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Original article

Replacement value of sweet orange (*Citrus Sinensis*) peels for wheat offals in the performance of broiler starter diets

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ABSTRACT

Two-hundred (200) day old broiler chicks of Anak 2000 breed from a commercial hatchery were used to investigate the effect of replacing wheat offals with sweet orange peel meal in broiler rations. The birds were fed on 0%, 50%, 75% and 100% dietary inclusion of sweet orange peel meal as replacement for wheat offals in a 28 day feeding trial. Significant interaction between dietary levels of sweet orange peel meal and wheat offals were observed on feed efficiency and weight gain (p<0.05). Increase in dietary levels of sweet orange peel meal reduced feed transit time in gastro-intestinal tract (GIT) (p<0.05) while supplementary wheat offal had the opposite effect (p<0.05). It was concluded that broiler chicks could tolerate up to 75% dietary levels of sweet orange peel meal without wheat offal added to such a diet, performance was comparable to that of birds fed a standard diet with money saved in the process.

1. Introduction

The poultry industry is one fast means of providing the much needed animal protein to the teeming populace. It has been suggested that the expansion of the Nigeria poultry holds the greatest promise of bridging the animal protein gap in the country within the shortest possible time (Dafwang, 1990). Some agro-industrial by-products like maize offal, cocoa husk meal, rice offal, brewer dried grain have been used in poultry diets to replace cereals (Uko et al., 1990, Sobamiwa and Akinwale, 1999, Udedibie and Emenalom, 1993). Broiler birds are probably the most universal and important of all poultry as producers of meat for human consumption. It has been reported that sweet orange (Citrus sinensis) peel meal obtained from ground sun dried peels can replace dietary maize in broiler chicken diet at 20% level without any adverse effect on performance (Agu, 2006). Feed processing helps to enhance the feeding quality of agro-industrial by-products by reducing the level of toxicants where present, improving their nutrient value, acceptability of feed, and utilization by animals. This study therefore investigated the effect of the fermentation of fresh sweet orange fruit peel on its maize replacement value in broiler chickens.

The shortage of good quality feeds needed to sustain livestock growth, especially during the dry season has been a major challenge to the industry in the developing countries. Thus crop residues, agro-industrial by products and non conventional feed resources which abound during the dry season are being evaluated to access their nutritive potential to support livestock productivity. Several factors have been generally identified as limiting to the utilization or high incorporation of non conventional feedstuffs in livestock feed. These include low protein content (Gohl 1981), high fibre (McDonald et al 1988), amino acid imbalance and presence of anti-nutritional factors (Tacon and Jackson 1985). Anti-nutritional factors have significant negative effects on livestock production. These effects include reduction in palatability, digestibility and utilization of ration, intoxication of different classes of livestock, resulting in mortality or decreased production of animal and reduction in the quality of meat, egg, and milk products due to the presence of hazardous residues (Amuchie 2001).

A number of agro-industrial by-products or wastes like citrus pulp, citrus meals, citrus seed meal, citrus molasses and citrus peels are generated from fresh citrus after the main products of interest have been removed or extracted during processing or peeled for direct human consumption as in the case of developing countries. Clusters of peel of the sweet orange are usually noticed on streets and along major roads in Nigeria because government and orange retailers have no strategic disposal programme thus becoming an environmental problem. Ipinjolu (2000) has suggested that rather than discarding the orange peels, they can be sun-dried and then milled in grinding machine to fine particle to obtain the orange peel meal which can be included in fish diets. Sweet orange fruit rind (peel) meal has been observed to be a source of calorie and protein comparable with maize (Oluremi et al 2006). The peel contains oil sacs and the oil is composed of 91-94% d-limonene and 2.0-2.1% β-myrcene as a minor constituent (Arizona Chemical 1999). Polymetholated flavones are also a class of compounds found in citrus peel and produce no negative side effects in the animals fed the polymetholated flavones containing diets (Davis 2004).

In poultry production, feed cost also claims the largest share of the total expenses involved in the production process. Feed alone accounts for over 75% of the total cost of production, out of which 50% is expended on protein and energy sources (Ahaotu et al., 2012). The unavailability and expensive nature of cereals (maize and sorgum) stemming directly from its use as staple human food as well as major feed ingredients in Nigeria creates the problem of rising feed costs. This unprecedented increase in the cost of feed has made the price of poultry products beyond the reach of the average Nigerian (Ahaotu et al., 2011). The solution naturally, is to increase the production of these cereals commonly used in poultry feed so as to cater for the needs both man and his livestock (Ahaotu and Ekenyem, 2009). But, as this cannot work owing to the continuous increase in human and livestock production, attempts should be made to replace these expensive energy supplements in poultry feeds with man conventional and cheaply sourced ingredients so as to sustain the efficiency and profitability of poultry industry (Madubuike et al. 2003).

The utilization and incorporation of sweet orange peel meal into broiler feed will go a long way in increasing broiler production, conceive the Nations foreign exchange used in importation of cereals and finally reduce the pressure on the major energy source in broiler rations.

2. Materials and methods

The experiment was carried out at the Imo State Polytechnic Teaching and Research Farm Umuagwo, Owerri, Imo State, Nigeria. The site is situated between longitudes 7o 01 0611E and 7o 031 0011 and latitudes 5o 281 0011N and 5o 301 0011N in the humid tropical West Africa (IMLS,2009). Sweet orange peel used for this study was collected from Eke Ukwu Market, Owerri, Imo State, Nigeria. The peels were spread on mat and concrete floor to be dried by solar radiation. This was done at the first week of December when the relative humidity was low, temperature high and accompanied by dry harmattan wind. On drying, the samples were milled. The processed sweet orange peel meal was subjected to proximate analysis (Table 1) at the Animal Science and Livestock Production laboratory, University of Agriculture, Abeokuta, Nigeria, using standard methods (AOAC, 2001). The mineral analysis was carried out using the methods of Grueling (2000) while gross energy was determined with a Gallen Pump Oxygen Adiabatic Bomb Calorimeter. The samples were also weighed, evaporated in rotary evaporator and then loaded into the Technicon sequential multi sample Analyzer for amino acid determination as described by Spackman et al. (1958).

2.1. Chemical composition and nutrition value

Table 1
The proximate composition of Sweet Orange Peel meal is shown in Table 1 as.

	%
Dry Matter Content	96.22
Crude Protein	7.71
Crude Fiber	9.58
Ether Extract	2.11
Ash	5.12
Nitrogen Free Extract	71.24
Metabolisable Energy	3752.12Kcal/Kg
ELEMENTAL ANALYSIS	
Calcium	3.30
Phosphorus	2.30
Iron	0.40
VITAMIN ANALYSIS	I.U
Ascorbic Acid	49.00
Thiamine	0.08
Riboflavin	0.03
Niacin	0.20

2.2. Procurement of experimental birds and brooding

Two hundred and twenty (220) day-old chicks (Anak 2000 broiler chicks) were brooded in the brooder house of the Imo State Polytechnic Umuagwo, Owerri, Nigeria for four weeks using commercial broiler starter feed. They were further fed 50% commercial and 50% experimental feeds, homogenized by thorough mixing for one week to stabilize the birds before the feeding trial. Out of the lot, 200 two weeks broiler chicks were on basis of good health, apparent viability and good conformation assigned to four dietary treatments.

2.3. Formulation of the experimental diets

Four experimental diets were formulated containing 0%, 50%, 75% and 100% SOPM replacing treatments 1, 2, 3 and 4 respectively in which 0% SOPM was the control (Table 2). The feed was fortified with vitamin premix and synthetic amino acid (NRC, 2004). The ingredients were thoroughly mixed to ensure homogeneity before grinding in a hammer mill. Experimental birds were randomly allocated to the four dietary groups containing 0, 50, 75 and 100% SOPM for treatments 1, 2, 3 and 4 and were replicated thrice in a completely randomized design. The birds were reared on deep litter floor, each pen measuring 3.5m x 3.5m. Each pen was equipped with feeding troughs and drinkers. Electric bulbs and kerosene lanterns alternated as sources of light. Treatment diets and water were administered ad libitum. Routine management practices such as vaccination, drug administration and scrupulous cleanliness of the pens and equipment were carefully applied.

2.4. Data collection

Initial weights were determined at the start of the experiment with the aid of salter weighing balance and thereafter at weekly intervals. The final weight was also taken by weighing the birds in each replicate on the last day of the experiment using the same weighing balance.

Table 2
Ingredient composition of broiler starter diets.

Ingredients (%)	**T_1**	**T_2**	**T_3**	**T_4**
Maize	36.27	36.27	36.27	36.27
Wheat offal	15.54	15.54	15.54	15.54
Sweet Orange Peel Meal	0.00	11.17	16.76	22.34
Soya bean Meal	22.34	11.17	5.59	0
Fish Meal	4.47	4.47	4.47	4.47
Spent Grain	17.88	17.88	17.88	17.88
Bone Meal	3.00	3.00	3.00	3.00
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Chemical Composition				
Nutrients				
Crude Protein %	22.00	20.00	19.00	18.00
Ether Extract %	3.93	3.78	3.70	3.63
Crude Fiber %	7. 12	7.09	7.07	7. 06
Calcium %	1.48	1.47	1.46	1.45
Phosphorus %	0.82	0.83	0.84	0.84
MEKCal/kg	2619	2654	2672	2690

- 2.5kg premix/tonne contain, Vitamin A 10,000 i.u, Vitamin D3 200,000 i.u, Vitamin E 12,000 i.u, Vitamin K 2.5g, Thiamine 1.5g, Riboflavin 5g, , Vitamin B6 1.5g, Vitamin B12 10mg, Biotin 2mg, Nacin 15g, Pantothenic acid 5g, Zinc 50g, Iron 25g, Copper 5g, Iodine 1.4g, Selenium 100mg, Cobalt 300mg, BHT. 125g.

The weight gains were calculated by subtracting the initial weight from the final weight. In addition, the feed intake was calculated by subtracting the feed remaining from the total feed supplied each day before serving fresh one. The feed conversion ratio was also calculated by dividing feed intake by weight gain. The feed cost was determined as the sum of the cost of all ingredients included in the diet.

2.5. Data analysis

All data generated were subjected to one way analysis of variance (Steel and Torrie, 1980), while significant differences in means were determined using Duncans Multiple Range Test (Gordon and Gordon, 2004).

3. Results and discussion

Table 3 showed that final weight of the experimental birds varied significantly ($p<0.05$) between treatments. Birds on 0% SOPM were significantly ($p<0.05$) heavier than those on 50% and 75%, which were also significantly heavier than birds on 100% SOPM. Daily weight gain followed the same trend. However feed efficiency for birds on the control diet and T2 were most efficient and were significantly ($p<0.05$) different from T3 and T4. Initial weights of the birds were similar ($p>0.05$) between treatments. Increasing levels of PPM reduced final weight. Though SOPM is highly nutritious, the high levels of Lectins and Proteinase (Norton, 1991, D'mello and Devendra, 1995 and Godbole et al. 1994) caused the reduction in weight gain as higher levels of PPM was included in the diets. The observation that increasing levels of PPM made birds consume more feed is explained by their quest to eat enough to meet their body nutritional requirement (Grant, 1999, D'mello, 1982, 1992, Godoy and Batista, 1997).

Table 3
Performance characteristics of broiler starter birds fed varying replacement levels of sweet orange peel meal for wheat offal

Parameters	0% SOPM	50% SOPM	75% SOPM	100% SOPM	SEM
Initial Live Weight (g)	58.60	57.00	57.50	58.40	0.0^{ns}
Final Live Weight (g)	983.30^{a}	875.00^{a}	816.60^{c}	758.30^{b}	1.50*
Daily Weight Gain (g)	32.40^{a}	29.40^{b}	27.00^{b}	21.60^{c}	0.05*
Daily Feed Intake (g)	46.21^{a}	58.71^{b}	77.00^{c}	83.00^{d}	1.80*
Feed Efficiency	0.50^{a}	0.52^{a}	0.45^{b}	0.34^{c}	0.05*
Cost Benefit Analysis (N)	41.10^{a}	36.40^{b}	31.50^{c}	30.50^{a}	2.28*
Feed Cost/kg weight gain	28.8^{a}	26.6^{b}	25.5^{b}	20.4^{c}	1.18*
Mortality	1.00^{a}	1.00^{a}	1.00^{a}	3.00^{b}	0.1*

abcd means within the same row, having different superscripts are significantly different (p<0.05).

Table 4 showed that the wing length and thigh length did not differ significantly (p>0.05) between treatments. Birds on 0% PPM were significantly (p<0.05) heavier than those on 50% and 75%, which were also significantly heavier than birds on 100% SOPM. Drum stick followed the same trend. However wing length for birds on diet T3 and T4 were most efficient. This agreed with result obtained by Ahaotu, (1997) that increasing levels of leguminous plants in diets will favour higher consumptions of the diets thus encouraging birds to meet their body nutritional requirement.

Table 4
carcass characteristics of broiler chickens fed Varying replacement levels of sweet orange peel meal for wheat offal.

Parameters	0% SOPM	50% SOPM	75% SOPM	100% SOPM	SEM
DRUM STICK	5.6^{a}	5.5^{a}	5.1^{b}	4.7^{c}	0.11
(cm)	SD +0.03	+0.05	+0.038	+0.04	
WING LENGTH	9.1	9.0	10.0	9.9	
(cm)	S.D+0.036	+0.115	+0.152	+0.092^{ns}	0.04
BODY LENGTH	16.6^{c}	16.7^{c}	19.7^{a}	17.4^{b}	
(cm)	S.D+ 0.099	+0.158	+0.132	+0.149	0.03
BODY WEIGHT	492.4^{a}	383.2^{b}	356.9^{c}	336.7^{d}	
(gm)	S.D+7.75	+7.95	+6.27	+9.45	4.09
THIGH LENGTH	5.2	5.0	5.5	5.4	
(cm)	+0.058	+0.070	+0.017	+0.041^{ns}	0.12

Abcd, Means within the same row, having different superscripts are significantly different (p<0.05). Ns, Not Significant

In addition, Ahaotu and Ekenyem (2009) observed that higher dietary fiber depresses weight gain in broiler chicks, thus confirming the results of the experiment. Feed cost per kg weight gain significantly decreased (p<0.05) with higher levels of SOPM. Thus considering the final weights and the cost per kg of weight, 50% SOPM appears to be the optimal replacement value of wheat offal

4. Conclusion

Sweet orange peel meal can replace wheat offal in starter broiler rations without deleterious effect. The results on final weight, weight gain and cost per kg feed suggest that 50% SOPM is the optimum replacement level for WO for starter broiler production. The cost of broiler production considerably reduced with increasing levels of SOPM in the diet thus, showing the potentials for broiler production at reduced cost when SOPM is used in the formulation of starter broiler diets.

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