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Full Length Research Paper

Bioavailability of micro and macro-minerals in cockerels fed processed ackee apple seeds in diets

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Ackee apple seeds from fruits of ackee trees grown in Ilorin, were processed into meal (AASM) by soaking (48 h), boiling (90 min) followed by addition of glycine and riboflavin to antagonize the toxic principles in ackee namely hypoglycin A and B. The treated AASM was included in diets at 17.50% in a complete randomized design experiment using 96-day old cockerels. Bioavailability and utilization of micro and macro-nutrients in AASM in diets by the cockerels were evaluated comparing with those on the conventional diet. The availability and utilization of the macro-minerals, Ca, Na, K similarly gave values on the treated AASM diets that were comparable or even superior to values on the control diet (P<0.05). The ratios of Na/K and Ca/P obtained were within the limit recommended for good health. Based on the findings of this study, it is concluded that inclusion of treated AASM in diet at 17.50% has no adverse effects on bioavailability and utilization of minerals in the cockerels.

Key words: Ackee apple seeds, treatments, cockerels, minerals availability and utilization.

INTRODUCTION

Micro and macro-nutrients deficiencies constitute significant nutritional and public health problems. Micro and macro-minerals are inorganic substances present in all living and non- living things including man, animals, rocks, soil. Their presence in living things is necessary for the maintenance of certain physiochemical processes essential to life. Every form of life requires these inorganic elements for normal life processes (Hays and Swenson, 1985; Ozcan, 2003). Macro or major minerals like sodium (Na), calcium (Ca), potassium (k), Phosphorus (P) are essential minerals found in the body in abundance and are critical to health while micro or trace minerals such as iron (Fe), magnesium (Mg), zinc (Zn), manganese (Mn), chloride are highly significant in the body. Dietary deficiencies due to absence of these vital nutrients in food/feedstuffs are observed to have significant adverse effects on man or animals consuming the food or feedstuffs in diets. The deleterious effect of the deficiencies is also shown to affect the entire food chain. While clinical manifestations of the deficiencies of these category of nutrients have been known for centuries in developed world, it has been only a couple of decades that the public health burden of micronutrients deficiencies in developing and less developed countries was fully elucidated.

On the global level, more than two billion people and their livestock are at the risk of deficiencies of micronutrients like iron, zinc, iodine, vitamin A and others. Both macro and micronutrients deficiencies are known to impair the body's functions and to elevate the severity of many diseases and infections in man and animals while compromising intellectual potential, growth, development

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Table 1. Percent composition of the experimental diets.

Diets / Ingredients	Diet 1	Diet 2	Diet 3	Diet 4
Maize	54.75	46.50	49.00	50.50
SBM	35.50	30.00	24.00	18.50
AASM	0.00	17.50	17.50	17.50
Bone meal	1.50	1.50	1.50	1.50
Oyster shell	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50
DL-methionine	0.25	0.25	0.25	0.25
Vit.premix	0.50	0.50	0.50	0.50
Palm oil	6.25	2.00	4.00	7.50
Glycine	0.00	0.75	1.00	1.25
Riboflavin	0.00	0.75	1.00	1.25
Lysine	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00

in the young and reducing productivity in both human and animal adults (NGMDCN, 2005). Iron deficiency for instance, is considered the most prevalent single deficiency state on a worldwide basis. Its economic importance is that it diminishes the capability of individuals who are affected to perform physical labour and diminishes both growth and learning in the young (James, 2012). Iron deficiency causes nearly half of all anaemia cases worldwide and affects females more than males. World estimates of iron deficiency occurrence are projected to exceed one billion (Brady, 2007). Iron deficiency (low red blood cell level) is defined as a decrease in total iron body content when the deficiency is severe enough to diminish erythropoiesis resulting to anaemia. The most common micronutrient deficiency disease is iron deficiency anaemia caused by insufficient dietary intake, poor iron absorption and loss from intestinal bleeding due in most cases by parasitic worms such as round, whip and hookworms. Since the red blood cells cannot be formed when iron is deficient, the objective of this study is to provide data with information on the composition of iron, other micro and macro-minerals in cockerels maintained on treated dietary ackee apple seed meal which in virgin state contains fatal phytotoxins, hypoglycins A and B. The various treatments to which the seed meal is subjected to are aimed at detoxification and improvement of the nutritional value of AASM for the cockerels with respect to mineral availability.

MATERIALS AND METHODS

Preparing the test feedstuff

Fruits of ackee apple (*Blighia sapida*) obtained from trees in Ilorin were harvested when ripened. Seeds were separated from the fruits and sun-dried to ease grinding. Mortar and pestle were used to pulverize the seeds to increase the surface area before soaking and boiling for 48 h and 90 min respectively. The aim of soaking and boiling was to leach out some of the ackee toxins of hypoglycin A and B hence at each treatment, water was decanted. The dough after processing was strained before air-drying to constant weight. The dried material was milled using an attrition miller prior to inclusion in diet mixtures.

Diets formulation, animals and feeding trial

Four diets containing similar energy and protein to meet day old chicks requirements were formulated (NRC, 1994). The control diets was made of a corn- soy basic ingredients while diets 2, 3 and 4 contained the treated AASM at a fixed level of 17.50% to which glycin and riboflavin were added to antagonize the anti-nutritional factors. Glycine and riboflavin were included at 0.75, 1.00 and 1.25% respectively. The composition of the experimental diets on as fed basis, the analyzed nutrients content of the diets are presented on Tables 1 and 2.

Ninety six Lairier breed of day old cockerel chicks were used for the experiment. They were housed in an electrically heated battery brooder cage and the chicks were randomly distributed to the four dietary treatments. A treatment contained 24-chicks and was replicated three times with 8-chicks per replicate. The experiment was designed as complete randomized. Chicks were fed twice daily 8.00 in the morning and 15.00 in the afternoon. Both feed and drinking water were given to appetite.

At the end of the experiment, one chick per replicate on all the treatment was randomly taken and blood samples collected for the analysis of serum chemistry with regards

Table 2. Analyzed nutrients content of diets (%).

Nutrients	Diet 1	2	3	4
Energy kcal/kg	45.70	45.90	47.70	47.50
Protein (%)	23.62	22.96	22.42	22.28
Fibre (%)	2.20	4.50	4.13	3.73
Total ash (%)	0.14	0.16	0.16	0.17
Fat (%)	10.21	12.46	16.91	14.54
NFE	48.00	47.66	49.23	57.64

Table 3. Micro-mineral content in cockerels fed processed AASM in diets (mg/kg).

Diets / Minerals	1	2	3	4	SEM
Iron	4.90^{a}	4.33^{a}	5.03^{b}	5.43^{b}	0.38
Magnesium	0.64^{a}	0.64^{a}	0.86^{c}	0.70^{c}	1.16
Manganese	0.05^{a}	0.06^{a}	0.06^{a}	0.07^{b}	0.32
Chloride	2.05^{a}	2.00^{a}	2.14^{b}	2.24^{b}	1.68

$^{a\text{-}b\text{-}c}$ means in rows not sharing common superscripts are significantly.

to some micro and macro-minerals. Blood for serological studies was collected without anti-coagulant in test tubes, allowed to stand for the separation of the sera. Sample bottles were further centrifuged to obtain the clear sera.

Chemical analysis

The proximate composition of the experimental diets to obtain the analyzed nutrients content was carried out using the procedures of AOAC (2005). Diets were analyzed for dry matter, crude protein, ether extract, crude fibre, mineral matter. Total carbohydrate (NFE) was determined by difference. The gross energy of the diets was computed using the laid down formula by Carpenter and Clegg (1956). Macro and micro-minerals were determined on the sera samples by established flame atomic absorption spectrophotometer model 372, Perkin Elmer, 1982. Sodium and potassium were determined using the standard flame emission photometer employing NaCl and KCl to prepare the standards (AOAC, 1984). Phosphorus was determined colorimetrically using the spectronic 20 (Gallenkamp, UK) as outlined by Pearson (1976) with KH_2PO_4 as standards.

Statistical analysis

ANOVA was performed on the results of the macro and micro-nutrients to determine the significance. Means separation were made where there were significant differences. Duncan multiple range test procedure as described in the SAS release 8.3 software was used. Significance was accepted at 5% probability (SAS, 2002).

RESULTS AND DISCUSSION

The micronutrients status in the blood of cockerels maintained on detoxified AASM in diets is presented on Table 3. Significant differences were observed on the content of iron, magnesium, manganese, chloride in the cockerel receiving the test diets relative to the conventional diet ($p<0.05$). Values of the microelement content on AASM based diets were recorded on some test diets as (4.33 mmole/L on diet 2) comparable with the control diet (4.90 mmole/l, diet 1) while on some test diets, Fe values were superior (5.03 and 5.43 mmole/L on diet 3 and 4 respectively) at 5% protection limit. Results on chloride, manganese, magnesium followed patterns similar to that on iron content values. Results on the micronutrients composition of the birds suggest that treating AASM before inclusion in diets is possible to meet the mineral requirements of the animals. These findings agreed with those of past workers (Apata and Ologhobo, 1990, 1994) who reported that the presence of anti-nutrients in feedstuffs, if not processed, could hamper the availability and utilization of nutrients and vice versa. The availability of the micronutrients and the utilization in this study showed that the treatments received by ackee seed meal before feeding were adequate for detoxification as exemplified in the blood content of iron and the other micronutrients. Iron is a trace nutrient needed in the body for haemoglobin

Table 4. Macro-mineral composition of cockerels given treated AASM based diets (ppm).

Diets / Minerals	1	2	3	4	SEM
Calcium	3.30[a]	3.97[a]	4.30[b]	5.37[b]	0.20
Sodium	116.00	129.00	140.00	141.00	3.16 NS
Phosphorus	1.63[a]	1.70[b]	1.80[b]	1.90[b]	1.11
Potassium	280[b]	263[b]	243[b]	123[a]	0.16
Na/K	0.41	0.49	0.57	1.14	
Ca/P	2.33	2.38	2.82	2.02	

[a-b] means in rows followed by different letters differed significantly ($p < 0.05$). NS, no significant difference ($p > 0.05$).

formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats (Adeyeye and Otokiti, 1999). Apart from the mentioned functions, iron also controls infections and cell mediated immunity (Beard, 2001). The level of iron content in the blood of cockerels fed treated AASM is an indication that AASM is a good source of this element suitable to maintain the daily balance since the daily required amount is 1.00 mg/day (Both well et al., 2000). Chloride, magnesium and manganese investigated are essential micro-minerals required in the body in amounts less than 100 mg/d. Chlorine in form of hydrochloric acid (HCl) is used for digestion and the element per se is used for the production of glandular hormones, maintenance of proper blood pressure and volume. Magnesium promotes absorption and metabolism of other minerals such as Ca, P, Na and K besides aiding bone growth and proper functioning of muscles including the heart muscles. Manganese on the other hand constitutes co-factor of enzymes like hydrolases, decarboxylases and transferases. Deficiency of Mn for instance, is attended by poor growth, reproduction and blood clotting. The presence of these trace minerals in the processed AASM in quantities comparable with the control diet or even higher than in the conventional diet suggests that treated AASM is a good source of the micro-minerals capable of meeting the livestock requirements.

Data on the macro-nutrients composition in the cockerels (Table 4) fed treated dietary AASM followed similar trend as that on micro-minerals. Calcium (Ca) content in the blood of cockerels given processed AASM based diets was comparable with that on the reference diet ($p <0.05$), that is 3.97 ppm control value and 3.30 ppm value on diet 4. Ca values on the test diets 2 and 3 were even higher (4.30 and 5.37 ppm respectively) than that on the orthodox diet ($p < 0.05$). Fleck (1976) found that calcium in combination with magnesium, phosphorus, manganese, vitamin A, C and D, chlorine and proteins (as obtained in treated AASM) are involved in bone mineralization and formation. Processed AASM in diet could therefore serve as a good source of Ca and when combined with the minerals and the other nutrients to act in concert, the formation of bones in the animal body is assured. Sodium (Na), the principal cation in the extra cellular fluids, is known to regulate plasma volume, acid-base balance, osmotic pressure, preserve normal irritability of muscles and cell permeability. Na also activates nerve and muscle functions. The content of Na in blood of cockerels offered the conventional diet was not different from that recorded on the blood of groups receiving the treated AASM based diets suggesting that the processed AASM could meet the Na requirement of the fed birds similar to those on the control diet (Monica, 1987).

Phosphorus (P) as one of the major minerals required by the body is found in every cell of the body and plays important roles in carbohydrates, fats, protein, B-complex utilization. P is needed to promote growth, maintain, repair and is responsible for energy production and storage (as ATP). It is also known to stimulate muscle contraction including the regular contraction and relaxation of the heart muscles. Balance of Ca and P in the body is required for their effective use in the body. Of similar importance is potassium (K), an intracellular fluid element (98%). K constitutes about 5% of the total mineral content of the body. Together with sodium, K helps regulate the distribution of body fluids, preserve the proper alkalinity of the body fluids besides regulating the transfer of nutrients to cells. K and P transfer oxygen to the brain and regulate neuromuscular activity with calcium and is also a mediator in the synthesis of muscle protein and protein from amino acids. Potassium also stimulates the kidneys to eliminate poisonous body waste. In addition to these functions by potassium, the metabolism of carbohydrates is potassium dependent. The ratios of sodium to potassium (Na/K) and calcium to phosphorus (Ca/P) are presented in Table 4. Na/K ratio is of great importance in the body for the control of high blood pressure (hypertension). Na/K ratio of less than 1 is recommended hence diet 4 might not be good for lowering blood pressure level since its Na/K value is slightly elevated, 1.14 (Aremu et al., 2006).

Research has shown that modern diets high in proteins and phosphorus tend to promote the loss of calcium in the excreta. Ca/P ratio below the normal level increases the loss of calcium in urine resulting to depletion in bone calcium (Shills and Young, 1988). A food or feed source is considered good if the Ca/P ratio is above 1 and poor if the ratio is less than 0.5 (Nieman et al., 1992). Result of this research gives Ca/P ratio of 2.33 on the control diet, 2.38, 2.82 and 2.02 on the test diets 2, 3 and 4 respectively indicating that processed AASM could be a good source of the minerals in question.

Conclusion

The blood composition of the cockerels fed the processed AASM in diets presented adequate values on the micro and macro-minerals investigated hence treated AASM could be used in nutrition of poultry without compromising the minerals status in the body.

REFERENCES

Adeyeye EI, Otokiti MKO (1999). Proximate composition and some nutritionally valuable minerals of two varieties of Capsicum annum (Bell and Cherry pepper) Discovery and Innovation, 11: 75-81.

AOAC (1984). Association of Official Analytical Chemists, 4th Edn. Washington D.C., pp. 105-119.

AOAC (2005). Official Methods of Analysis, 19th Edn. Association of official Analytical Chemists, Washington D.C. USA.

Apata DF, Ologhobo AD (1994). Biochemical evaluation of some Nigerian legume seeds. Food Chem., 49: 333-338.

Apata DF, Ologhobo AD (1990). Some aspects of the biochemical and nutritive value of African yam bean seeds (*Sphenostylis stenocarpa*). Food Chem., 36: 271-280.

Aremu MO, Olaofe O, Akintayo TE (2006). A comparative study on the chemical and amino acid composition of some Nigerian under-utilized legume flours. Pak. J. Nutr., 5: 34-38

Beard JL (2001). Iron biology in immune function, muscle metabolism and neuronal functioning. Nutrition, 131: S568-S599.

Bothwell TH, Baynes RD, MacFarland BJ, Macphail AP (2000). In: Ishida, H; Suzuno, H; Sugiyama, N; Innami, S; todokoro, T and Maekawa, A (2000). Nutritional evaluation of chemical component of leaves, stalks and stems of sweet potatoes (*Ipomoea batatas* poir). Food Chem., 68: 359-367.

Brady PG (2007). Iron deficiency anaemia. South Med. J. 100(10): 966-967.

Carpenter KJ, Clegg KM (1956). The metabolizable energy of poultry feeding stuff in relation to their chemical composition. J. Sci. Food Agric., 45-48.

Fleck H (1976). Introduction to nutrition. 3rd Edn. Macmillan, New York, USA Hassan, L.G and K.J. Umar 2006. Nutritional value of Balsam apple (*Mormodica balsamina* L.) leaves. Pak. J. Nutr., 5: 522-529.

James JH (2012). Iron deficiency anaemia http://www.pubmed.org.

Monica C (1987). Electrolyte. In: Medical Laboratory Manual for Topical countries. Vol. 1: 2nd (ed). Tropical Health Technology, Butters worth, Heinemann, 548.

NRC (1994). Nutrients requirement of Poultry. National Research Council, National Academy Press, Washington D.C. U.S.A.

NGMDCN (2005). National Guideline on Micronutrients Deficiencies Control in Nigeria. Federal Ministry of health, Dept. of Community and development population, Abuja, Nigeria. pp. 15, 44-45, 52-53.

Nieman DC Butterworth DE, Nieman CN (1992). Nutrition, Wmc Brown Publishers. Dubugye, U.S.A, pp. 237-312.

Pearson D (1976). Chemical analysis of foods 7th ed. Churchill, Livingstone, London.

SAS (2002.) Statistical Analysis System Proprietary Software, Release 8.3, SAS Institute Inc; carry, NC.