EFFECT OF STEAM PROCESSING ON THE MINERAL COMPOSITION OF BLOOD MEAL SOURCED FROM CATTLE, GOAT AND SHEEP IN ZARIA, NIGERIA

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Abstract: The study assessed the effect of steam processing on the mineral element content of five composite sample of blood meal sourced from each of cattle, goat and sheep. The mineral composition of five composite samples of blood meal sourced from each of cattle, goat and sheep were analysed for the presence of the following mineral elements: sodium and potassium using flame photometry; phosphorus using colorimetric technique; while calcium, magnesium, iron, manganese, zinc and nickelusing atomic absorption spectroscopy respectively for both the steam processed and non-steam processed blood meal. The result indicated that steam processing significant elevate the concentration of sodium, potassium, calcium, phosphorus, magnesium and manganese while zinc and nickel content depreciates but the concentration of iron and copper remains unaffected by steam processing in the various blood meal sourced from cattle, goat and sheep ($P<0.05$).

Keywords: Blood meal, cattle, goat, mineral composition, sheep, atomic absorption spectroscopy.

Introduction

Blood meal is a product from slaughtered animals like cow, horse, and swine e.t.c. The product is reported to be rich in lysine, arginine, methionine, cystine, and leucine (NRC, 1994). Hence blood meal is being used as supplement to compensate the lysine and methionine usually being deficient in vegetable protein based diets in poultry and fish feeds (McDonald *et al*., 1992). Blood meal has been prepared using various methods and the common fact among them all is that the product is dehydrated to a very low moisture content, after most of the water has been dried off it is then spread out for more drying using the sun or by means of other artificial heating system before grinding into fine particles (Tabinda *et al*., 2007). Moreover, the quality of blood meal protein is usually affected by its processing method. Hence, variation in the quality of the products in processing plants is very common (McDonald *et al*., 1992). For instance an elevation in calcium/phosphorus ratio, acidity, ash content and crude lipid has been reported due to processing of blood meal sourced from cattle and goat (Omoniyi *et al*., 2013).

Processing methods of blood meal is of great importance since blood is a highly perishable product and must be processed as soon as possible to avoid decadence usually by reducing its moisture content to less than 10.0-12.0% moisture and stored in a dry place in order for it not to deteriorate. Other processing methods of blood meal preparation include: solar drying, oven drying, drum drying, flash drying and spray drying among others (Heuze &Tran, 2013).Raw blood has also been stabilized and stored for one week by adding 0.70% sulphuric acid or an equivalent of another acid. Blood can equally be coagulated to aid the removal of water, by the additionof 1.0% unslaked lime or 3.0% slaked lime even though this method of dehydration is usually evidence with an increase in the amount of dry matter losses by about 10.0-15.0%, which may include some of the useful minerals present (Maiga *et al*., 1996).

Blood meal is used in most occasions as feed ingredient and may be incorporated into animal feed during feed manufacturing processes which may include: grinding of feed ingredients to enable mixing of different ingredients (Peisker, 2008); conditioning and pelleting to agglomerate smaller feed particles with the help of mechanical pressure, moisture and heat to larger particles. This tends to improve animals performance by reducing feed wastage as well as selective feeding and improves palatability (Hacking *et al*., 1978; Pietzsch 1985); expansion to enhance the flexibility of ingredients usage as well as animal performance (Wilson *et al*., 1998).

Nevertheless, the aim of this study is to assess the effect of steam processing on mineral composition of blood meal sourced from cattle, goat and sheep.

Materials and Methods

Sample collection and treatment

Five composite samples of blood were collected from cattle, goat and sheep at the point of slaughter separately in sterilized beakers at Zango and Yan Awaki abattoirs in Zaria, Nigeria. The samples were preserved in polyethylene buckets packed with ice from the sampling point to the laboratory. A 0.5 liters portion of each of the sample collected were allowed to stand for 6 h, after which the liquid portion was decanted, the solid was then sun-dried and ground to powder. While another 0.5 liters portion of each of the blood from cattle, goat and sheep was processed by steam at a regulated temperature of 100^{o}C for 45 min by means of steam bath. The coagulated solid of each sample was separated from its serum by decantation and sun dried for 72 h before grinding into meals using an agate mortar and pestle (Procter and Meullenet, 1998; Marichal *et al*., 2000).

Sample digestion for elemental analysis

One gramme of each of the sample of cattle, goat or sheep blood meal was reflux with 30.0 ml aqua regia in a beaker at a temperature of 75^{o}C until brown fumes were completely liberated; the solution was allowed to cool, filtered and made up to 100 ml with distilled water (Jon, 1980; Ehi-Eromosele *et al.*, 2012).

Determination of mineral content

The concentration of the mineral elements: calcium, iron, magnesium, manganese, zinc, copper and nickel in the blood meal samples were determined by the means of an automated atomic absorption spectrophotometer (Unicam 669) set at the wavelengths of 422.7, 248.3, 285.2, 279.4,

213.8, 324.7 and 236.0 nm, respectively while the concentrations of potassium and sodium were determined using the flamephotometer (Jenway PFP7),set at the wavelength of 589.0 and 766.0 nm, respectively after acid digestion of the samples. The phosphorus content was determined by means of a colorimeter at a wavelength of 430 nm after colour development with the aid of vanadate molybdate reagent (AOAC, 1990).

Results and Discussion

Sodium

The mean concentrations of sodium in the non-steam processed blood meal sourced from cattle, goat and sheep were 0.224%, 0.222% and 0.228% while in the steam processed blood meal it was 0.801%, 0.730% and 0.775%, respectively as shown in Fig. 1. This indicates that the concentrations of sodium have significantly increased by about three fold at 95.0% confidence limit as a result of steam processing. The higher concentration of sodium may be due to effective concentration of the minerals on dehydrating and effective denaturisation of blood protein which tend to release the mineral from its matrix while heating. The low concentrations of sodium in the non-steam processed blood meal may be due to loss of minerals on decantation of the liquid portion of the blood in order to get it in the dry form.

Potassium

The mean concentrations of potassium were 0.0396%, 0.256% and 0.214% in the non-steam processed blood meal sourced from cattle; goat and sheep while in the steam processed blood meal were 0.186%, 0.408% and 0.452%, respectively as presented in Fig. 1; indicating an elevation in potassium content as a result of processing. The higher concentrations of potassium may be due to effective concentration of the minerals on dehydrating and denaturisation of blood protein with heat. Sodium and potassium are generally required for the maintenance of osmotic balance of the body fluids and retention of protein during growth (NRC, 1989).

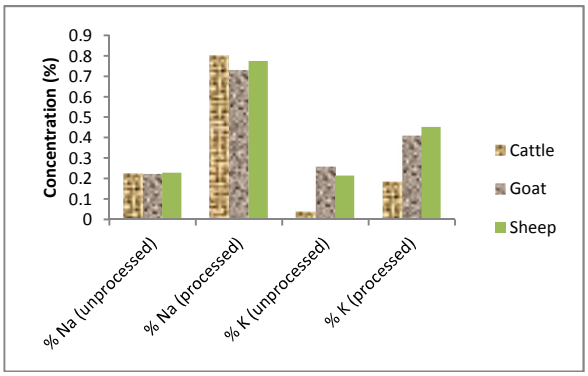

Fig. 1: Effect of steam processing on sodium and potassium concentrations in blood meal

Calcium

The average concentrations of calcium in the non-steam processed blood meal from cattle, goat and sheep were 0.0467%, 0.0511% and 0.0431% while in the steam processed product it was 0.796%, 0.869% and 0.831% for cattle, goat and sheep as presented in Fig. 2. The concentration of calcium showed a statistical difference between the steam and non-processed product indicating a higher concentration in the steam processed product implying that steam processing affects the concentration of calcium in the product due to denaturising of blood protein and consequent release of mineral ion in the various samples. The high calcium content of the product alongside other elements like potassium and magnesium will help lower blood pressure as reported in several clinical studies (Osborne *et al*., 1996; Zewel, 1977).

Phosphorus

The mean phosphorus content of the non-steam processed blood meal from cattle, goat and sheep were 0.0482%, 0.0731% and 0.0688% while in the steam processed blood meal were 0.157%, 0.157%and 0.147%, respectively as presented in Fig. 2; indicating a significant difference in phosphorus content between the steam processed and non-steam processed product. The higher content of phosphorus in the steam processed product may be due to effectiverelease of phosphate ion on steam heating as blood protein gets denatured at elevated temperatures. The presence of abundant phosphorus and calcium would make the steam processed product more useful in proper bone formation (Shills, 1992).

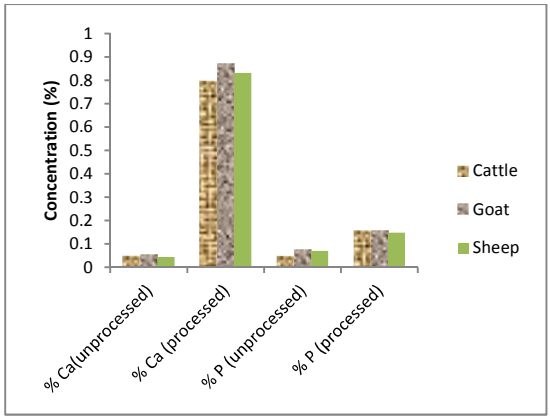

Fig. 2: Effect of steam processing on calcium and phosphorus concentrations in bloodmeal

Iron

The mean concentrations of iron in the non-steam processed blood meal sourced from cattle, goat and sheep were 1330 mg/kg, 1715 mg/kg and 1458 mg/kg while in the steam processed blood meal it was 1368 mg/kg, 1352 mg/kg and 1450 mg/kg as presented in Fig. 3. This indicates no significant difference in concentration as a result of processing ($P<0.05$) between the steam and non-steam processed products. Since the products are rich in iron which is an important component of the haemoglobin hence both the steam and non-steam processed products are essential for blood formation as well as the normal functioning of the central nervous system (Vyas & Chandra, 1984).

Magnesium

The concentrations of magnesium in the non-steam processed blood have their average values as 263.9 mg/kg, 236.1 mg/kg and 231.9 mg/kg while they were 2688 mg/kg, 2521 mg/kg and 3009 mg/kg for the steam processed product samples as shown in Fig. 3, indicating that steam processing significantly elevates the magnesium content of blood meal. The higher content of magnesium of the steam processed product may be due to effective

release of magnesium on dehydrating via steam processing and denaturingof blood protein as a result of heat. Magnesium is also an activator of many enzymes systems and also maintains the electrical potential in nerves (Shills, 1992).

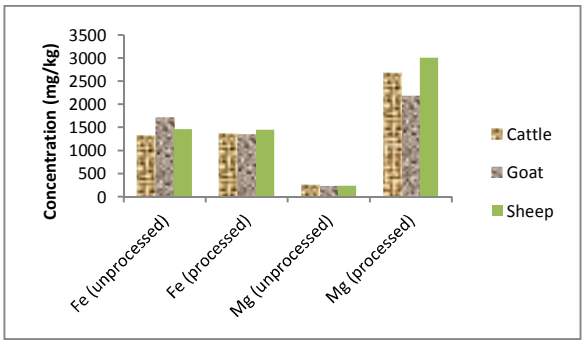

Fig. 3: Effect of steam processing on iron and magnesium concentrations in blood meal

Manganese

The mean concentrations of manganese in the non-steam processed blood were 12.2 mg/kg, 18.9 mg/kg and 21.1 mg/kg for cattle, goat and sheep while the steam processed products records 24.5 mg/kg, 39.8 mg/kg and 50.9 mg/kg concentrations of manganese as presented in Fig. 4, indicating a significant difference between the steam processed and non-steam processed product ($P<0.05$). The blood type with the highest concentration of manganese was sheep with mean value of 50.94 mg/kg. There was a general increase in manganese concentration as a result of steam processing. Deficiencyof manganese in animal feed can affect their reproductive performance (Agricultural & Rural Development, 2002).

Zinc

The mean concentrations of zinc in the non-steam processed blood meal sourced from cattle, goat and sheep were 83.92 mg/kg, 82.18 mg/kg and 75.00 mg/kg while they were 21.84 mg/kg, 24.39 mg/kg and 21.84 mg/kg in the steam processed product as shown in Fig. 4. There is a significantdecrease in zinc concentration as a result of steam processing ($P<0.05$).This may imply that zinc content of blood meal is more concentrated in the blood cells that remains after decantation in the process of drying. Zinc is a micronutrient which serves as cofactor in many metabolic activities in living organisms (Gatline & Wilson, 1983).

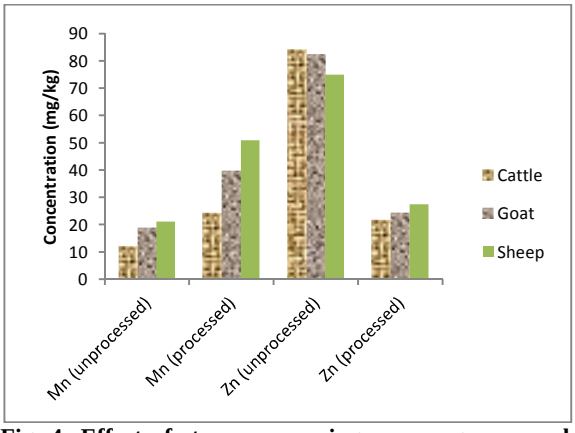

Fig. 4: Effect of steam processing on manganese and zinc concentrations in blood meal

Copper

The mean concentrations of copper in the non-steam processed blood meal sourced from cattle, goat and sheep were 5.84 mg/kg, 9.94 mg/kg and 6.76 mg/kg while they were 4.71 mg/kg, 6.77 mg/kg and 11.7 mg/kg in the steam processed as presented in Fig. 5. There is no significant difference in the concentration of copper between the steam processed and non-steam processed product, indicating that steam processing has no effect in the concentration of copper in blood meal.Copper is required as a co-factor in different oxidative and reductive enzymes. According to Nair *et al.* (1997), it'salso important for red blood cell formation, mitochondria function and a component of ribonucleic acid (Mielcarz*et al.*, 1997).

Nickel

The mean concentrations of nickel in non-steam processed blood meal sourced from cattle, goat and sheep were 5.88 mg/kg, 6.64 mg/kg and 4.2 mg/kg while they were 1.49 mg/kg, 1.61 mg/kg and 1.78 mg/kg in the steam processed blood meal as shown in Figure 5. This indicates a slight decrease in nickel concentrations in the steam processed product. More than 90% of Nickel taken in is held in the organic form that can be safely excreted (ATSDR, 1999).

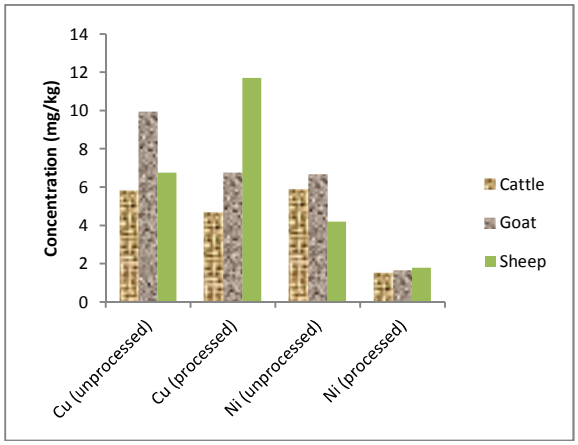

Fig. 5: Effect of steam processing on copper and nickel concentrations in blood meal

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Conclusion

The study reveals that steam processing of blood meal sourced from cattle, goat and sheep significantly elevate the concentrations of phosphorus and manganese by about two fold their initial concentrations; sodium and potassium by about three fold their initial concentrations; calcium and magnesium by about ten times their initial concentrations as a result ofthe effect of steam processing of blood while zinc and nickel content depreciates by about one fold of their initial concentrations. Nevertheless

the concentration of iron and copper showed no significant change as a result of steam processing in the various blood meal sources ($P<0.05$).

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