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EVALUATION OF A BLEND OF MAIZE COB AND CATTLE BLOOD AS PROTEIN FEEDSTUFF FOR BROILER CHICKENS

***MAKINDE, O. A. AND UDOMA, B. A.**

Department of Animal Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria 220005
*Corresponding author: olukayodemakinde@oauife.edu.ng

ABSTRACT

Maize cob and cattle blood are largely wastes from agricultural processes, which, if converted into useful products, will contribute to reducing environmental pollution. The study was conducted to develop and evaluate a maize cob and cattle blood blend as an alternative protein feedstuff for broiler chickens. Finely ground maize cobs were mixed with cattle blood at different ratios, comprising 1:0, 1:2, 1:3, and 1:4. All combinations were sun-dried to < 10% moisture content in about four hours. The nutritional chemical components of the mix were determined by proximate analysis, and gross energy content by bomb calorimeter. Gross energy content ranged from about 3,800 to 4000 kcal/kg, crude protein (6-32%), crude fibre (15-27%), ether extract (4-5%), ash (2-6%), and NFE (38-57%). Apparent metabolizable energy (AME), protein, and dry matter digestibility were determined by the precision digestibility method. The AME ranged from 1,700-2,400 kcal ME/kg, crude protein digestibility from 10-48%, and dry matter digestibility (DMD) from 44-60%. The DMD was significantly higher (P<0.05) for maize cob than for all maize cobs with cattle blood blends, and all maize cobs with cattle blood blends had higher crude protein digestibility coefficients than maize cob. Maize cob-blood meals of 1:2, 1:3, and 1:4 can serve as protein supplements for broilers because of the crude protein contents of 26%, 30%, and 32%, respectively. The maize cob-blood meal produced under the conditions of this study can serve as a potential moderate energy and a fair protein supplement for finisher broiler chickens. However, further evaluation may be required in a growth trial to underscore its usefulness.

Keywords: ***blood meal, digestibility, protein supplement, unconventional feedstuffs***

INTRODUCTION

A major waste from the harvesting and processing of maize is maize cob, making up to about 18.7% of the grain mass (Blandino *et al.*, 2016). Maize production in Nigeria was estimated to be about 23 million metric tons in 2022 (The Poultry Site, 2022), which will result in 4.3 million metric tons of maize cob of the grain mass. However, there is little or no use for maize cob in Nigeria in contrast to more developed countries where it is utilized in various processes such as adsorbent (Siresha *et al.*, 2022), bio-oil (Wu *et al.*, 2023), bio-ethanol (Sandoval-Salas et al 2021), brake lining (Ganesha et al 2021), fuel (Wakudkar and Jain, 2022), structural material (Selvan, 2021). One potential for the use of maize cob in developing countries could be as animal feed. However, use as animal feed may be limited by its nutrient composition, which is about 4% crude protein and 35% crude fiber (Heuze *et al.*, 2016). This may be suitable for ruminants (Quadros *et al.*, 2023), which have a capacity for utilizing high fibre sources but not for non-ruminant animals. Earlier investigations on the utilisation of maize cob as feed for non-ruminants (Heuze *et al.*, 2016) found it unsuitable. Nevertheless, Donkoh *et al.* (2003a) found that it could satisfactorily replace wheat offal (a conventional feed ingredient) up to 7.5% in broiler diets. Furthermore, additional investigations by Donkoh *et al.* (2003b) found that the crude protein content could be improved by over 400% by blending maize cob with cattle

blood in a 1:1 (w/w) proportion, and this could completely replace wheat offal. Cattle blood has about 80% crude protein and high lysine content, which is an essential amino acid and, therefore, would improve the feed quality of maize cob for non-ruminants. However, the maize cob and blood blend by Donkoh (2003b) took 3 days to dry in the sun and had 13.6% CP, which falls short of the blend being a potential protein supplement for non-ruminants. Protein supplements for non-ruminants should not be less than 20% CP (NRC, 1994; SDSU Extension, 2022), therefore, it may be necessary to explore the possibility of increasing the protein content of such a blend by increasing the content of cattle blood in the blend. In addition, the application of a procedure to sun-dry the blend in less than 3 days would improve the efficiency of processing such a blend. Therefore, this study was conducted to investigate the possibility of increasing the proportion of cattle blood in the blend of maize cob and cattle blood and shortening the time for its processing. In addition, the nutritional value of the blend will be evaluated in terms of protein and energy bioavailability for broiler chickens.

MATERIALS AND METHODS

The maize cob for the experiment was obtained from the Feed Mill of the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria. Cattle blood was collected early in the morning (between 7.00 - 7.30 h) from the necks of the cattle at the point of slaughter from a slaughter slab near the university. Blood was prevented from clotting (up to 24 h) by mixing vigorously with 20 g of common salt (NaCl) to 1 L of blood, according to Makinde and Sonaiya (2010). The maize cob was finely ground by a hammer mill at the workshop of the Department of Agricultural Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria, mixed with the blood in ratios of 1:1, 1:2, 1:3, and 1:4 (w/w), and sun-dried on black polythene sheets for 4 h at a drying surface temperature of about 490C and ambient temperature of about 340C.

Five 8-week-old male Arbor Acres broiler chickens, in separate cages, were used in a modified precision digestibility assay (Ragland *et al.* (1997); Adeola *et al.* (1997)) for each blend and for maize cob, thereby making five groups. Briefly, each bird was tube-fed 30 g of each blend or maize cob mixed in 100 mL of de-ionized water after they were initially fasted for 24 h but supplied with glucose in water (30 g/100 mL) 8 h into the fast and for the duration of the assay. Excreta was collected twice for 48 h (at 24 h intervals) after intubation in wooden trays covered in polythene and attached to the base of each cage. Excreta samples were dried for 48 hours at 600C °C, according to Dale and Fuller (1983). The proximate composition of the maize cob and cattle blood blends and excreta was determined in triplicate samples according to procedures of AOAC (1990), and gross energy was determined by bomb calorimeter. Energy or nutrient availability is given by the following:

$$Availability(\%) = \frac{100\times(FI\times GE\ or\ N\ in\ D) - (Excreta\ (E)\times GE\ or\ N\ in\ E)}{FI}$$

Where, FI = feed intake; GE/N in D or in E = Gross energy (GE) or nutrient (N) content in diet (D) and excreta (E), respectively (Reza Abdollahi *et al.*, 2021).

RESULTS AND DISCUSSION

Table 1 shows the chemical composition of cattle blood meal, maize cob, and the blend of maize cob and cattle blood. The dry matter values of the blends show that they were properly dried because the moisture content range was 3.06 – 4.53% for 1:1 - 1:4 blends sun-dried in 4 h, which was much lower than 10% obtained by Donkoh *et al.* (2003b) for the 1:1 blend sun-dried for three days.

Table 1. Chemical composition of cattle blood meal, maize cob, and a blend of maize cob and cattle blood

			Maize cob and Cattle blood blend (w/w)			
	Blood meal[1]	Maize cob	1:1	1:2	1:3	1:4
Parameters (%)						
Dry Matter	94	96.94	96.46	96.08	95.52	95.47
Crude protein	81.1	5.97	17.5	26.63	30.17	31.17
Ether extract	1.6	4.45	4.27	4.16	4.2	4.68
Crude fibre	0.5	26.88	24.76	21.48	18.02	14.93
Ash	2.45	2.44	5.04	4.78	5.56	5.72
NFE	NA	57.19	44.9	39.02	37.59	38.42
GrossEnergy, kcal/kg	4,300	3,823	3,860	3,905	4,022	4,105

[1]NRC (1994) Vat-dried blood meal; NA = Not available; NFE = Nitrogen free extract

This was probably because Donkoh *et al.* (2003b) did not prevent the blood from coagulating when mixed with the maize cob. In this study, the blood was prevented from coagulating, thereby ensuring proper mixing of the fluid into the dry material. Blood clots will reduce the surface area for drying because it will not be thinly spread out in the drying matrix, thereby reducing the air/product exchange area (Rozis, 1997). The very low moisture content in the blends also indicates good keeping quality or shelf life and preservation from microbial contamination due to the low water activity. Generally, very low moisture contents indicate low water activity (Chen, 2019). The crude protein (CP) contents of the 1:2, 1:3, and 1:4 blends indicate their potential as protein supplements because their CP was greater than 20% (NRC, 1994; SDSU Extension, 2022). However, the 1:1 blend had higher CP than obtained by Donkoh *et al.* (2003b), probably due to better blood absorption as stated earlier. The CP content of pure blood meal is expectedly to be higher than all the blends because it was only blood that was dried without maize cob, and this could also be related to its differences in the ether extract, crude fibre, and ash values from the blends. The nitrogen-free extract value of maize cob was higher than that of the blends because of blood substituting for parts of it, and the general trend was a decline as blood quantity was increased. The gross energy of the blends was moderately lower than the blood meal but higher than the maize cob because the gross energy in blood seems to be additive to that in maize cob, and it also increased as the quantity of blood increased. Their results suggest that the maize cob and cattle blood blends could serve as a potential protein feedstuff for animals.

Table 2 shows the digestibility or bioavailability of dry matter, crude protein, and apparent energy utilization by broiler chickens. Dry matter digestibility (DMD%) was higher ($P<0.05$) for maize cob than for any maize cob to blood blends, except the 1:3 blend, probably because it had the highest dry matter and NFE contents (Table 1), which accounts for the relatively soluble carbohydrate content in feed. A similar result was obtained by Donkoh *et al.* (2003b) between maize cob and a 1:1 blend. The DMD% of the 1:3 blend was at par ($P>0.05$) with the 1:2 and 1:4 blends but higher ($P<0.05$) than the 1:1 blend, probably due to

the increasing blood concentration in those blends despite the higher NFE in the 1:1 blend. Blood meals have been reported to have good digestibility in animals (Hussain *et al.* 2011; Heuze *et al.* 2016).

Expectedly, crude protein digestibility of all blends was significantly higher (P<0.05) than that of maize cob but was at par (P>0.05) with each other. This was apparently due to the higher crude fibre content in maize cob than all the blends (Table 1), which decreased as the blood concentration was increased. Crude fibre is the relatively insoluble fraction of carbohydrates in the feed and is poorly utilized by most non-ruminants, and this may probably be responsible for the moderate CPD% of all the blends (Table 2).

Energy availability in terms of apparent metabolizable energy (AME) was not significantly different (P>0.05) among maize cob and the blends, but that of the 1:1 blend was numerically lower. However, the AME for the 1:1 blend was higher than that obtained by Donkoh *et al.* (2003b) (1,720 vs. 1,230 kcal ME/kg), and this may be due to differences in the source of blood (cattle vs. pig blood), ages (8 weeks vs. 6 weeks), and strain of broiler chickens used. Nevertheless, the highest AME content of the blends was lower compared to values for commercial blood meal (2,413 vs. 3,020 kcal ME/kg; Feedtables (2021)). This appears to be a dilution of the AME for raw blood (3,124 kcal ME/kg) by that for maize cob (2,406 kcal/kg). It can be inferred from these results that the maize cob to cattle cob blends of 1:2, 1:3, and 1:4 (w/w) offer potential feedstuffs with moderate dry matter and crude protein digestibility and moderate energy availability for broiler chickens.

Table 2. Apparent availability of dry matter, crude protein, and energy for broilers from maize cob and cattle blood blend

		Maize cob and Cattle blood blend (w/w)					
Parameters	Maize cob	1:1	1:2	1:3	1:4	SEM	P-value
DMD (%)	60.26a	44.66c	47.60bc	53.80ab	46.95bc	2.0883	0.03
CPD (%)	10.20b	40.02a	44.63a	47.11a	47.44a	4.7202	0.05
AME (kcal/kg)	2,406.60	1,720.00	1,904.50	2,413.60	2,395.70	0.1166	0.12

abc Means that within the same row, with different superscripts, are significantly different (P<0.05)

SEM = Standard error of the mean; DMD = Dry matter digestibility; CPD = Crude protein digestibility; AME = Apparent metabolizable energy

CONCLUSION

It can be concluded that a blend of maize cob and cattle blood under the conditions of this study with higher concentrations of blood up to 1:4 (w/w), with good keeping or storage qualities, can be produced by sun drying within a day, especially during the dry season. In addition, the maize cob-blood meals produced can serve as protein supplements, with moderate energy and fair protein utilization by finisher broiler chickens.

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