

Research Article

Apparent Nutritional Composition of Locally Sourced Blood Meal from *Bos primigenius* and *Ovis aries* for Poultry Applications

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Abstract

Nutritional compositions of blood meal sourced from *Bos primigenius* (cattle) and *Ovis aries* (sheep) were determined. The moisture, ash, crude lipid, crude fibre, crude protein, carbohydrate (proximate), sodium, potassium, calcium, phosphorus (macro element), iron, magnesium, manganese and zinc (micro element) content of samples from *Bos primigenius* range from 8.99-10.08%, 9.01-10.99%, 7.15-9.99%, 10.86-12.98%, 2.24-2.97%, 2.21-3.99%, 0.658-0.885%, 0.122-0.322%, 0.648-0.883%, 0.119-0.196%, 1242-1517 mg/kg, 2136-3925 mg/kg, 16.4-30.6 mg/kg and 17.01-30.46 mg/kg respectively. Values for samples sourced from *Ovis aries* range from 0.98-80.01%, 72.31-77.01%, 0.05-0.07%, 0.07-0.09%, 0.79-0.99%, 0.87-0.99%, 0.639-0.860%, 0.404-0.492%, 0.758-0.901%, 0.139-0.157%, 1425-1472 mg/kg, 2468-3897 mg/kg, 46.40-55.10 mg/kg and 19.99-50.97 mg/kg respectively. Comparison of the obtained values showed no significance difference. Therefore authors recommend the use of locally sourced blood meal as supplement to the expensive imported blood meal in order to reduce the cost of poultry production.



Keywords: *Bos primigenius*; *Ovis aries*; Blood meal; Proximate; Composition

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Introduction

It is a known fact that individuals, especially those who are resident in the rural areas survive on low incomes under high levels of uncertainty. This is as a result of low returns from farming which is the major source of their livelihood. Specifically, approximately 70% of workers in low income countries are employed in the agricultural sector, thereby exhibiting higher vulnerability to risk and uncertainty situations [1]. These uncertainties range from crop yield failure, input price variability due to high cost of feeds, incidences of pests and diseases, environmental degradation, pollution from industrial sites and so on [2]. Majority of the world's rural poor depends on livestock as a viable and active component of their livelihoods. Many livestock farmers in rural areas are into poultry [3], despite the fact that poultry farmers in rural areas are faced with diverse forms of risks [4], yet among the rural poor, poultry is a crucial means of livelihood [5,6,7].

The poultry industry has a key role to play in many parts of the world as the most common and economic source of protein. It serves as sources of income in times of financial distress, contributes to household nutrition, as many rural poor households rely on their own poultry production to supply the majority of their animal source of protein and essential micronutrients. These micronutrients are vital for nourishment especially in areas where chronic malnutrition and micronutrient deficiencies are very high [8]. In Nigeria, high cost of feeds is one of the major setbacks in commercial poultry production. Its cost usually ranged between 65-75% of the total production cost. This problem has resulted to reduction in the rate of expansion of the poultry industry and has added to the low level of

animal protein consumption and ultimately malnutrition to its people. A prospective way of increasing the supply of poultry products at cheaper prices is by reducing the cost of production through the use of cheaper, locally available sources of animal protein such as blood meal in place of costly fish meal and imported soybean meal, protein concentrates, meat and bone meal [9]. Therefore, there has been continuous effort on the replacement of the more expensive protein concentrates in poultry diets with cheaper and less competitively demanded feeding resources, as this would be accompanied with a reduction in feeding cost [10,11].

Blood meal is a dark chocolate-coloured powder with characteristics smell, contains high percentage of crude protein and certain minerals particularly iron and copper. It is highly nutritive and represents a very important source of food ingredient for humans and animals. It is one of the richest sources of lysine, a rich source of arginine, methionine, cystine and leucine [10,12]. The high lysine and methionine content makes plant protein inferior to animal proteins [13]. Therefore, blood meal could be used to compensate the lysine and methionine deficiencies in vegetable protein based diets [14]. Functional properties of blood meal concentrates are mainly dependent on their protein content and quality. For instance, the water holding capacity of animal protein concentrates is an important factor for pellet manufacturing. The lower dry matter solubility of blood indicate a more favourite availability of the product dry matter for birds because the solubility is mainly attributed to mineral salt contents of the products [15,16].

Researchers have proved that inclusion of 1 to 4% blood meal in diets could improve poultry performance [17,18]. Effect of different levels of blood meal on broiler performance during two phases of growth had been studied with positive result recorded [12]. The use of higher levels of dietary blood meal on growth of chickens has also been reported to have no adverse effect [17,19]. However, the relatively high bulk density and lower coarse particle (>350 μm) distribution pattern indicates that blood meal has lesser preservation potential if it has to be use in the fresh form [20,21].

In Nigeria large numbers of animals are slaughtered every day and the blood from the slaughtered animals drained off. The proper utilization of this product from the slaughter house has been limited due to lack of scientific knowledge regarding the processing and preservation [9]. The aim of this study is to determine the nutritional composition of blood meal sourced locally from our indigenous breeds of *Bos primigenius* and *Ovis aries* and compare them with an imported blood meal as an alternative source of protein.

Experimental

Materials and Reagents

Five composite samples of blood were collected from matured *Bos primigenius* (cattle) and *Ovis aries* (sheep) respectively in a slaughter house located at Zango and Yan Awaki both in Zaria, Kaduna State, Nigeria in March, 2013. Imported blood meal from the Grand Cereals and Oils mills limited, Jos, Plateau State, Nigeria used as standard reference sample was obtained. Soxhlet extractor, vacuum pump, rotary evaporator, oven, muffle furnace, analytical balance, pH meter (Jenway 2000), Flame photometer (Jenway PFP 7), Atomic Absorption Spectrophotometer (Unicam 669). Sulphuric acid, nitric acid, boric acid solution, sodium hydroxide, ammonium molybdate and ammonium metavanadate mixtures, mixed catalyst (16.00 g anhydrous K_2SO_4 , 1.00 g $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and 0.30 g selenium), methyl red indicator and anti-bumping granules. All reagents for this work are of the Analar grade and were prepared with distilled /deionised water according to standard analytical procedures.

Preparation of blood meal samples

Blood samples were collected in sterilised beakers as the animals were being bled. The samples were preserved in ice packed containers from the sampling point to the laboratory. Exactly 1000.00 cm^3 portion of blood from *Bos primigenius* and *Ovis aries* respectively was processed by steam coagulation at a temperature of 100°C for 45 minutes ($n = 10$). The coagulated solids were separated from the plasma by decantation and then sun-dried for 5.00 days before grinding into meal using pestle and mortar. The solids were further sun dried for 72 hours before being ground into fine powder [22,23].

Proximate Analysis

Moisture and ash content

Moisture content was obtained based on the difference between the net weight and the weight after oven drying to a constant weight, while ash content was determined based on the difference in weight between the gross weight and the net weight after ashing in a furnace at 550°C for one hour [24].

Crude lipid content

Exactly 200 cm³ of petroleum ether (40 – 60°C) was transferred into a clean and dry 250 cm³ capacity round bottomed flask fitted with soxhlet extraction unit and some antibumping granules added. The extraction thimble was weighed and 20 g of the blood meal sample from *Bos primigenius*, was added and weighed. The thimble was then fixed into the soxhlet extraction unit with forceps and cold water circulated. The heating mantle was switched on and the temperature adjusted between 40°C to 60°C until the solvent refluxed at a steady rate. Extraction was carried out for 8 h after which the heating mantle was switched off. The thimble was removed and dried to a constant weight in an oven at 70°C and reweighed and the percentage of extractible lipid calculated [25]. This procedure was repeated for the samples from *Ovis aries* and imported blood meal respectively.

Crude fibre

Exactly 2.00 g of the finely ground sample of *Bos primigenius* was placed into a round bottomed flask, 100 cm³ of 0.023 M H₂SO₄ solution was added and the mixture boiled under reflux for 30 min. The hot solution was then filtered quickly under suction and the insoluble materials washed several times with hot water until it was acid free. This was then transferred into a flask and 100 cm³ of hot 0.312 M sodium hydroxide solution added, the mixture was boiled again under reflux for 30 min and filtered quickly under suction. The insoluble residues was washed with boiling water until it was base free and dried to constant weight in an oven set at 100°C, this was then cooled in a desiccator and weighed. The weighed residue was then incinerated in a muffle furnace at 550°C for 2 h, cooled in a desiccator and reweighed. The percentage crude fibre content was then calculated [25]. This procedure was repeated for the samples from *Ovis aries* and imported blood meal respectively.

Crude protein

The crude protein content was obtained using the standard method developed by Kjeldahl comprising of three steps; digestion, neutralisation and titration, adopted by the Association of Official Analytical Chemists method [25].

Exactly 2.00 g of sample from *Bos primigenius*, was weighed into a dried Kjeldahl flask, 1.00 g of mixed K₂SO₄ and CuSO₄ were added as catalyst, then 6.00 cm³ of concentrated H₂SO₄ with some antibump granules added. The mixture was then heated until the greenish solution turns colourless. After cooling, the solution was transferred into a 100 cm³ volumetric flask and diluted to mark with distilled water.

Exactly 10.00 cm³ of the above solution was transferred into a Kjeldahl distillation apparatus where 10.00 cm³ of 40% NaOH solution was added to liberate NH₃. The NH₃ liberated was received in 100.00 cm³ conical flask containing 5.00 cm³ of 40% boric acid and 2 drops of methyl red indicator.

The distillation continued until the pink colour of the indicator turned greenish. The content of the conical flask were titrated with 0.10 M HCl with end point indicated by a change from green to pink colour and the volume of acid used recorded. Total nitrogen was calculated and the percentage of crude protein obtained [25]. This procedure was repeated for the samples from *Ovis aries* and imported blood meal respectively.

Carbohydrate

The carbohydrate content of the non-steam and the steam processed blood meal obtained from *Bos primigenius* and *Ovis aries* and the imported blood meal were estimated respectively by the difference method. That is the sum of percentage moisture, ash, crude lipid, crude protein and crude fibre were subtracted from 100 [26]. This procedure was repeated for the samples from *Ovis aries* and imported blood meal respectively.

Elemental analysis

Exactly 1.00 g of sample from *Bos primigenius*, was reflux with 30.0 cm³ aqua regia in a beaker at a temperature of 75°C until brown fumes were completely liberated; the solution was allowed to cool before making it up to 100 cm³ with distilled water [27]. The concentrations of calcium, iron, magnesium, manganese and zinc were determined with an automated Atomic Absorption Spectrophotometer (Unicam 669), at wavelength 422.7, 248.3, 285.2, 279.4 and 213.8 nm respectively while sodium and potassium were determined using the flame photometer at wavelength of 589 and 766 nm (Jenway PEP 7) respectively.

Determination of phosphorus

Exactly 4.39 g potassium dihydrogen phosphate (anhydrous) was dissolved in water and made up to 1000 cm³. Serial dilution was carried out to obtain standard solutions of phosphate. Absorbance of standard solutions was taken with the colorimeter at the wavelength of 430 nm and standard curve calibrated. Exactly 2.00 cm³ of ammonium molybdate and ammonium metavanadate mixtures were added to 2.00 cm³ of sample solution from *Bos primigenius* in an acidic medium obtained by adding 1.00 cm³ of dilute hydrochloric acid to the sample solution before diluting to 10.00 cm³ with distilled water and the mixture was allowed to stand for 30 min for complete formation of the yellow coloured molybdophosphate complex. The absorbance of the coloured complex was measured against standard phosphate solutions at the wavelength of 430 nm and the phosphorus concentrations of samples were obtained by reference to the standard calibration curve [25]. This procedure was repeated for the samples from *Ovis aries* and imported blood meal respectively. Analysis of every test sample was carried out in triplicate and the mean calculated.

Results and Discussion

Proximate composition

Moisture content

The percentage moisture content of blood meal samples from *Bos primigenius* and *Ovis aries* have their minimum and maximum values as 8.99-10.08% and 9.01-10.99% respectively as presented in **Table 1**, while that of imported product is 8.010% indicating that the imported product will have better stability on microbial action [28]. Nevertheless higher moisture content of the local products will aid digestion and peristaltic movement on consumption [29].

Ash content

The ash content ranged from 7.15-9.99% and 10.86-12.98% for the samples from *Bos primigenius* and *Ovis aries* respectively and 7.010% for imported product as presented in Table 1. The percentage ash content of sample from *Bos primigenius* compares favourably with imported sample with no significant difference ($P < 0.05$) but there was a significant difference ($P < 0.05$) when compared with that sourced from *Ovis aries* which is slightly higher. Ash content is a measure of the total amount of mineral present in a giving sample of food [24]. Generally, the relatively high values of percentage ash content of the products, implies high mass and mineral content for building healthy body and proper functioning of body tissues.

Crude lipid content

The crude lipid values ranged from 2.21-3.99% and 2.24-2.97% for samples from *Bos primigenius* and *Ovis aries* respectively while the imported product had 2.28% as presented in Table 1. These values showed no significant difference ($P < 0.05$) and are too low for the product to be regarded as oil product in comparison to *A esculentus* with crude fat content of 17.2% that is regarded as moderate in crude fat content and bush mango with crude fat content of 62.0% which is regarded as relatively high [30].

Crude protein content

Crude protein content ranged from 75.98-80.01% and 72.31-to 77.01% for the product sourced from *Bos primigenius* and *Ovis aries* respectively and 82.08% for imported product as presented in Table 1. These values showed a significant difference ($P < 0.05$) between the local product and the imported. Nevertheless the relatively high value of

protein content of the local product indicates that they would be useful as alternative source of protein in livestock feeding and also in man [31].

Crude fibre content

The crude fibre content ranged from 0.05- 0.07%, and 0.07-0.09% for the product sourced from *Bos primigenius* and *Ovis aries* respectively while that of the imported product was below the detection limit as presented in Table 1. Therefore the product is expected to be poor in dietary fibre. Low crude fibre content is usually attributed to a decrease in microbiological metabolism due to non-utilization of sugar during metabolic activities leaving a lower percentage of fibre content. Nevertheless blood meal is not of plant origin [32]. Therefore the dietary fibre content could be generally defined as lignin plus plant polysaccharides that cannot be digested by human enzymes, although some starch are indigestible in the small intestine and as such fits the definition of dietary fibre [33].

Carbohydrate content

The carbohydrate content range were 0.79-0.99% and 0.87-0.99% for samples sourced from *Bos primigenius* and *Ovis aries* respectively while the imported product has a value of 1.70% as presented in Table 1. This indicates a very low level of carbohydrate content in the product. However, since the product is from animal source the low carbohydrate content is not unexpected.

Table 1 Proximate composition of blood meal sourced from *Bos primigenius* and *Ovis aries*

Proximate Composition	Sample	Mean \pm Standard deviation	Minimum	Maximum	Variance
Moisture	C	9.51 \pm 0.50	8.99	10.08	1.09
	S	9.97 \pm 0.70	9.01	10.99	1.98
	F	8.02 \pm 0.01	8.01	8.02	0.02
Ash	C	8.77 \pm 1.20	7.15	9.99	2.84
	S	12.09 \pm 1.05	10.86	12.98	2.12
	F	7.00 \pm 0.01	6.99	7.01	0.02
Crude lipid	C	2.55 \pm 0.32	2.24	2.97	0.73
	S	3.20 \pm 0.70	2.21	3.99	1.78
	F	3.25 \pm 0.03	3.23	3.28	0.05
Crude protein	C	78.24 \pm 1.76	75.98	80.01	4.03
	S	74.18 \pm 2.24	72.31	77.01	4.70
	F	82.33 \pm 0.35	82.08	82.58	0.50
Crude Fibre	C	0.06 \pm 0.01	0.05	0.07	0.02
	S	0.08 \pm 0.00	0.07	0.09	0.02
	F	0.00	-	-	
Carbohydrate	C	0.90 \pm 0.08	0.79	0.99	0.20
	S	0.93 \pm 0.05	0.87	0.99	0.12
	F	1.51 \pm 0.26	1.32	1.70	0.38

C= blood meal sourced from *Bos primigenius*; S= blood meal from; *Ovis aries* and F= imported blood meal

Mineral composition

Sodium and potassium

The mean concentration of sodium in the sample sourced from *Bos primigenius* and *Ovis aries* are 0.801 \pm 0.09% and 0.775 \pm 0.08% respectively as presented in **Table 2**, while for the imported product the value is 0.600%. These values

are higher compared to the values obtained from imported product indicating higher abundance in the local product with that of *Bos primigenius* having the highest value.

The mean concentrations of potassium in samples sourced from *Bos primigenius* and *Ovis aries* are $0.186\pm 0.07\%$ and $0.452\pm 0.03\%$ respectively, while in the imported product the value is 0.660% . The blood meal type with the highest abundance of potassium is that from *Ovis aries* which is still below that of the imported sample while *Bos primigenius* have the least value.

Sodium/potassium ratio

The sodium to potassium ratio of the blood meal from *Bos primigenius* and *Ovis aries* ranged from 2.10-6.23 and 1.54-1.94 respectively while for the product is 0.80 as presented in Table 2. Sodium and potassium are generally required for the maintenance of osmotic balance of the body fluids and retention of protein during growth [34]. The sodium to potassium ratio in the body is of great concern for the prevention of high blood pressure. The sodium/potassium ratio of less than one is usually recommended, however the sodium/potassium ratio in the samples are generally greater than one suggesting that the product will encourage blood pressure [35]. Nevertheless since the product is just an ingredient addition to other ingredients, the combination should be carried out in such a way that the ratio will be balance.

Calcium and phosphorus

The mean concentration of calcium in the samples sourced from *Bos primigenius* and *Ovis aries* are $0.796\%\pm 0.09\%$ and $0.831\pm 0.06\%$ respectively as presented in Table 2, while it is 0.823% in the imported product. These values are far above 0.250% calcium requirement of Rainbow trout (*S. gairdneri*) and 0.30% specified by blood meal product of Agro-industrial complex, Backa Topola. 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 [35].

The phosphorus content of the samples from *Bos primigenius* and *Ovis aries* are $0.157\%\pm 0.03$ and $0.147\pm 0.01\%$ while 0.100% for the imported product. These values are generally below National Research Council value of 0.250% [10].

Calcium/phosphorus ratio

The calcium/phosphorus ratios of the samples sourced from *Bos primigenius* and *Ovis aries* ranged from 4.06-7.15 and 4.81-6.47 respectively, while for the imported product the value is 8.23 as presented in Table 2. The calcium/phosphorus ratio is above 2.00 which is considered very high indicating abundance of calcium in the product which implies increase in the absorption of calcium into the cells of animals that consume these product [34]. Abundance of phosphorus and calcium would make the product useful in bone formation in poultry since deficiencies of these minerals yield abnormal bone development.

Phosphorus is always found with calcium in the body, both contributing to blood formation and supportive structures of the body. When the calcium/phosphorus ratio of any food is above 1.00, that food is considered good. But if the ratio is less than 0.50 is considered poor while a ratio above 2.00 helps to increase the absorption of calcium in the small intestine [34].

Table 2 Macro element composition of blood meal sourced from *Bos primigenius* and *Ovis aries*

Elements	Samples	Mean \pm standard deviation	Minimum	maximum	Variance
Na (%)	C	0.801 ± 0.09	0.658	0.885	0.227
	S	0.775 ± 0.08	0.639	0.860	0.221
	F	0.600 ± 0.00	0.600	0.600	0.000

K (%)	C	0.186±0.07	0.122	0.322	0.200
	S	0.452±0.03	0.404	0.492	0.088
	F	0.660±0.00	0.452	0.452	0.000
Ca (%)	C	0.796±0.09	0.648	0.883	0.235
	S	0.831±0.06	0.758	0.901	0.143
	F	0.823±0.00	0.823	0.823	-
P (%)	C	0.157±0.03	0.119	0.196	0.077
	S	0.147±0.01	0.139	0.157	0.018
	F	0.100±0.00	0.100	0.100	0.000
Na/K	C	4.866±1.63	2.10	6.23	4.130
	S	1.712±0.16	1.54	1.94	0.400
	F	0.900±0.00	0.90	0.90	0.000
Ca/P	C	5.304±1.58	4.06	7.15	3.090
	S	5.650±0.66	4.81	6.47	1.660
	F	8.230±0.00	8.23	8.23	0.000

C= blood meal sourced from *Bos primigenius*; S= blood meal from *Ovis aries* and F= imported blood meal

Micro element composition

Iron

The concentrations of iron in the samples sourced from *Bos primigenius* and *Ovis aries* are 1368 mg/kg and 1450± mg/kg, while 1399± mg/kg for the imported product indicating no statistical difference at $P < 0.05$. The high concentration of iron in these samples indicates that the product is rich in iron which is an important component of the hemoglobin and essential for blood formation as well as the normal functioning of the central nervous system [36].

Magnesium

The concentrations of magnesium in the samples sourced from *Bos primigenius* and *Ovis aries* are 2688±0.07 mg/kg and 3009±0.32 mg/kg respectively, while for the imported product the value is 6292±0.00 mg/kg. The blood type with the highest amount of magnesium is *Ovis aries* which is in agreement with the reported value of 3000 mg/kg [37] and less than 2200 mg/kg [10]. Magnesium serves as an activator of many enzymes systems and also helps maintain the electrical potentials in nerves [38].

Manganese content

The mean concentrations of manganese in the samples from *Bos primigenius* and *Ovis aries* are 54.52±0.30 mg/kg and 59.88±0.90 mg/kg respectively, while for the imported product the value is 60.10±0.02 mg/kg. There is no significant difference ($P < 0.05$) in the manganese content of the blood meals. These values are higher than values obtained for corn distillers dried soluble grains, dehydrated cane molasses, dehydrated fish solubles, copra meal which is 50.00±100.00 mg/kg [34].

Zinc

The amount of zinc in the samples from *Bos primigenius* and *Ovis aries* is 21.84±0.22 mg/kg and 22.44±0.20 mg/kg respectively, while for the imported product the value is 22.52±0.20 mg/kg. There is no significant difference ($P < 0.05$) in the amount of zinc in the samples. The importance of zinc as an essential nutrient has been recognised for many years, only recently have researchers understood the full impact of this nutrient on animal and human health. Over 200 zinc-dependent enzymes in all the major biochemical pathways in the body have been identified. It is an essential component of both DNA and RNA polymerase enzymes and vital to the activity of a variety of hormones including glucagon, insulin, growth hormone, and the sex hormones and also plays a key role in the immune system [39].

Table 3 Micro element composition of blood meal (mg/kg) sourced from *Bos primigenius* and *Ovis aries*

Elements	Samples	Mean \pm Standard deviation	Minimum	Maximum	Variance
Fe	C	1368 \pm 110	1242	1517	275
	S	1450 \pm 23.2	1425	1472	47.0
	F	1399 \pm 0.03	1399	1399	0.30
Mg	C	2688 \pm 707	2136	3925	1789
	S	3009 \pm 532	2468	3879	1411
	F	6292 \pm 0.00	6292	6292	0.00
Mn	C	54.52 \pm 0.30	16.40	30.00	13.6
	S	59.88 \pm 0.90	46.40	55.10	8.70
	F	60.10 \pm 0.02	60.00	60.12	0.12
Zn	C	21.84 \pm 0.22	17.01	30.46	13.5
	S	22.44 \pm 0.20	19.99	50.97	30.9
	F	22.52 \pm 0.01	22.50	22.21	0.29

C= blood meal sourced from *Bos primigenius*; S= blood meal from; *Ovis aries* and F= imported blood meal

Conclusions

The proximate, macro and micro elemental compositions of the obtained values of the locally sourced blood meal from *Bos primigenius* and *Ovis aries* compares favourably with the values obtained from imported blood meal with no significance difference at $P < 0.05$, indicating that locally sourced blood meal could when improved upon could favourably compete with the imported product and could effectively serve as substitute for the imported product.

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