

DIETARY EFFECT OF PROCESSED ORANGE PEELS ON GROWTH PERFORMANCE OF BROILER FINISHER BIRDS

ABSTRACT

A study was conducted to investigate the effect of varying dietary levels of processed orange peels on the performance of broiler finisher birds. A total of 60 4-week old Anak broiler birds were allocated into four treatment groups of 15 birds each. ~~The experiment lasted for four weeks and was conducted at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka.~~ The treatment groups were randomly assigned to four iso-nitrogenous (20.01-20.04% CP) and iso-caloric (2.88-2.95 Mcal/kgME) diets containing four levels (0, 5, 10, and 15%) of processed orange peels. Each treatment was replicated three times with five birds per replicate. The Response parameters studied were body weight, feed intake, body weight gain, feed conversion ratio and protein efficiency ratio. The results showed that significant ($P<0.05$) differences existed in average daily feed intake (ADFI), feed conversion ratio (FCR), daily protein intake (DPI) and protein efficiency ratio (PER). Increasing levels of processed sweet orange peel significantly ($P>0.05$) decreased the average final body weight, average daily weight gain, ADFI, DPI and PER, and increased FCR as the level of processed orange peels increased in the diet. Based on the results obtained in the present study, it was therefore concluded that inclusion of processed sweet orange peels had adverse effect on the growth rate and nutrient utilization by broiler finisher birds.

Keywords: Broiler finishers, growth performance, processed orange peels, diets

INTRODUCTION

Nutrition and diseases are 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 [1]. Availability of quality feed at a reasonable cost is therefore the key to successful poultry production. Poultry are excellent feed converters and do not suffer social infringement on consumer acceptability like other livestock species such as pig. The foregoing has triggered the rising demand for poultry products like eggs and meat, given their palatability and high nutritional value. These attributes amongst others, make the poultry industry stand tall amidst rival livestock producing ventures. The development of the poultry industry has been described as the fastest way of ameliorating the animal protein deficiency in third world countries, due to the high turn-over rate associated with poultry production and consequent economic efficiency [2]. In spite of the aforementioned benefits derived from poultry, the ever-increasing cost of products such as meat and egg makes it imperative to explore the use of alternative feed ingredients that are cheaper, locally available and of low human preference in poultry ration formulation. One of such alternatives is the sweet orange (*Citrus sinensis*) peel. A number of orange by-products like citrus pulp, citrus meal, citrus seed meal, citrus peels, citrus molasses, etc are generated from fresh citrus after the main product of interest has been extracted during processing for direct human consumption as in the case of developing countries [3]. In Nigeria, all the varieties of citrus, the sweet orange is consumed on a wide scale, and the peels are usually considered as waste 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. It can be inferred that one of the present day core foci of science is to come up with modalities on how to recycle waste materials that are hazardous to the environment into useful products that can be of benefit to humans. It is on this premise that [4] suggested that rather than discarding these peels, they can be sun-dried and then milled in grading machine to obtain fine-particles of orange peel meal which can be included in fish diet. Sweet

orange fruit peel meal has been observed to be a source of calorie and protein comparable with maize [5]. Besides, [6] reported that dried grapefruit waste materials are good for growing animals based on the nutritive and digestible nutrients contained therein. According to [7], citrus molasses was also found to be a viable substrate for fermentation in the beverage-alcohol industry. Thus far, nutritional trials with monogastric animals have shown that the meal of sun-dried peels of *Citrus sinensis* can replace up to 20% of dietary maize in broiler diet [8], and 40% in rabbit [9], without any adverse effect on their performance. Furthermore, the orange peel is shown to contain oil sacs and the oil is composed of 91-94% D- limonene and 2.0-2.1% B- myrcene as a minor constituent [10]. Polymetholated-flavones are also a class of compound found in citrus peel and produce no negative effect in the animals fed on the polymetholated flavones-containing diets [11]. However, citrus seed meal has been reported to contain limonene which is toxic to pig and especially to poultry [12]. While orange peel has been included in the diet of ruminant especially in those areas where its production is high [13], the presence of limonene may be a limitation to its use in raising monogastric animals. Additional reports [14], shows that citrus fruit peel meal contains anti- nutritional factors such as limonene, tannin, saponin, phytate, oxalate which interfere with digestive processes, prevent effective absorption and utilization of micro/macro nutrients in the body. It is against the aforementioned backdrops that the present study was conducted to investigate the performance of broiler finisher birds fed graded levels of processed orange peels.

MATERIALS AND METHODS

The study was carried out at the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. The experiment lasted for four weeks.

Formulation of Experimental Diets

Four (4) broiler finisher diets were formulated to contain 0, 5%, 10%, and 15% levels of processed orange peels, respectively. The percentage composition of the diets is shown in Table 1.

92 **Table1:** Percentage composition of experimental diets

	Dietary Processed Orange peel levels (%)			
	0	5	10	15
Ingredients/Treatment	A	B	C	D
Maize	44	39	34	29
Wheat offal	12	12	12	12
Soybean meal	18	18	18	18
Palm kernel cake	17	17	17	17
Fishmeal	4	4	4	4
Sweet orange peels	0	5	10	15
Salt	0.25	0.25	0.25	0.25
Bone meal	4	4	4	4
Vitamin/min. premix	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated composition				
Crude protein (%)	20.01	20.02	20.04	20.04
Energy (Mcal/Kg ME)	2.91	2.88	2.89	2.95
Fibre	5.11	5.64	6.27	6.9
Cost of feed (₦)/Tonne	51,851	50,472	49,311	48,125
Cost differential	-	1379	2540	3726

93 *Vit.A- 8,000,000 iu., D₃ 1,600,000 i.u., B₁₂ 10mg., E, 5,000 iu.,K,2,000 mg Niacin 15,500mg,
 94 Manganese 80g, Zinc,50g.,Pantothenic Acid,5,000mg,Iron,20g,Folic
 95 Acid,500mg,Copper,5g.,Thiamine,B₁,1500mg.,Biotin 20mg Iodine, 1.2g.,Riboflavin, B₂,
 96 4000mg., Choline Chloride ,200g,Selenium,200mg,Pyridoxine, B₆ 1500mg, Antioxidant, 125g,
 97 Cobalt, 200mg

98 **Experimental Birds and Experimental Design**

99 A total of 60 4-week old broiler finishers (Anak strain) with initial body weight of were used for the study
 100 which lasted for four weeks. The birds were randomly divided into four treatment groups of 15 birds each.
 101 The groups were randomly assigned to the four experimental diets containing 0, 5%, 10% and 15% levels
 102 of processed orange peels (POP), respectively in a completely randomized design (CRD). Each
 103 treatment was replicated 3 times with 5 birds per replicate. The birds were reared on deep litter with floor
 104 covering of 2 cm thick fresh wood shavings changed on weekly basis.

105 **Management of Experimental Birds and Data Collection**

106 The birds were properly vaccinated as and when due following the vaccination protocol for broiler birds by
 107 the National Veterinary Research Institute (NVRI), Vom, Plateau State, Nigeria (unpublished). In order to
 108 prevent the outbreak of coccidiosis in the birds, coccidiostats were also administered at intervals. Feed
 109 and water were offered fresh and ad libitum every morning, between 7:00 am and 8:00 am. The weight of
 110 the feed offered minus the weight of the left over feed was recorded as the daily feed intake. The birds
 111 were weighed at the beginning of the experiment to determine their initial body weights, and subsequently
 112 on weekly basis to determine their live body weights and body weight gain. The birds were also weighed
 113 at the end of the experiment to determine their final body weights. Feed conversion ratio was then
 114 calculated from these data as gram feed consumed per gram weight gained over the same period.

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Proximate and Statistical Analyses

Samples of experimental diets were subjected to proximate analysis according to [15]. The peels which were collected from a single orange plant were fermented in a synthetic sack for 48hrs and afterwards, they were subjected to steaming in a steaming chamber in the laboratory for 30 minutes after which they were sun-dried till the peels became crispy. Thereafter, dried sweet orange peels were ground, and the chemical composition was determined at the Veterinary Physiology and Biochemistry, Departmental Teaching Laboratory, University of Agriculture, Makurdi, Benue State, Nigeria. Data collected were subjected to analysis of variance (ANOVA) for completely randomized design (CRD) using a Stat Graphic Computer Package (SPSS, 2007). Significantly different means were separated using the Duncan's New Multiple Range Test option in SPSS (2007).

RESULTS

Chemical Composition of Processed Orange Peels and Experimental Diets

The proximate composition of the experimental diet is shown in "Table 2", while the proximate and phyto-chemical compositions of the processed sweet orange peels used in the study are presented in Tables 3 and 4.

Table 2: Proximate composition of the experimental diets

	Orange peel levels (%)			
	0	5	10	15
Component (%) / Diets	A	B	C	D
Dry matter	94.10	87.70	92.50	88.50
Crude protein	20.02	19.70	19.26	19.70
Ether extract	1.30	1.50	2.35	1.25
Ash	8.60	9.25	9.05	10.23
Crude fibre	3.46	3.37	3.50	3.96
Nitrogen-free extract	66.62	53.88	58.34	53.36

Table 3: Proximate Composition of Processed Orange Peels (Fermented for 48hrs)

Components (%)	
Dry matter	89.20
Crude protein	10.00
Crude fibre	14.60
Ether extract	2.95
Ash	4.47
Nitrogen-free extract	67.90
Gross energy (Mcal/ Kg)	2.89

Table 4: Phyto- Chemical Composition of Sample Peel samples

Sample type	Phyto- Chemical Type			
	% Tannin	% Phytate	% Saponin	Cyanogens (mg/100)
Fresh	0.04	0.75	2.0	20.80
Dried	0.12	0.21	4.0	75.40

The crude protein value of 10% obtained from the 48 hr fermented orange peels is in agreement with the value reported by [5].

Effect of Varying Dietary Levels of Sweet Orange Peels on Performance of Broiler Finishers

Data on the growth performance of the broiler finishers fed the experimental diets are shown in “Table 5”.

Table 5 : Performance of broilers finisher birds fed graded levels of processed orange peels

Parameters	Dietary level of processed orange (%)				SEM
	0	5	10	15	
Average initial body weight(g)	426.7	423.3	423.3	426.7	0.01
Average final body weight(g)	2106.7 ^a	1760.0 ^b	1426.7 ^c	1060.0 ^d	0.02
Average daily weight gain(g)	60.00 ^a	47.74 ^b	35.83 ^c	22.74 ^d	0.59
Av. Daily feed intake (g)	151.43 ^a	117.38 ^b	109.29 ^b	108.57 ^b	1.84
Total feed intake(g)	1680 ^a	1336.72 ^b	1003.24 ^c	636.72 ^d	1.48
Feed conversion ratio	2.45 ^b	2.51 ^b	3.04 ^b	4.79 ^a	0.19
Daily protein intake(g)	30.32 ^a	23.12 ^{ab}	21.39 ^b	21.09 ^b	1.52
Protein efficiency ratio	2.00 ^a	2.10 ^a	1.72 ^a	1.09 ^b	0.13
Mortality(%)	0	0	0	0	-

^{a,b,c,d} Means with different superscripts in the row are significantly (P<0.05) different.

SEM = Standard Error of Mean

The effect of treatment on final weight and daily weight gain were significant (P<0.05). Birds on control diet (0% POP) had significantly (P<0.05) higher weight than those fed other diets. This was followed by broilers fed 5% POP having significantly (P<0.05) higher weight than those on 10% and 15% POP, with those on 15% POP having the least growth performance. The same trend was observed for average daily weight gain. For average daily feed intake, broilers on control diet consumed significantly (P<0.05) higher amount of feed than those fed other diets. There were no significant differences (P>0.05) in feed intake for broilers receiving the orange peel meal based diets. However, significant (P<0.05) differences existed between treatments in total feed intake. Total feed intake increased significantly as the level of POPM increased from 0% to 15% in the diets. Broilers fed 15% POPM had significantly (P<0.05) higher FCR values than those on control (no POP), 10 and 15% POP diets. The FCR for broilers on 0, 5 and 10 % POP did not differ significantly (P> 0.05). For daily protein intake, broilers on control diet had higher protein intake (P<0.05) than those on other diets. There was however no significant differences (P>0.05) in protein intake for broilers on POP diets. Broilers on 15% POP had the least protein efficiency ratio (P>0.05).

Cost implication of feeding graded levels of processed sweet orange peel to broiler finishers

“Table 6” shows the cost implication of feeding graded levels of processed sweet orange peel to broiler finishers. There were significant differences among treatments in total feed intake, cost of total feed consumed, cost of daily feed intake and feed cost per kg weight gain. Broilers fed 0% POPM diet had significantly (P<0.05) higher total feed intake, cost of total feed consumed, cost of daily feed intake and lower feed cost per kg weight gain than birds fed 5, 10 and 15% POPM diets. As shown in table 6, cost of total feed consumed and cost of daily feed intake were significantly reduced with increasing levels of POPM in the diets, while feed cost per kg weight gain increased significantly as the level of POPM

increased from 0% to 15% in the diets. This finding is in consonance with the report of [16] which showed that broiler birds fed 10, 15 and 20% raw Bambara nut waste diets had significantly ($P<0.05$) lower costs of daily and total feed intakes than birds on control diet. The reduction in costs of daily and total feed intakes observed at the 5, 10 and 15% POPM inclusion levels could be attributed to low cost of 1kg feed of the POPM diets and low feed intake observed in birds that consumed the POPM diets. The observed increase in feed cost per kg weight gain may be attributed to poor efficiency of feed conversion and utilization, and poor growth rate of birds that consumed the POPM- containing diets.

Table 6: Cost implication of feeding graded levels of processed sweet orange peel to broiler finishers

Parameters	Dietary level of processed orange peel (%)				SEM
	0	5	10	15	
Cost of 1kg feed(₦)	51.85	50.47	49.31	48.13	-
Cost of total feed intake(₦)	87.11 ^a	67.46 ^b	49.47 ^c	30.65 ^d	8.01
Cost of daily feed intake(₦)	7.85 ^a	5.92 ^b	5.39 ^c	5.23 ^d	0.39
Feed cost per kg wt gain(₦)	127.03 ^c	126.68 ^d	149.90 ^b	230.54 ^a	16.11

^{a,b,c,d}Means with different superscripts in the row are significantly ($P<0.05$) different.

SEM = Standard Error of Mean

DISCUSSION

Growth Performance of Broiler Finisher Birds Fed Diets Containing Graded Levels of Processed Orange Peels

As shown in Table 5, feed intake declined significantly at all the sweet orange peel inclusion levels in the diets. This finding is consistent with the observations of [14], [17] and [18]. The reduction in feed intake could have been as result of the orange peel based diets being less palatable than the control diet. Perhaps the inclusion of fermented orange peels in the broiler finisher diets might have rendered the compounded diets unpalatable. Consequently, the appetite of the treated birds for these diets dropped, thus resulting in depressed feed intake. The problem of palatability is therefore critical to increased feed intake in orange peel meal based diet. The decrease in feed intake noticed in broilers that consumed the sweet orange peel based diets may be attributed to an anti- nutritional factor in citrus peel known as saponin. Saponins are bitter and reduce the palatability of livestock feeds. Besides, orange fruit peel contains oil which is acidic and confers on it a sharp taste which may also have been responsible for the depression in the quantity of feed consumed by the treated broilers. It does seem that the processing of orange peel by fermentation applied in this study could not improve the feed intake and efficiency of feed utilization by the birds. That broiler birds fed 0% sweet orange peel diet had significantly higher feed intake (151.43g) than those fed diets containing 5, 10, and 15% sweet orange peel meal could be attributed to the fact that those birds in the control group had significantly higher rate of growth than those in the treated groups. Animals feed in proportion to their body weight and general metabolic requirement which increases with growth rate. The higher values of the feed intake observed in the control group may be a response to the relatively higher metabolic activities which take place in broilers at the finisher phase and which is a major characteristic of this physiological phase of growth. This is purported in the findings by [19], that the more feed an animal consumes each day, the greater will be the opportunity for increasing its daily production. As such, the birds had to consume more feed in order to meet their basic dietary needs.

It was observed "Table 5" that the inclusion of sweet orange peels in the broiler finisher diets resulted in growth depression as evidenced by significant decrease in final body weight and body weight gain. Previous reports on growth performance of broilers fed varying levels of dietary orange peel agree considerably with the findings in the present study. For instance, [14] fed fermented sweet orange peels

to broiler chicks at 0-48% levels and reported that fermentation of sweet orange peels depressed the body weight gain, and live weight of the treated broilers. The performance of broilers fed the orange peel based diets was therefore observed to be inferior to that of broilers in the control group. However, the result obtained in this study which reveals a noticeable decrease in body weight gain as the level of inclusion of POP increased from 0- 15%, undoubtedly contradicts the findings of [17] which showed that sweet orange peel meal can be a dietary substitute for maize up to 20% level in the diet of broilers.

It is well known that feed intake is a major factor that influences weight gain. The decline in weight gain of birds that consumed the sweet orange peel based diets may be attributed to depressed feed intake and lower efficiency of feed utilization. [20] made a similar suggestion. Growth depression had earlier been attributed to reduced feed intake [21], [22] and [23]. As the daily feed intake per bird decreased, invariably, the chickens receiving these diets did not have sufficient dietary nutrients, hence resulting to depressed growth. Therefore, the metabolic and production requirements of the birds could not be satisfied with the decline in feed intake. [24], has reported that weight and feed intake were negatively affected as the level of citrus peel in poultry diet increased. The decrease in growth rate noticed in broilers on the POP meal based diets may be attributed to an anti- nutritional factor in citrus peel known as saponin. Among the effects of saponin on animals are growth inhibitions in swine and poultry, reduced palatability of food and increased excretion of cholesterol concentration [25]. The saponin content of the citrus peel used was observed to be 2% (when wet) and 4%(when dry) and quite above 3% which was reported by [26] to be responsible for animals losses when they grazed on alfonibrilla (Drymaria arenaroides).

As shown in "Table 5", the experimental diets also had significant effect ($P<0.05$) on FCR, daily protein intake and protein efficiency ratio. While daily protein intake declined at the 10 and 15% sweet orange peel inclusion levels, protein efficiency ratio and efficiency of feed conversion and utilization were observed to have declined at the 15% sweet orange peel inclusion level. This observation agrees with the findings of [27] which showed that dried sweet orange pulp when incorporated into the diet of rabbits had a significant effect on protein efficiency ratio. The superior growth performance (final body weight and average daily weight gain) of birds fed the control diet (0% FOPM diet) over those fed the orange peel meal based diets tends to suggest that inclusion of FOPM in the diet of broiler birds had deleterious effect on growth performance. While the nutrient composition of orange fruit peel seems to highlight its potential to serve as an alternative feed stuff to maize, it is apparent that the fermentation technique employed in the present study is not adequate to transform it into a form that will enhance its usefulness. It thus appear that if adequate processing techniques are employed to enhance the nutritive value of sweet orange fruit peel, then it can be a viable dietary energy substitute for maize in feeding broilers with a view to reducing the cost of production.

CONCLUSION

The results obtained in the present study show that the inclusion of processed sweet orange peels in broiler finisher diets had adverse effect on the growth rate and nutrient utilization by broiler finisher birds.

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