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Effect of Soaking Duration of Sweet Orange Peel Meal *(Citrus Sinensis)* On The Gastrointestinal and Organmorphometry Of Broiler Chickens

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Abstract

One hundred and eighty day-old Marshall Broiler chicks were used to study the effect of dietary sweet orange peel meal (SOPM) on their internal organs. The birds were weighed and randomly distributed to six dietary treatments. Treatments T_2, T_3, T_4, T_5 and T_6 were soaking duration for 0, 24, 48, 72, and 96 hours respectively and T_1 served as the control diet. *Each treatment had 30 broiler chicks divided into three equal replicates in a completely randomized design (CRD). The study lasted five weeks. The proventriculus, kidneys, spleen, gall bladder, heart, lungs, pancreas and liver relative to percent live weights of the finisher chickens sacrificed per group showed that the use of water soaking as a processing technique for SOP as a replacement for maize in their diet did not significantly alter the development of these organs, except the empty gizzard. As the dietary crude fibre content of SOP diets increased, the gizzard weight also increased. The large intestine expressed as percentage GIT had significant (P< 0.05) difference among the treatment means. Soaking as a processing method of orange peels did not affect the length of the gastro-intestinal tract, small intestine and caeca as duration of soaking increased.*

Keywords: *Soaking, broilers, sweet orange peel meal, internal organs, gastrointestinal tract*

Introduction

The peels, in sweet orange (*Citrus sinensis*) represents roughly 30% of the fruit mass (Saleh *et al*., 2009). Sweet orange (*Citrus sinensis*) production in Nigeria is significant according to FAO (2004). Nigeria produces 3% of fresh citrus in the world, and Africa produces 3,741, 000 tons of different varieties of citrus fruits of which Nigeria contributes 3, 240,000 tones. Sweet orange fruit peel is one of the by-products. In Nigeria, it is mostly obtained after the exocarp is peeled off and the fruit juice extracted or sucked. Orange fruit peel is available throughout the year even though high production of the fruit is from October through March, and it is not being put into any productive use. In developing countries like Nigeria residues are obtained when citrus fruits are peeled for direct human consumption. Agu *et al.* (2010) reported a crude protein value of 10.73%, crude fiber of 7.86%, ether extract of 12.60%, ash content of 11.90%, nitrogen free extract of 56.91% and dry matter of 89.65%.Oluremi*et al.* (2008) reported the crude protein contents of sweet orange fruit peel meal fermented for 0, and 24 hours as 7.44 and 8.29%, respectively, and were lower than that of maize 9.25% (Tuleun *et al*. 2005), 9.0% (Aduku, 1993), 10.04% CP for peels fermented for 48 hours (Oluremi *et al.,* 2008) and Guluwa (2014) reported 10.79- 13.01% CP of water soaked sweet orange peel. According to Agu (2006), gizzard, proventriculus, the head and shanks of chickens fed diets containing 30-50% sweet orange peel meal as replacement for maize were relatively heavier than those at lower levels of replacement.

Soaking could be one of the processes to remove soluble anti-nutritional factors, which can be eliminated with the discarded soaking solution. However, some metabolic reactions can take place during soaking which will affect some of the constituent compounds (Vidal-Valverde *et al*., 1992).

The study of Guluwa *et al.* (2016) observed that water can be applied to soak sweet orange peels for the biochemical manipulation of the peels to improve the nutritional value of this potential maize replacement feed ingredient in broiler chicken feeding. The use of non-conventional sources to complement the conventional ones is affected by several factors ranging from low protein content, high fiber content (Gillespie, 1987., Mc-Donald *et al*., 1988; Church and Pond, 1988).Recent scientific and practical research indicates that dietary fibre can have numerous positive benefits including improved litter quality and bird health. Dietary fibre is necessary to regulate digestion in broilers and laying hens. Including dietary fibre aids will support peristalsis, thus moving along the development of the fermentation process into the large intestine and increasing the growth of beneficial bacteria. The fermentable fibre fraction is not digested by the bird itself, but is utilized by the microbes in the large intestine (Kroismayr, 2012).

In view of this, the use of sweet orange peel meal, a by-product of sweet orange, as energy source may be useful as an alternative to more expensive ones because there is no competition in the use of orange peels by human food.Orange peel is obtained when the yellowish to greenish outer coat is peeled. It is used by gardeners as a slug repellant. The main objective of the study is to evaluate the effect of replacement of maize with sweet orange peel meal (SOPM) in the diet of broiler chickens on their internal organs and gastrointestinal morphometry organs.

Material and methods

The experiment was conducted at the Poultry unit of the Plateau State College of Agriculture, Garkawa. Garkawa town is located on latitude 8^0 58E and longitude $9^0$45N, with an elevation of 240m above sea level determined using global positioning system (GPS) (Guluwa, 2014).Sweet orange peel meal was collected from orange retailers who peeled sweet orange fruits for direct human consumption. The peels were sun dried immediately. Sun drying lasted for 48 hours for the peels to be crispy. The peels were stored in synthetics bags, tied at the open end to keep them. The sun-dried peels was divided into five (5) equal portions and soaked in water for 0, 24, 48, 72, and 96 hours. Thereafter, they were again sun dried and milled to obtain sweet orange peel meal coded SOP_o, SOP_{24}, SOP_{48}, SOP_{72}, and $SOP_{96,}$ respectively. The experimental diet for finishers phase is presented in Table 1.

One hundred and eighty day-old Marshal Broiler chicks purchased from Obasanjo farms, Ogun State were used for the study. The birds were weighed and randomly distributed to the six dietary treatments. Each treatment had 30 broiler chicks divided into three equal replicates in a completely randomised design (CRD). Newcastle (Lasota) and infectious Bursal disease (Gumboro) vaccines were administered at 2^{nd} and 3^{rd} weeks of age, respectively. Coccidiostats were also given at alternate weeks. Anti-stress multivitamins were administered as prophylactic measures through drinking water. The experimental diets and water were provided *ad libitum* and the experiment lasted for 5 weeks.

At the end of the finisher phase, two (2) birds from each replicate with an average live weight of each replicate group were fasted (feed only) for 18 hours and used for internal organs and gastrointestinal tract morphometry studies. Internal organsstudied were: the liver, kidneys, spleen, gizzard, heart and lungs. They were taken and expressed as percentages of live weight.Gastrointestinal tract morphometry were determined by taking their length with a meter rule (Oluyemi and Robert, 2000).Data collected were subjected to one-way analyses of variance (ANOVA) using the SPSS (2010) statistical software. Where significant difference was observed at 5%, means were separated using Duncan's Multiple Range Test (DMRT) as outlined by SPSS (2010).

Table 1: Gross ingredients and nutrient composition of broiler finisher diets containing sweet orange (*Citrus sinensis*) peel meal.

	Experiment diet					
Ingredients	Control	$SOPM_0$	$SOPM_{24}$	$SOPM_{48}$	$SOPM_{72}$	$SOPM_{96}$
Maize	61.52	36.91	36.91	36.91	36.91	36.91
SOPM	0.00	24.61	24.61	24.61	2461	24.61
SBM	23.40	23.40	23.40	23.40	23.40	23.40
BDG	8.00	8.00	8.00	8.00	8.00	8.00
Blood meal	2.58	2.58	2.58	2.58	2.58	2.58
Bone meal	2.95	2.95	2.95	2.95	2.95	2.95
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00
Nutrients composition of experimental diets						
ME.Kcal/kg	2952.09	2888.95	2894.56	2875.02	2881.94	2865.74
Crude protein (%)	20.00	20.46	20.63	21.82	20.89	21.01
Crude fibre (%)	4.16	8.63	8.99	9.46	9.52	9.93
Ether extract (%)	3.89	3.52	3.58	3.64	3.72	3.63
Lysine (%)	1.23	1.17	1.17	1.17	1.17	1.17
Methionine (%)	0.59	0.54	0.54	0.54	0.54	0.54
Calcium (%)	1.47	1.71	1.77	1.74	1.70	1.75
Phosphorus (%)	0.75	0.68	0.68	0.68	0.68	0.68.

Control diet, $SOPM_0$= Diet of sweet orange peels meal not soaked in water, ($SOPM_{24}$) = Diet of sweet orange peels meal soaked in water for 24 hours, $SOPM_{48}$ = Diet of sweet orange peels meal soaked in water for 48 hours, $SOPM_{72}$= Diet of sweet orange peels meal soaked in water for 72 hours, $SOPM_{96}$ = Diet of sweet orange peels meal soaked in water for 96 hours. BDG = Brewers dried grain, SBM = Soybean meal, SOPM= Sweet orange peel meal, ME = Metabolisable energy *Vitamin-Mineral premix ($BIOMIX^{(R)}$) will supply per kg diet; Vit. A 500IU; Vit. D_3 888, IU; Vit. E_{12}, 000mg; Vit. $K_3$15000mg; Niacin 12000mg; Pantothenic acid 2000mg, Biotin 1000mg; Vit b12 3000mg; Folic acid 15000mg; Choline chloride 6000mg, Manganese 1000mg; Vit. Iron 15000mg; Zinc 800mg; Copper 400mg; Iodine 80mg; Cobalt 400mg; Selenium 8000mg.

Results and Discussion

The internal organs of broiler finisher chickens fed the experimental diets are presented in Table 2. The result showed that there were no significant ($P>0.05$) differences among treatments in proventriculus, kidneys, spleen, gall bladder, heart, lungs, pancrease and liver of the birds. The diets, however, produced significant ($P<0.05$) effect on the empty gizzards among the treatments. The mean percent weights of the empty gizzards of the chickens fed the sweet orange peel meal diet based groups were significantly higher ($P<0.05$) than mean percent live weight of empty gizzard of the control. The result of the evaluation of the average weights of the proventriculus, kidneys, spleen, gall bladder, heart, lungs, pancreas and liver relative to live weights of the finisher chickens revealed that the use of water soaking as a processing technique for SOP as a replacement for maize in their diet did not significantly alter the development of these organs except the empty gizzard. The higher crude fibre content of SOP diets may have possibly caused the higher gizzard weight of the birds fed these diets compared to the maize-based control diet. The grinding process of these relatively more fibrous diets may be attributed to muscular development or activity of the gizzard in breaking down fibrous SOPM thus causing higher weight. The gizzard constitutes between 1.92% - 2.46% of the body weight of broiler chickens fed SOPM which were lower than 3.80% - 4.80% reported by Amaefule *et al.* (2006) working with treated rice mill waste. As the dietary crude fibre content of SOP diets increased, the gizzard weight also increased.

Table 2: Effect of experimental diets on internal organs (%LW) of broiler finisher chickens

Internal organs	Experimental Diets						
	Control	$SOPM_0$	$SOPM_{24}$	$SOPM_{48}$	$SOPM_{72}$	$SOPM_{96}$	SEM
Proventriculus	0.36	0.60	0.52	0.49	0.54	0.47	0.03 ^{ns}
Kidney	0.45	0.78	0.75	0.72	0.73	0.76	0.04^{ns}
Spleen	0.07	0.11	0.11	0.11	0.12	0.27	0.03^{ns}
Gall bladder	0.11	0.19	0.19	0.16	0.16	0.16	0.01 ^{ns}
Heart	0.37	0.50	0.39	0.46	0.36	0.43	0.02^{ns}
Lungs	0.54	0.57	0.60	0.59	0.48	0.65	0.02^{ns}
Pancrease	0.22	0.30	0.31	0.27	0.25	0.24	0.02^{ns}
Liver	1.47	1.94	1.86	1.81	1.86	1.93	0.06 ^{ns}
Empty gizzard	1.72^{b}	2.46^{a}	2.32^{ab}	2.25^{ab}	2.40^{a}	1.92^{ab}	0.08*

$^{*\ a,\ b,\ c}$ Means on the same row with different superscripts are significantly different (P< 0.05), ns Not significant (P> 0.05), SEM = Standard error of mean, % LW = Percent live weight, Control diet, $SOPM_0$= Diet of sweet orange peels meal not soaked in water, ($SOPM_{24}$) = Diet of sweet orange peels meal soaked in water for 24 hours, $SOPM_{48}$ = Diet of sweet orange peels meal soaked in water for 48 hours, $SOPM_{72}$= Diet of sweet orange peels meal soaked in water for 72 hours, $SOPM_{96}$ = Diet of sweet orange peels meal soaked in water for 96 hours.

Table 3: Effect of experimental diets on Gastro-intestinal tract morphometry of broiler finisher chicken

GIT Indices	Experimental Diets						
	Control	$SOPM_0$	$SOPM_{24}$	$SOPM_{48}$	$SOPM_{72}$	$SOPM_{96}$	SEM
GIT (cm)	267.67	261.67	255.00	274.10	274.67	269.17	2.78^{ns}
Small intestine (% GIT)	70.60	68.74	69.81	70.96	70.14	70.40	0.90^{ns}
Large intestine (% GIT)	5.42^{a}	4.83^{ab}	5.51^{a}	4.31^{b}	4.61^{b}	4.95^{ab}	0.13*
Caeca (% GIT)	13.95	14.01	15.79	13.87	15.10	13.68	0.26 ^{ns}

$^{*\ a,\ b}$ Means on the same row with different superscripts are significantly different (P< 0.05), ns Not significant (P> 0.05), SEM = Standard error of mean, %GIT = percent gastro-intestinal tract length., Control diet, $SOPM_0$= Diet of sweet orange peels meal not soaked in water, ($SOPM_{24}$) = Diet of sweet orange peels meal soaked in water for 24 hours, $SOPM_{48}$ = Diet of sweet orange peels meal soaked in water for 48 hours, $SOPM_{72}$= Diet of sweet orange peels meal soaked in water for 72 hours, $SOPM_{96}$ = Diet of sweet orange peels meal soaked in water for 96 hours.

Data obtained from the evaluation of the length of the GIT and its parts expressed as percent of the GIT is presented in Table 3. The variation in the length of the GIT and the length of small intestine and caeca expressed as percent GIT were not significantly affected (P>0.05) by the experimental diets among the treatment groups. The large intestine expressed as percent of GIT had significant (P< 0.05) difference among the treatment means. It was observed that there was no particular order in the pattern of variation. Soaking as a processing method did not suppress the length of the gastro-intestinal tract, small intestine and caeca as duration of soaking increased. However, there were no clear trends of significance different for large intestine as the soaking time increased from 0 – 96 hours.

Conclusion

The functions of proventriculus, kidneys, spleen, gall bladder, heart, lungs, pancrease, liver and the length of the gastro-intestinal tract, small intestine and caecawere not affected by the inclusion of water soaked sweet orange peel meal in the diets of broiler chickens as their soaking duration increased. However, the diets produced significant (P<0.05) effect on the empty gizzards among the treatments.

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