galactosidase, lipase and mannanase all of which are able to digest complex carbohydrates at the company recommendation dose of 400gm per ton of mash feed. Therefore, this experiment was conducted to determine the effect of partial replacement of maize with dietary sun-dried sweet orange peel with and without enzyme treatment on growth performance, nutrient digestibility and economic of production of starter broiler chicks.

Materials and Methods

Experimental Site

The study was conducted at the Poultry House of the Livestock unit, Teaching and Research Farm, Federal University of Agriculture, Makurdi, Benue State. Makurdi is located between latitude $7^{0}44'$N and longitude $8^{0}21'$E in the Guinea Savanna Zone of West Africa. The area has an annual rainfall between 6 - 8 months (March - October) and ranging from 508 to 1016mm with a minimum temperature range of 24.20 ± 1.4^{0} C and maximum temperature range of 36.33 ± 3.70^{0} C. The relative humidity ranges between 39.50 ± 2.20 % and 64.00 ± 4.80 % (TAC, 2011).

Collection and Preparation of Test Ingredients

The test ingredient, sweet orange (*Citrus sinensis*) fruit peel was collected fresh from orange retail sellers on the university campus and clean of dirt. To prevent fermentation and other forms of deterioration, the peel was immediately sun-dried on concrete platforms to attain less than 12% moisture. It was milled to obtain the sweet orange peel meal and stored for use in feed formulation for the broiler chicks

Experimental Birds and management

Before the feeding trial, the deep litter poultry house was thoroughly cleaned, washed and disinfected with 1% formalin solution. Heat and light were provided 24 hours daily throughout the brooding period of 14 days. Adequate cross ventilation for more conducive environment was ensured throughout the experimental period and standard hygienic practices were also maintained throughout the 42 days experimental period. Feed and water were provided *ad-libitum*

Experimental Diets and Design

Two hundred and fifty two (216) unsexed day old *Abor acre plus* broiler chicks were obtained from Vertex Farms in Ibadan and used for this experiment. The birds were randomly distributed in 2 x 3 factorial designs with two levels of polyzyme® (0 % and 0.04 %) and three levels of sun-dried sweet orange peel meal (15 %, 20 % and 25 %) making six treatments, each having three replicates with twelve (12) chicks per replicate, housed in a deep litter compartments. All the diets were iso-nitrogenous and iso-caloric as shown in Table 1.

Data collection:

Feed intake was calculated as difference in the quantity of feed given and left over after 24 hour. Weight gain was determined as the difference in the weight of the birds after 7 days period. Feed: grain ratio was calculated from feed intake and weight gain. Protein conversion ratio was calculated by multiply feed intake by dietary protein intake divided by body weight gain. Cost of feed was calculated from the cost of ingredients used in feed preparation. Feed cost per kilogram live weight gain was calculated from feed cost and feed: gain ratio. Feed cost per weight gain was calculated by multiply the feed cost per kg with total feed intake and divided by total weight gain. Feed cost/chick was calculated by multiply feed intake per day by the number of days then multiplies by feed cost per kilogram. Operational cost per bird was calculated by adding all other expenses except expenses on feed and day old broiler chick. Cost savings due to SOPM was calculated by subtracting total cost of production of each treatment from total cost of production of the broiler chickens fed control diet. Total cost of production was calculated by adding cost of day old chick, feed cost per chick and operational cost. Feed cost as a percentage of total production cost was calculated by dividing cost of feed per kg with total cost of production and multiply by hundred.

Nutrient Digestibility

Determination of nutrient digestibility was done at the end of the starter phase of the experimental period. Two birds per replicate were selected and transferred into metabolic cages. The first 3 days was allowed for adaptation of birds and the respective diets were offered liberally. Daily feed intake and daily faecal output was recorded for 4 days. The droppings were collected per replicate once

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daily at 8:00 am, weighed and dried in an oven at 70°C to constant weight. Dried excreta were bulked, milled and the representative samples taken for proximate analysis.

Chemical analysis:

Proximate composition of Sweet orange peel meal, feeds and excreta were determined using AOAC (2006) methods of analysis, while the metabolizable energy was calculated using the equation; ME (kcal/kg) = 37 x % CP + 81.1 x % EE + 35.5 x % NFE (Pauzenga, 1985).

Statistical Analysis

All generated data were subjected to two-way analysis of Variance (ANOVA) using SAS (2008) software package and the means were separated using Duncan's Multiple Range Test (DMRT). All statements of significance are based on the 0.05 level of probability.

Table 1. Gross Composition of the Experimental Broiler Starter Diets

	Experimental diets					
Enzyme Levels	0 %			0.04 %		
SOPM levels	15 %	20 %	25 %	15 %	20 %	25 %
Treatments	T_1	T_2	T_3	T_4	T_5	T_6
Ingredients						
White maize	44.71	42.08	38.45	44.67	42.04	39.41
SOPM	7.89	10.52	13.15	7.89	10.52	13.15
Soya bean meal	37.35	37.35	37.35	37.35	37.35	37.35
Rice bran	3.25	3.25	3.25	3.25	3.25	3.25
Blood meal	2.00	2.00	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Palm oil	1.00	1.00	1.00	1.00	1.00	1.00
Herbo-Methionine	0.15	0.15	0.15	0.15	0.15	0.15
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.20	0.20	0.20	0.20	0.20	0.20
Common salt	0.20	0.20	0.20	0.20	0.20	0.20
Enzyme	-	-	-	+	+	+
Total	100	100	100	100	100	100
Calculated analysis						
**ME (Kcal/kg)	2888	2876	2864	2888	2876	2864
Crude protein (%)	23.82	22.98	22.93	23.82	22.98	22.93
Crude fibre (%)	5.19	5.46	5.77	5.19	5.46	5.77
Ether extract (%)	3.94	4.04	4.14	3.94	4.04	4.14
Lysine (%)	1.46	1.45	1.45	1.46	1.45	1.45
Methionine (%)	0.62	0.61	0.61	0.62	0.61	0.61
Calcium (%)	1.04	1.04	1.04	1.04	1.04	1.04
Available P (%)	0.87	0.86	0.84	0.87	0.86	0.84

**To provide the following per kg of diet vitamin A – 15,000.00IU, Vitamin D3 - 3, 000,000IU, Vitamin E- 30,000IU,Vitamin K3,000mgVitamin B1 3000,mg Vitamin B2-6000mg, Vitamin B- 5,000mg, Vitamin B12-40mg, Biotin 200mg, Niacin-40,000mg, Pantothenic acid 15,000mg,Folic acid 2,000mg, choline 300,000mg,Iron 60,000mg, manganese 80,000mg, copper 25,000mg,Zinc 80,000mg cobalt 150mg,iodine 500mg, selenium 310mg, Antioxidant 20,000mg.*

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**ME kcal/kg calculated using 37 X % CP + 81.1 X % EE + 35.5 X % NFE (Pauzenga, 1985) SOP = Sweet orange peel meal; (-) = No enzyme; (+) = 0.04 % with enzyme; P = Phosphorus; ME = Metabolizable energy; T_1 Maize: replaced at 15 % sun-dried sweet orange peel meal without polyzyme®, T_2 Maize: replaced at 20 % sun-dried sweet orange peel meal without polyzyme®, T_3: Maize replaced at 25 % sun-dried sweet orange peel meal without polyzyme®, T_4: Maize replaced at 15 % sun-dried sweet orange peel meal plus 0.04 % polyzyme®, T_5: Maize replaced at 20 % sun-dried sweet orange peel meal plus 0.04 % polyzyme®, $T_{6:}$ Maize replaced at 25 % sun-dried sweet orange peel meal plus 0.04 % polyzyme®

Results and Discussion

The proximate composition and energy content of sweet orange peel meal and maize used in this study is presented in Table 2. The proximate composition of sweet orange peel meal (*Citrus sinensis*) had crude protein (CP) and metabolizable energy (ME) contents of 8.20 % and 3079.61 kcal/kg ME respectively. The CP 8.20 % in the peels were lower than CP in maize, a

Table 2. Proximate Composition and Energy Content of Sweet Orange (*Citrus sinensis*) Peel meal and Maize (% DM)

Nutrients (%)	Feedstuff	
	[1]SOPM	[2]Maize
Dry matter	89.20	86.50
Crude protein	8.20	9.10
Crude fibre	13.30	1.30
Ether extract	4.51	4.00
Ash	6.09	2.70
Nitrogen free extract	67.90	83.00
[3]ME kcal/kg	3079.61	3432.32

[1]Laboratory Analysis; [2]Aduku (2005); [3]Metabolizable energy as determined using Pauzenga (1985) SOPM = Sweet orange peel meal

conventional energy feedstuff with CP content of 9.25 % (Tuleun *et al*., 2005), while crude fibre (CF) of 13.30 % in the peel was higher than 2.20 % CF reported for maize. The high CF in the peel may reduce its feeding value compared to conventional dietary maize in poultry nutrition; however the energy contents of both SOPM used in this study (3079.61 kcal/kg) and maize (3432 kcal/kg) were comparable. Ojabo *et al.* (2014) reported 86.20 % DM, 7.40 % CP, 8.19 % ash, 7.19 % EE, 13.50 % CF, 62.65 % NFE and 3674.44 kcal/kg ME for sun-dried sweet orange peel meal while Agu *et al.* (2010) reported 89.65 % DM, 10.74 % CP, 7.86 % ash, 12.00 % EE, 11.90 % CF, 56.91 % NFE and 3988.70 kcal/kgME. Also, 7.0 % CP, 12.50 % CF and ME of 3420 kcal/kg reported by Ashbell and Weinbegger (1999) in Israel for sweet orange peel. Therefore, the results of proximate composition of SOP showed that it some nutritional benefits that can make it to be used in broiler chickens diets with proper handling.

The performance of starter broiler chicks fed diets containing dietary SOPM with and without polyzyme treatment is shown in Table 3. All groups of starter broiler chicks had initial weight of between 33.54 – 33.64 g. The final body weight ranged from 688.64 – 843.69 (g/bird). Dietary SOPM significantly ($P<0.05$) influenced average final weight, average weight gain, average feed intake and feed conversion ratio. This may be attributed to high fibre in sweet orange peel. Similar observation was also reported by Abbas *et al*. (2013) on broiler chicks fed sweet orange peel based diet. Significantly ($P<0.05$) highest value of average final weight and average weight gain was recorded on broiler chicks fed 15 % dietary the performance. The least value was recorded on broiler chicks fed 20 % dietary SOPM, though, not significantly ($P>0.05$) differed from the broiler chicks fed 25 % dietary SOPM. The values of daily weight gain and daily feed intake obtained for starter broiler chicks were above the expected minimum value of 19 g and 37 g respectively, reported by Aduku (2005). The broiler chicks fed 15 % dietary SOPM had significantly ($P<0.05$) best value of average feed intake and feed conversion ratio compared with the broiler chicks fed 20 % dietary SOPM but not significantly ($P>0.05$) differed from the broiler chicks fed 25 % dietary SOPM. This may be attributed to low fibre content of the diet compared to those fed 20 % and 25 % dietary SOPM. Significant interactions were observed between dietary level of sweet orange peel and addition of polyzyme on protein conversion ratio (Table 4). Sweet orange peel meal and polyzyme had no significant ($p<0.05$) interaction effect

Table 3. Effect of Experimental Diets on Growth Performance of Broiler Starter Chicks

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Dietary treatments	AIW (g)	AFW (g)	AWG (g)	AFI (g)	FCR	PCR
SOPM levels						
15 %	33.54	843.69^{a}	28.93^{a}	44.64^{a}	1.54^{b}	0.34^{b}
20 %	33.64	688.64^{b}	23.39^{b}	37.28^{b}	1.59^{ab}	0.35^{ab}
25 %	33.59	706.31^{b}	24.03^{b}	40.72^{ab}	1.70^{a}	0.38^{a}
Polyzyme levels						
0 %	33.57	752.02	25.66	40.67	1.59	0.37
0.04 %	33.60	740.40	25.24	41.09	1.63	0.38
SEM	0.03	34.63	1.24	1.98	0.02	0.03

^{a,b}Means within each column with different superscripts are significantly different (P< 0.05). ns - not significantly different (P>0.05); * significantly different (P<0.05) Note: AIW = average initial weight; AFW = average final weight; AWG = average weight gain; AFI = average feed intake; FCR = feed conversion ratio; PCR = Protein conversion ratio; SEM = standard error of mean; SOPM – Sweet orange peel meal

Table 4. Interaction Effect of Dietary Sweet Orange Peel meal and Enzyme Treatment on Starter Broiler Chicks Growth Performance

Enzyme Levels	SOPM Levels	AIW (g)	AFW (g)	AWG (g/d)	AFI (g/d)	FCR	PCR
	15 %	33.53	823.74^{a}	28.22^{a}	42.05^{ab}	1.49^{b}	0.34
0%	20 %	33.63	704.55^{b}	23.96^{b}	37.50^{b}	1.57^{b}	0.35
	25 %	33.53	727.78^{b}	24.79^{b}	42.47^{ab}	1.72^{a}	0.38
	15 %	33.53	863.64^{a}	29.64^{a}	47.24^{ab}	1.59^{a}	0.37
0.04%	20 %	33.63	672.73^{b}	22.82^{b}	37.07^{b}	1.61^{ab}	0.37
	25 %	33.63	684.55^{b}	23.25^{b}	38.96^{b}	1.67^{a}	0.38
SEM		0.00^{ns}	0.03*	1.08*	1.25*	0.02*	0.03^{ns}

^{a,b}Means within each column with different superscripts are significantly different (P< 0.05). ns -not significantly different (P>0.05); * significantly different (P<0.05). Note: AIW = average initial weight; AFW = average final weight; AWG = average weight gain; AFI = average feed intake; FCR = feed conversion ratio; PCR = Protein conversion ratio; SEM = standard error of mean; SOPM – Sweet orange peel meal

on average final weight, average daily weight, average feed intake and feed conversion ratio of the birds at 15 %, 20 % and 25 %. At 15 % sweet orange peel inclusion however, addition of polyzyme significantly (P<0.05) influenced the interaction effect on protein conversion ratio. Brenes *et al*. (1993) also reported improvement in protein utilization of chicks fed barley containing diets as a result of enzyme addition. The nutrient digestibility of starter broiler chicks fed dietary SOPM is shown in Table 5.Nutrient digestibility values showed that birds in all dietary groups were not significantly (P>0.05) affected by the diets, except for ether extract where the value obtained on broiler chicks fed 15 % dietary SOPM was significantly (P<0.05) highest than that obtained for the broiler chicks fed 20 % and 25 % dietary SOPM. This was not in line with the findings of Ojabo *et al.* (2014) who reported significantly (P<0.05) differences of all nutrient digestibility on pullet chicks fed dietary SOP between 20 – 40 %, this may be attributed to the different types of the birds used for the study. The similarity in the nutrient digestibility values for all nutrients across the dietary treatments showed that the birds were able to digest the nutrients optimally. Diets containing dietary SOPM at substitution levels of 25 % proved to be less digested as the ether extract digestibility progressively decrease significantly (P<0.05) as the level of dietary SOPM in the

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diets increased from 15 % to 25 %. There was no interaction effect between dietary SOPM and polyzyme across the dietary treatment except for nitrogen free extract at 15 % and 25 % inclusion level of dietary SOPM which was improved by addition of polyzyme (Table 6). The nitrogen free extract improvement may indicate that the level of dietary SOP of 15 % – 25 % and polyzyme 0 % – 0.04 % used are not detrimental to the starter broiler chicks nutrients digestibility. Significant improved nitrogen free extract observed on broiler chicks fed 15 % and 25 % dietary SOPM may imply that polyzyme enhanced the readily available carbohydrate of the diet. The cost implication of feeding graded levels of processed sweet orange peel to starter broiler chicks is shown in Table 7. As the SOPM/maize replacement levels increased, the feed cost progressively decreased in both groups fed dietary SOPM with and without polyzyme. The progressive decreased is in line with the report of Ani *et al.* (2012); Ojabo *et al*. (2014); Ngiki *et al.* (2014) and Olaifa *et al.* (2015) who reported that the feed cost per weight gain decreased with increased dietary levels of bambara nut, sweet orange peel, cassava root-leaf meal mixture and cassava peel meal based diet respectively on broiler chickens. The broiler chicks fed dietary SOPM with polyzyme attracted relatively higher cost of feed compared to those fed dietary SOPM without polyzyme. This was as a result of the additional cost of polyzyme. The cost per day old broiler chick amounted to $0.305 across the dietary treatments. Broiler chicks fed 25 % dietary SOPM with polyzyme had better feed cost per weight gain compared to the broiler chicks fed 25 % dietary SOPM without polyzyme. Highest feed cost per weight gain recorded on broiler chicks fed 15 % and 20 % with polyzyme compared with 15 % and 20 % without polyzyme was the function of highest feed consumed that was inefficiently converted and utilised. Cost savings due to sweet orange peel increased with increased levels of sweet orange peel as a replacement for maize (conventional feed). Broiler chicks fed 15 % dietary SOPM in both groups recorded the highest amount of feed cost per kg which was associated with the highest feed intake.

Table 5. Effect of Experimental Diets on Nutrients Digestibility of Broiler Starter Chicks

Dietary treatments		**DM**	**CP**	**CF**	**EE**	**NFE**
SOPM level	15 %	90.33	88.78	87.44	89.23^{a}	93.15
	20 %	89.92	88.78	80.50	87.81^{ab}	92.42
	25 %	90.17	87.75	85.62	86.81^{b}	92.70
Polyzyme level						
	0 %	90.09	88.27	83.40	87.74	92.29
	0.04 %	90.19	88.08	85.64	88.16	93.22
SEM		0.52	0.72	1.13	0.85	0.68

^{a,b}Means within each column with different superscripts are significantly different (P< 0.05). ns – not Significantly different (P>0.05); * Significantly different (P<0.05). DM = Dry Matter; CP = Crude protein; CF = Crude Fibre; EE = Ether Extract; NFE = Nitrogen Free Extract; SEM = standard error of mean; SOPM = Sweet orange peel meal; NS = No significant

Table 6. Interaction Effect of Enzyme and Sweet Orange Peel Meal on the Dry Matter and Nutrient Digestibility of the Starter Broiler chicks

Enzyme level	**SOPM level**	**DM**	**CP**	**CF**	**EE**	**NFE**
	15 %	90.27	88.69	87.42	88.68^{ab}	92.73^{b}
0 %	20 %	89.91	87.24	77.28	87.07^{ab}	92.04^{b}
	25 %	90.09	88.03	85.50	87.46^{ab}	92.11^{b}
	15 %	90.39	88.87	87.45	89.78^{a}	93.56^{a}
0.04 %	20 %	89.93	87.92	83.72	88.54^{ab}	92.80^{b}
	25 %	90.24	87.46	85.74	86.16^{a}	93.29^{a}
SEM		0.34^{ns}	0.63^{ns}	1.01^{ns}	0.53^{*}	0.42^{*}

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[a,b]Means within each column with different superscripts are significantly different (P< 0.05). ns - not significantly different (P>0.05); * significantly different (P<0.05). E – Enzyme; SOPM – Sweet orange peel meal; DM = Dry Matter; CP = Crude Protein; CF = Crude Fibre; EE = Ether Extract; NFE = Nitrogen free extract SEM = standard error of mean; SOPM – sweet orange peel meal

Table 7. Economics of Production of Starter Broiler Chicks Fed Diets Containing Sweet Orange Peel Meal with and without Enzyme

Economic Indices	Experimental diets					
	T_1	T_2	T_3	T_4	T_5	T_6
C of DOC ($)	0.305	0.305	0.305	0.305	0.305	0.305
FC/kg ($)	0.392	0.381	0.368	0.394	0.383	0.367
FC/WG ($/kg)	0.584	0.596	0.623	0.628	0.622	0.615
FC/chicks ($)	0.459	0.400	0.434	0.520	0.398	0.400
OPC ($)	0.389	0.389	0.389	0.389	0.389	0.389
TCP ($/chick)	1.153	1.094	1.129	1.152	1.093	1.095
CS due to SOPM ($/chick)	0.154	0.213	0.178	0.092	0.214	0.213
FC (% TCP)	0.110	0.101	0.106	0.119	0.101	0.101
C of DOC (%TCP)	0.073	0.077	0.075	0.069	0.077	0.077

FC = feed cost; CS = Cost savings; DOC = Day old chicks; C = Cost; TCP = Total cost of production; OP = Operational cost; $T_{1\,=}$ 15 % SOPM without enzyme; $T_{2\,=}$ 20 % SOPM without enzyme; $T_{3\,=}$ 25 % SOPM without enzyme; $T_{4\,=}$ 15 % SOPM with enzyme; $T_{5\,=}$ 20 % SOPM with enzyme; $T_{6\,=}$ 25 % SOPM with enzyme, SOPM = sweet orange peel meal

Conclusion

Sun-dried sweet orange peel meal has some comparable nutritional benefits to maize and can be used in the diet of broiler chicks. Progressive replacement of dietary maize up to 25 % level with or without polyzyme in broiler starter chicks diets had no depressive effects on performance and nutrient digestibility.

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