PHYSICO – CHEMICAL COMPOSITION OF PALM KERNEL SHELL ASH (PKSA) AS A POTENTIAL MINERAL SUPPLEMENT IN LIVESTOCK NUTRITION

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Abstract

The aims of this study were to determine the physico – chemical composition of palm kernel shell ash (PKSA) as a potential mineral supplement in livestock nutrition. Properties such as bulk density, water holding capacity, specific gravity, ash yield percentage and pH of the PKSA were evaluated. The mineral content was also assayed to ascertain its concentrations of minerals. Results obtained showed that PKSA had 92.68% dry matter, 0.8206 g/cm^3 bulk density, 0.8977 g water/g feed water holding capacity, 0.8149 specific gravity and was mildly alkaline (8.39). The order of mineral elements in PKSA were K> Mg> Ca> P> Na> Fe> Mn> Zn> Cu. A calcium/phosphorus ratio of 1.01 and sodium/ potassium ratio of 0.15 was also calculated for PKSA. Thus, PKSA can serve as a mineral supplement in livestock feeding.

Keywords: Ash, palm kernel shell, mineral contents.

Introduction

Palm kernel shell (PKS) is a readily available agricultural industry residue that has found limited application in the Nigerian industry. It is obtained as the crushed pieces of the hard endocarp of palm seed after crushing or threshing to remove the kernel, which is used in the production of palm kernel oil and palm kernel cake as a by-product (Olutoge, 1995). PKS can be considered as a natural pellet and a high grade solid renewable biofuel for burning. The resultant ash is high in potash and therefore could also be used in a variety of agricultural and cultural applications (Campbell, 1990) including cooking fuel and mineral supplement in livestock diets (Ndlovu, 2007; Iwu *et al*., 2013).

It is well documented that wood ash is a ready source of lime material rich in calcium and has been used successfully as fertilizer, especially to ameliorate acidic soils (Demeyer *et al*., 2001).

Similarly, several cultural reports have highlighted the value of highly alkaline plants in the improvement of the nutritional value of animal feeds (Ramirez *et al*., 1992; Kyarisima *et al*., 2004). Recently Nwogu (2013) reported some observable effects in laying hens when 1g/kgBW of plantain root ash (PRA) and 2g/kgBW of plantain stalk ash (PSA) were supplemented in their diets. Ash supplementation was found to influence higher mineral uptake from the intestine of birds, while shell quality and laying performance were compromised. Similar study by Iwu *et al*. (2013) showed that supplementation with coconut shell ash (CSA) at the level of 1g/kgBW was optimal and supported superior testicular development in growing rabbits fed commercial diet. This study evaluated the physicochemical composition of palm kernel shell ash as a potential mineral supplement in livestock feeding.

Materials and Methods

Collection and Preparation of Palm Kernel Shells

The palm kernel shells (PKS) were collected from a local oil mill at Enyiogugu, Imo State. Thereafter, they were washed with water, sun – dried, weighed and ashed in a bread oven after which the resultant product was placed inside a porcelain pot and ashed again till the ash produced became red hot (Iwu *et al*., 2013). At the end of the ashing process, the palm kernel shell ash (PKSA) produced was weighed again to ascertain PKS ash yield.

Analyses of Physicochemical Properties of PKSA

Bulk density (BD)

The method described by Makinde and Sonaiya (2007) and modified by Omede (2010) was adopted. To obtain the BD of the experimental material, a Pyrex glass funnel of known volume was weighed and the test sample was poured into it and then leveled off. The funnel and its content were weighed again and initial weight of funnel was subtracted from the final weight to obtain the weight of the test material. The weight of the test material was then divided by the known volume of the funnel. For example, the BD of a dry sample weighing 50g in a 165 cm^3 will be: 50g/165 cm^3= 0.3030 g (Makinde and Sonaiya, 2007).

Water holding capacity (WHC)

The filtration method described by Makinde and Sonaiya (2007) was adopted with slight modification (Omede, 2010). The initial weight of the funnel and its content was subtracted from the weight of the wet set-up to obtain weight of water absorbed by the test sample material.

Specific gravity (SG)

The specific gravity of a substance is a comparison of the density of the substance relative to a standard value (e.g. density of water). The procedure that was used in determining BD was repeated to determine BD of test sample material of 1kg. This BD value was used to determine SG of the test sample material. SG was determined as the ratio of the bulk density.

pH of the PKSA

A known weight of the PKSA was dissolved in known volume of deionized water and stirred to obtain a homogenous mixture. The pH of the mixture was thereafter determined with the aid of a pH meter (Hanna Combo pH Meter, Model: HI 98129). pH is a measure of hydrogen ion activity in solutions.

Mineral Content of Palm Kernel Shell Ash (PKSA)

A measured quantity (2g) of the PKSA was put into a Kjeldahl flask; 20 ml of concentrated nitric acid (HNO_3) was added and the sample was digested by heating. clear digest was obtained, cooled and filtered into a 50 ml volumetric flask through a Whatman (No. 42), 150 mm diameter filter paper and was made up to mark with distilled water. The resultant solution was analysed for mineral elements using the Atomic Absorption Spectrophotometer (Bulk Scientific, 205). Thereafter, the calcium - phosphorus and the sodium - potassium ratios of the product were also calculated.

Data analysis

Data generated was presented in table format

Results and Discussion

PKSA yield characteristics

Table 1 showed that ashing of 55kg palm kernel shell (PKS) led to a loss of about 42kg of shell material representing about 76% of combustible material. The percentage ash produced from the shell was approximately 24%. This is much higher than the 2.11% ash yield obtained by Iregbu, (2015) from pulverised PKS ashed in a porcelain plate over a Bunsen burner. It is therefore possible to achieve a lower ash yield by grinding the PKS before ashing. The ash yield is also higher than the 10.88% and 21.12% reported for plantain stalk ash (PSA) and plantain root ash (PRA) respectively by Nwogu *et al*. (2012).

Earlier reports from studies carried out (Nwogu, *et al.,* 2012; Iwu *et al*., 2013) have shown that plant ashes such as coconut shell ash (CSA), plantain root (PRA) and plantain stalk (PSA) ashes could serve as good sources of bioavailable minerals for livestock and possibly humans.

Table 1: Ash yield from Palm kernel

Parameters	*Values*
Initial weight of palm kernel shell (kg)	55.00
Weight of ash produced (kg)	13.00
Weight of material lost (kg)	42.00
Percentage ash yield (%)	23.64
Percentage combustible material (%)	76.36

Physical characteristics of PKSA

The physical characteristics of PKSA are summarized in Table 2. Its pH value at 8.39 was lower than the 12.40 and 12.50 reported for plantain stalk ash (PSA) and plantain root ash (PRA) by Nwogu *et al*. (2012) and the 11.90 reported for coconut shell ash (CSA) by Iwu *et al*. (2013). The present result indicates that PKSA is mildly alkaline. Moisture content (MC) of PKSA recorded in this study was 7.30% which is lower than the 8.9% reported by Akpakpan *et al*. (2012) and 9.61% reported by Iregbu (2015). PKSA also has a dry matter content of 92.68% suggesting that it is a very dry material.

Results also showed that the bulk density (BD), water holding capacity (WHC) and specific gravity (SG) of PKSA were 0.8206 g/cm^3, 0.8977 g water/ g dry ash and 0.8149 respectively. The BD of PKSA obtained here compared favorably with the 0.73 g/cm^3 reported by Iregbu (2015).

Table 2: Physical characteristics of PKSA

Parameters	Values
Moisture content (%)	7.30
Dry matter (%)	92.68
Bulk density (g/cm^3)	0.8206
Water holding capacity (g water/g feed)	0.8977
Specific gravity	0.8149
pH	8.39

Again, the WHC obtained in this study at 0.897 g water/g ash was lower than the 2.10 g water/g ash reported for CSA by Iwu *et al*. (2013). Omede (2010) reported a range of 0.85 – 1.11g water/g feed and 0.64 – 1.22g water/g feed for commercial broiler starter and finisher feeds respectively produced in Nigeria. The implication of these results is that the inclusion of PKSA in a broiler diet would not alter the WHC of the diet. It is known that high WHC feeds absorb excess water within the GIT of birds and then swell up to form a gel beyond the holding capacity of the bird's gut. This mechanism triggers satiety and reduces feed intake, with an after effect of poor growth and performance (Kyriazakis and Emmans, 1995).

Specific gravity of feed and feedstuff has an important role in the transit of digesta particles through the gastrointestinal tract of animals as a measure of physical quality of feed (Bhatti and Firkins, 1995). The SG value of PKSA at 0.814 was much higher than the range of 0.33 – 0.46 reported for broiler rations produced in Nigeria (Omede, 2010).

Mineral composition of palm kernel shell ash

The mineral analysis of palm kernel shell ash is summarized in Table 3. The study showed that the major metals in PKSA were potassium (150.52 mg/kg), magnesium (43.52 mg/kg), calcium (33.14 mg/kg), phosphorus (32.75 mg/kg), with copper recording the lowest concentration of 0.76 mg/kg. Thus, the order of mineral elements in PKSA is K> Mg> Ca> P> Na> Fe> Mn> Zn> Cu. The contents of several metals such as calcium (33.14 mg/kg), and magnesium (43.52 mg/kg) were similar to the range of values reported by Akpakpan *et al*. (2012) for palm kernel shell and coconut shell. This is in agreement with Ndlovu (2007) that Ca, K, Mg, Si, and P are the major mineral components in wood ash. The present study also showed that PKSA contained more K and Mg than Ca and P. Akpakpan *et al*. (2012) also reported higher values of K in PKSA and CSA (118.70 and 348.40 mg/kg respectively) than Ca (33.14 and 43.52 mg/kg respectively). It is therefore possible that these plants are natural accumulators of potassium in their shells.

The very high value of K in PKSA is of interest because K is often called the alkalizer. It neutralizes acids and restores alkaline salts to the blood stream. It also works with Na in all cells to maintain membrane potentials and assist in metabolic processes. Together with Mg, it helps prevent kidney stone, promote healthy adrenal glands etc (Sanchez, 2010).

The zinc, copper and manganese recorded in the present study were relatively lower than those reported by Akpakpan *et al*. (2012). The differences could be a reflection of soil mineral content of the locations from where the PKS were harvested.

A calcium/phosphorus ratio of 1.01 and sodium/ potassium ratio of 0.15 was calculated for PKSA. The Na/K ratio obtained in this study is much lower than the range of 2.09 – 3.85 reported for CSA by Iwu *et al*. (2013). The Ca/P ratio of 1:1.01 obtained in this study is normal since it indicates that for every gram of P supplied by PKSA, 1.01g of Ca is also supplied making it unnecessary for the birds to recruit Ca from storage deports in the bone (Reinhart and Mahan, 1986).

Table 3: Mineral compositions of the PKSA

Sample Parameters	Results
Calcium (mg/kg)	33.14
Phosphorus (mg/kg)	32.75
Sodium (mg/kg)	22.35
Magnesium (mg/kg)	43.52
Potassium (mg/kg)	150.52
Manganese (mg/kg)	2.01
Iron (mg/kg)	10.02
Zinc (mg/kg)	1.65
Copper (mg/kg)	0.76
Cobalt (mg/kg)	1.23
Ca/P ratio	1.01
Na/K ratio	0.15

Conclusion

This study showed palm kernel shell could yield approximately 24% ash which contains K, Mg, Ca and P among others as it major minerals and was mildly alkaline indicating that palm oil tree could be a natural accumulator of potassium in its kernel shell. The order of mineral elements in PKSA were K> Mg> Ca> P> Na> Fe> Mn> Zn> Cu. Thus, PKSA can serve as a mineral supplement in the nutrition of animals.

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