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Mineral Uptake of Broiler Chicken Fed Palm Kernel Shell Ash as a Mineral Supplement in Finisher Ration

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Abstract

The objective of this study was to determine the mineral uptake of broiler whose diets were supplemented with palm kernel shell ash (PKSA) as a mineral supplement using faecal mineral composition as indicators of mineral uptake by the birds. Ninety six Arbor Acre day old chicks were randomly assigned in triplicates of eight birds per replicate to four experimental diets containing graded levels of PKSA at 0, 5, 10 and 15 kg/ton. Results obtained showed that there was a lowering of most mineral concentrations below the control in the experimental diets while Cu and Mg were increased. The faecal mineral concentrations recorded in this study tend to suggest that there is accumulation and concentration of higher levels of minerals in the faeces, more than the levels found in the diets. Faecal Mg, K, Cu and Zn concentrations of PKSA treated birds were higher than the control values, while those of Ca, Na, Mn, Fe and P reduced as a result of PKSA inclusion in the diets. PKSA could serve as potential sources of absorbable mineral supplements and also could improve mineral uptake from commercial diets offered to broilers.

Keywords: PKSA, mineral absorption, fecal

Introduction

Under the intensive production system, feeding involves providing rations with balanced nutrients that best meets the animals' needs for growth, maintenance and production (Lawrence and Fowler, 1997). These nutrients must be provided at the appropriate concentrations and amount as well as in the right form in order to enhance their bioavailability (Suttle, 2010). One of the critical nutrients required by animals for optimal productivity is minerals. Minerals are dietary essentials to all classes of livestock needed for structural, physiological, catalytical and reproductive functions (Suttle, 2010).

All natural feedstuffs contain some minerals but their contents are usually not enough to meet the requirements of the modern chicken hence, supplemental minerals are provided in various forms including salt; trace mineralized salt, oyster shell, limestone, bone meal and a wide variety of other forms (Power and Horgan, 2007). Majority of the minerals used in supplementing intensively farmed animals come from rock or inorganic substances (Di calcium phosphate) which are mostly expensive and therefore not readily accessed by small holder farmers. The organic minerals sources such as bone meal and oyster shell, although cheaper, are not readily available due to its low output (Alu, 2013). Lately, some attempts have been made towards improving the mineral contents of poultry feeds with unconventional alternative sources such as egg shell (Alu, 2013) and fossil shell (Adeyemo, 2013). Wood ash could also form a readily available source of mineral supplement in animal ration (Iwu *et al*., 2013; Nwogu *et al*., 2014; Okoli *et al*., 2014). Specifically, Okoli *et al.* (2014) reported that plantain ash is a good source of absorbable mineral supplements in the diets of pullets.

PKS is a readily available agricultural industry residue that has found limited application in the Nigerian industry. It is currently used as biofuel in palm oil processing operations and the ash residue is discarded as waste material. In producing PKSA, the burnt organic components of the shell, which ordinarily interact with mineral molecules to reduce their bioavailability (Power and Horgan, 2007) are completely eliminated. It is therefore expected that the ash may be a valuable mineral source and may successfully replace intact plant and rock mineral sources in animal diets when properly processed.

This study therefore investigates the uptake of minerals in broilers fed PKSA as a potential mineral source for broiler rations.

Materials and Methods

The PKS were collected from a local oil mill, washed with water, sun – dried, weighed and ashed in a bread oven after which the resultant product was ashed again using a porcelain pot till the ash produced became red hot (Iwu *et al*., 2013). 96 Arbor acre day old chicks were purchased from a reputable local hatchery and were divided into four groups of 24 birds with each of the group further replicated three times with 8 birds per replicate in a completely randomized design. The birds were managed intensively as practiced at the Teaching and Research Farm of Federal University of Technology Owerri.

The birds were assigned to four treatment diets containing graded levels of PKSA at 0, 5, 10 and 15kg/ton of feed to partially replace graded levels of bone meal in the diets respectively. Each sample of the diet was subjected to mineral analysis using the method of official analytical chemist (AOAC, 1995) with the aid of atomic absorption spectrophotometry. At the 8 weeks of the experiment, faecal samples were collected from each treatment group and prepared for mineral content analysis. The samples were air dried until they become crispy to touch. Thereafter, they were subjected to AAS analysis as earlier described to determine their concentrations for minerals (AOAC, 1995).

Data obtained were subjected to analyses of variance using Statistical Package for Social Sciences (SPSS version 20, 2012) and the differences between the treatment means were compared using the Duncan Multiple Range Test (SPSS, 2012).

Table 1: Mineral concentration of experimental finisher diets

Parameters	T1	T2	T3	T4	Mean	SD	CV
Macro minerals							
Calcium (mg/kg)	266.51	222.54	243.52	163.21	223.94	44.29	19.78
Magnesium (mg/kg)	78.56	79.54	137.54	120.34	103.99	29.65	28.51
Potassium (mg/kg)	238.15	249.22	200.02	184.23	217.90	30.79	14.13
Sodium (mg/kg)	92.84	73.72	86.45	88.44	85.36	8.20	9.60
Phosphorus (mg/kg)	303.46	277.38	248.39	203.88	258.27	42.67	16.52
Micro minerals							
Manganese (mg/kg)	4.56	3.22	3.87	3.66	3.82	0.55	14.39
Iron (mg/kg)	27.66	18.55	26.72	20.21	23.28	4.57	19.63
Copper (mg/kg)	0.30	1.17	0.44	0.98	0.72	0.41	56.94
Zinc (mg/kg)	2.85	2.23	2.43	2.86	2.59	0.31	11.97
Mineral ratios							
Ca/P ratio	0.88	0.80	0.98	0.80	0.87	0.09	10.34
Na/K ratio	0.39	0.30	0.43	0.48	0.40	0.08	20.00
Proximate							
ME Kcal/kg	2107.00	2348.00	2401.00	2251.00	2276.75	129.09	5.67
Crude protein %	17.65	20.16	19.49	22.33	19.91	1.93	9.69

Results and Discussion

The mineral concentrations of the finisher diets are summarized in table 2. The most abundant macro minerals in the diets were profiled as P >Ca>K>Mg>Na, while the order of micro mineral abundance was Fe> Mn> Zn> Cu. These mineral concentrations were however below the values recommended by Standard Organization of Nigeria (SON) for broiler finisher diets (SON, 2003), for broiler finisher ration. The mean Ca/P ratios of the broiler finisher diets indicate that for every 0.87 mg of calcium in the feed, there is 1 mg of phosphorus. The value still falls short of at least 1:1 ratio recommended for broilers (Reinhart and Mahan, 1986). PKSA inclusion also tended to improve the Na/K ratio of treated diets over control diet value.

The data on mineral content of faeces voided by the experimental birds were shown in table 3. Generally, the order of abundance of minerals in the faecal materials were P> K> Ca> Mg> Na> Fe> Mn> Zn> Cu. This mimicked the order of mineral concentrations in the finisher diet except that potassium and calcium swapped places at positions 2 and 3. This is expected since the faecal samples were collected towards the end of the finisher phase of the experiment. The faecal mineral concentrations recorded in this study tend to suggest that there is accumulation and concentration of higher levels of minerals in the faeces, more than the levels found in the diets. For example, the levels of all the minerals in the control birds' faeces were much higher than that of the control feed with most of them doubling. The same trend was observed across PKSA treatment groups except for copper.

Table 2: Mineral concentrations of fecal materials from experimental birds fed PKSA supplemented diets

Parameters	T1	T2	T3	T4	SEM
Calcium (mg/kg)	301.42^{b}	321.25^{a}	218.54^{c}	220.45^{c}	14.11
Magnesium (mg/kg)	160.25^{b}	207.56^{a}	196.47^{a}	207.58^{a}	6.15
Potassium (mg/kg)	321.14^{c}	426.26^{a}	374.52^{b}	361.90^{b}	11.58
Sodium (mg/kg)	113.58^{a}	108.29^{ab}	114.66^{a}	100.02^{b}	2.43
Manganese (mg/kg)	7.91^{a}	8.14^{a}	5.63^{b}	5.09^{b}	0.47
Iron (mg/kg)	62.80^{b}	59.82^{b}	46.57^{c}	73.28^{a}	2.91
Copper (mg/kg)	0.74^{a}	0.52^{b}	0.75^{a}	0.75^{a}	0.03
Zinc (mg/kg)	2.31^{b}	6.02^{a}	4.42^{ab}	6.76^{a}	0.61
Phosphorus (mg/kg)	692.27^{a}	504.98^{b}	421.52^{c}	412.52^{c}	33.97

Faecal Mg, K, Cu and Zn concentrations of PKSA treated birds were higher than the control values, while those of Ca, Na, Mn, Fe and P reduced as a result of PKSA inclusion in the diets. Among the former group of minerals, faecal concentrations were significantly higher ($p<0.05$) than control values. In some cases among the latter group of minerals such as Ca and Fe, T2 values rose above control values before dropping with subsequent increases in PKSA inclusion. There was indeed for many minerals (Ca, K, Mg, Mn and Zn) this T2 rise which was observed before the drop in value, with increasing PKSA inclusion.

Mineral data of the experimental finisher diets fed the birds as shown in table 3 indicate that all the concentrations of the analyzed minerals reduced with increasing inclusion of PKSA in the diets, with the exception of Mg and Cu. Therefore the faecal concentrations of Cu in the present study could be explained as improved uptake as a result of PKSA inclusion. For Ca, Na, Mn, Fe and P, the reduction in faecal concentrations could be due to the need of the birds to make up for the reductions in their diets as a result of PKSA inclusion.

Okoli *et al*. (2014) reported similar result with pullets fed plantain stalk and root base ashes supplemented to commercial grower and layer rations. The study specifically reported reductions in faecal K, Mg, Ni, Fe and Mn and concluded that plantain ash is a good source of absorbable minerals and that it has the potential of improving mineral uptake from commercial diets. The present study however shows that lower faecal values may be due to the diluting effect of the PKSA used and the need by the birds to make up for these in the diets. However, the ability of the birds to absorb more of these minerals, especially the passively transported ones as the inclusion level of PKSA increased shows that the threshold for further absorption has not been attained since such passive absorption is gradient dependent (Okoli *et al*., 2014). Before minerals could be absorbed from the GIT, they must become available in ionic form, which is the only form suitable for their uptake and transportation (Jongloed and Mroz, 1997). The highly soluble monovalent minerals such as Na, K, and Cl could be transported passively into GIT mucosal cells, while other metals depend on the presence of other compounds in the GIT for their transportation. This is because they can easily precipitate or form non – absorbable complexes at the normal pH of the GIT (Ashmead, 2012).

Ashing has been reported to convert most plant materials into their oxide, hydroxide, carbonate and bicarbonate states depending on the temperature of the ashing process. It has also been reported that the degree of solubility of most metal oxides is $M^{3+} > M^{2+} > M^{+}$, indicating that the PKSA may contain more of M^{3+} and M^{2+} (Okoli *et al*., 2014). In the present study, the PKSA was blended with dry methionine and lysine powders and allowed to stand for 24 hours before mixing in the feed. It would seem from the available results that such treatment did not improve the bioavailability of minerals in the PKSA, beyond the expected. There is the need to investigate other methods of achieving the complexing of minerals in such plant ash with natural ligands.

Conclusion and Recommendations

The most abundant macro minerals in the diets were P >Ca>K>Mg>Na while the order of micro mineral abundance was Fe> Mn> Zn> Cu. It is concluded that PKSA causes improved uptake of Ca, Na, Mn, Fe and P as shown by their lower concentrations in the faeces of birds that received the treated diets.

References

Alu, S.E. (2013). Effect of Replacing Bone Ash with Eggshell Meal on Nutrient Digestibility and Blood Parameters of Broiler Chickens. *Iranian J. Applied Ani. Sci.,* 3(1), 125-129.

Adeyemo, G.O. (2013). Growth Performance of Broiler Chickens Fed Fossil Shell Growth Promoter *Food and Nutrition Sciences,* 4:16-19.

AOAC (1995). *Official methods of analysis*. 16th edition. Association of Official Analytical Chemists, Washington DC, USA.

Ashmead, H.D. (2012). *Amino acid chelation in human nutrition*. CRC Press, Taylor and Francis Group, Boca Raton, FL., USA.

Iwu, A.N., Ebere, C.S., Ogbuewu, I.P., Etuk, I.F., Opara, M.N., Uchegbu, M.C., Okoli, I.C., Iheukwumere, F.C. and Herbert, U. (2013). Coconut Shell Ash as a Mild Agonist of Reproductive Organ Development and Sex Hormone Release in Growing Rabbits. *J. of Med. Sci*., 13: 563 – 570.

Jongloed, A.W. and Mroz, Z. (1997). Exchanges of macro and micro elements along the gastrointestinal tracts of pigs. In: J. P. Laplace, C. Fevrier and A. Barbeau (eds), *Proc. 7th Intl. Symposium on Digestive Physiology in Pigs*. INRA, St. Malo, France. EAAP Publication No. 80 pp. 348 - 352.

Nwogu C.M., Nwogu, R.K., Etuk, I.F., Okoli, I.C. and Madubuike, F.N. (2014). Growth performance, carcass and organ characteristics of pullets fed plantain ash supplemented commercial diets. *Media Peternakan*, 37(1): 43 – 49.

Okoli, I.C., Nwogu C.M., Etuk, I.F., Omede, A.A., Ogbuewu, I.P., Aladi, N.O., Okoro, V.M.O., Opara, M.N., Ezema, C., Uchegbu, M.C., Ekenyem, B.U., Anyanwu, G.A., Okeudo, N.J., Udedibie, A.B.I. and Madubuike, F.N. (2014). Plantain ash enhances dietary mineral elements absorption in pullets. *Iranian Journal of Applied Animal Science*, 4(2): 351 – 360.

Power, R. and Horgan, K. (2007). Biological chemistry and absorption of inorganic and organic trace metals. European bioscience center. Alltech Inc., Dunboyne, Co. Meath, Ireland.

Reinhart, G.A. and Mahan, D.C. (1986). Dietary phosphorus for Starter, Grower and Finisher Swine. Effects of various calcium: phosphorus ratios at low and high. *J. Anim. Sci*., 63: 457 – 466.

SON. (2003). Specification for poultry feeds. Nigerian Industrial Standards. N15259: 2003. Standard Organization of Nigeria. Abuja, Nigeria.

SPSS (2012). Statistical Packages for Social Sciences, Ver. 20.0, SPSS Inc. Illinois (USA).
Suttle, N.F. (2010). *Mineral nutrition of livestock, 4th edition*. CAB International, Wallingford, Oxford shire, United Kingdom.