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Conversion of abattoir wastes into livestock feed: Chemical composition of sun-dried rumen content blood meal and its effect on performance of broiler chickens

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Abstract

Identification, development, and utilisation of potential alternatives to conventional ingredients (such as soybean and fishmeal) are imperative for the sustainability of livestock production. One of such is from abattoir wastes comprising rumen content and blood (about 50,000 and 17,000 metric tonnes available/year, respectively), a potential alternative protein source. Therefore, this study was set up to evaluate the chemical composition of rumen content blood meal and its effect on performance of broiler chickens. Fresh blood prevented from coagulation, mixed with dewatered rumen content, was sun-dried, ground, mixed again with blood and ground into a meal. The crude protein, fat, fiber, ash, NDF, ADF and gross energy contents of sun-dried rumen content blood meal (SDRBM) were, 47.06, 6.55, 9.59, 11.6, 58.75, 19.84 %, and 17.6 kJg−1, respectively. It was adequate in all essential amino acids. In a feeding trial, starter (14–35 d) and finisher phases (35–49 d), eighty14-day-old commercial broiler chicks were randomly allocated to one of four dietary treatments in a completely randomised block design. The dietary treatments (isoproteic and isoenergetic, and fed ad libitum) consisted of the control diet, which contained fishmeal (starter diet only), groundnut cake and soybean meal as the main protein sources, and three other diets, which contained varying levels of SDRBM (5, 10 and 15 %). The starter dietary treatments did not have significant impact ($p > 0.05$) on body weight gain and feed conversion efficiency. However, birds fed SDRBM at 0, 5, and 10% had higher feed intake ($p < 0.05$) than birds fed 15% SDRBM and feed cost per unit weight gain lower ($p < 0.05$) for SDRBM diets than the SDRBM-free diet. Birds fed 15% SDRBM had the lowest ($p < 0.05$) feed intake while body weight gain, feed conversion efficiency, and feed cost per unit weight gain were superior ($p < 0.05$) for birds fed 10% SDRBM compared with other SDRBM diets in both the finisher phase and the whole period. Carcass yields were higher ($p < 0.05$) for SDRBM diets than the SDRBM-free diet. Mortality was unaffected by dietary treatments. The study demonstrated that dietary SDRBM up to 10% was beneficial for growth performance and that total replacement of fishmeal was possible in broiler diets.

Keywords: Abattoir waste conversion, alternative protein source, rumen content

Introduction

The attraction of feedstuffs such as fishmeal and soybean to use as valuable components of poultry diets is because of their high protein content and good amino acid profile. However, current global biofuel mediated increases in the cost of grains as energy sources in poultry feed, may constrain this utilisation because of their high cost since they are mostly imported. Therefore, identification, development, and utilisation of potential alternatives are imperative for the sustainability of livestock production. One of such is from abattoir wastes comprising rumen content and blood, a potential alternative protein source.

Rumen content and blood are substantial wastes (about 50,000 and 17,000 metric tonnes available/year, respectively; Makinde, 2006) generated daily at abattoirs in Nigeria (Adeniji, 1995; Odunsi, *et al.*, 2004). Rumen content is plant material at various stages of digestion rich in microbial protein (Emmanuel, 1978; McDonald et al., 1990). Blood is a source of high quality protein as blood meal (80-90% crude protein high in the essential amino acids, especially lysine; NRC, 1994), and nutritional value of blood meal increases when fed in combination with other protein sources (Ilori et al., 1984; Dafwang et al., 1986). Therefore, a combination of rumen content and blood assures a potential alternative protein source. However, results from growth performance trials have been variable and a simple standard processing method is not available and despite previous work on such a combination as feed for poultry (Adeniji, 1995; Lien, *et al.*, 1995; Odunsi, 2003; Odunsi, *et al.*, 2004). These studies involved the heating of blood for various time-periods, but blood is sensitive to heat damage (reduction in the availability of essential amino acids due to reactions between lysine and reducing sugars; NRC, 1994). However, sun drying offers a cheaper and probably less deleterious alternative (Azad, 2008). Therefore, this study involved development of a simple processing method for rumen content and blood employing sun drying and evaluation of the nutritive value of such sun-dried rumen content blood meal (SDRBM) as feedstuff for broiler chickens. Conversion of these wastes into animal feed will increase the flexibility of ration formulation, conserve foreign exchange, and reduce environmental pollution.

Materials and Methods

Fresh rumen content obtained from the rumen of slaughtered cattle was dewatered with a 10-ton hydraulic press for 30 minutes and the resulting press cake broken up by sieving through a 2 mm wire mesh sand sieve. Fresh blood (prevented from coagulating by mixing with18 g common salt/liter blood) mixed with the dewatered rumen content (DRC), sun-dried for between 3-4 h, ground, mixed again with blood and ground into a meal after drying again.

Chemical composition of DRC and SDRBM were determined using standard procedures of AOAC (1990). The crude fiber fraction was further partitioned into neutral detergent fiber (NDF), acid detergent fiber (ADF) and hemicellulose fractions (Van Soest *et al.*, 1991). Amino acid composition of SDRBM was determined following acid hydrolysis using a Technicon® Sequential Multisample Amino Acid Analyzer (TSM-1, model DNA 0209, Swords Co., Dublin, Ireland; reproducibility, ±3%) at the Zoology Department, University of Jos, Jos, Nigeria. The gross energy content of the vegetable-carried meals was determined by oxygen bomb calorimeter (Gallenkamp Ballistic Bomb Calorimeter, Cambridge Instrument Co. Ltd, England).
The concentrations of calcium, iron, zinc magnesium, manganese and copper were determined according the methods of AOAC (1990). Phosphorus was estimated using the stannous-chloride method.

The experiment was divided into two phases, starter (14-35 d) and finisher (35-49 d) phases. Eighty14-day-old commercial broiler chicks (Anak-2000 strain) were randomly allocated to four dietary treatments replicated four times with five birds per replicate (Table 1) in a completely randomized block design. The dietary treatments consisted of the control diet, which contained fishmeal (starter diet only), and three other diets, which contained varying levels of SDRBM at 5, 10, and 15 %. The test diets for the starter phase were formulated to be isocaloric and isonitrogenous containing 12.6 MJ ME/kg and 22% crude protein (PTF, 1992), and the finisher

Table 1. Gross and nutrient composition of experimental broiler starter and finisher diets

	SDRBM[1] (% diet)							
	Starter				Finisher			
Ingredients	0	5	10	15	0	5	10	15
Maize	58.94	58.64	59.58	60.65	61.42	62.47	63.75	64.37
Soya bean meal	16.0	16.0	16.0	12.35	15.8	9.8	7.2	4.25
Groundnut cake	14.5	15.38	10.0	8.2	7.0	7.8	4.5	2.85
Fishmeal	3.0	0	0	0	0	0	0	0
SDRBM	0	5	10	15	0	5	10	15
Wheat offal	4.06	1.48	0.92	0.3	12.28	11.43	11.05	10.03
Bone meal	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Premix[3]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Calculated composition[3]								
ME in MJ kg^{-1}	12.56	12.56	12.56	12.56	12.34	12.34	12.34	12.34
%CP	22.19	22.01	22.04	22.05	18.02	18.17	18	18.18
%CF	3.32	3.39	4.47	4.95	3.65	4.08	4.57	5.05
%Ca	1.26	1.09	1.09	1.09	1.07	1.07	1.07	1.07
%P	0.96	0.79	0.79	0.76	0.79	0.74	0.72	0.7
%Lysine	1.15	1.38	1.67	1.9	0.97	1.18	1.43	1.69
%Methionine	0.48	0.48	0.5	0.52	0.42	0.44	0.46	0.48
Cost of diet (N/kg)	60.79	49.82	49.55	48.19	54.06	51.99	50.99	47.14

[1]SDRBM = sun-dried rumen content blood meal.

[2]Provides per kg of diet: Vitamin A, 12,500 IU; Vitamin D, 2,500 IU; Vitamin E, 40 mg; Vitamin K, 2 mg; Vitamin B1, 3 mg; Vitamin B2, 5.5 mg; Niacin 55 mg; Calcium pantothenate, 11.5 mg; Vitamin B 6, 5mg; Vitamin B 12, 0.025 mg; Choline chloride, 500 mg; Folic acid, 1 mg; Biotin, 0.08 mg; Manganese, 120 mg; Iron, 100 mg; Zinc, 80 mg; Copper, 8.5 mg; Iodine, 1.5 mg; Cobalt, 0.3 mg; Selenium, 0.12 mg; Anti-oxidant, 120 mg.

[3]ME = metabolizable energy; CP = crude protein; CF = crude fiber; Ca = calcium; P = phosphorous (total).

phase formulated to contain 12.34 MJ ME/kg and 18% crude protein (PTF, 1992). The birds were confined in floor pens (0.3 m^2 /bird) with wood shavings in an open-sided poultry house constructed from wood and wire gauze, with asbestos roof and concrete floor. Birds were fed ad libitum with free access to water and routine management and vaccination were carried out.

Data on feed consumption, average daily gain (ADG), average daily feed intake (ADFI), feed conversion ratio (FCR) were determined weekly and records of mortality/veterinary intervention kept. Carcass yield (from three birds selected randomly/pen) calculated as dressed weight per unit live weight excluded all the organs, head, feathers, neck and shanks. Economics of production were evaluated by considering feed cost/kg feed, feed cost/kg gain, cost of production/kg gain, and benefit/kg gain.

Data were analyzed as completely randomized block design using the General Linear Models procedure of SAS® (2000) for analysis of variance (ANOVA). The four replicates per treatment were considered as blocks in order to increase the precision of the experiment. Differences between means were resolved by Duncan's multiple range test of the SAS® statistical package. Statistical significance was established when probability was less than 5% level of significance.

Results and Discussion

The chemical composition of DRC and SDRBM in Table 2 indicates that the potential feeding value of DRC increased after mixing with blood. Crude protein (CP) content increased about four

Table 2. Chemical composition of dewatered rumen content, sun-dried rumen content blood meal and vat-dried blood meal[1]

Composition	Rumen content	SDRBM[2]	Vat dried[3] blood meal
Dry Matter,%	71.15	89.10	92
GE, kJg^{-1}	12.6	17.6	21.8
Crude protein,%	12.85	47.06	77.1
Arginine, %	NA	2.68	3.34
Histidine, %	NA	1.03	5.06
Isoleucine, %	NA	1.28	0.91
Leucine, %	NA	2.42	10.99
Lysine, %	NA	1.89	7.04
Methionine, %	NA	0.8	0.99
Phenylalanine, %	NA	1.6	5.34
Threonine, %	NA	1.13	4.05
Valine, %	NA	1.98	7.05
Alanine, %	NA	1.06	NA
Aspartic acid, %	NA	3.34	NA
Cystine, %	NA	0.76	NA
Glutamic acid, %	NA	4.29	NA
Glycine, %	NA	2.04	4.59
Proline, %	NA	0.98	NA
Serine, %	NA	1.12	3.14
Tyrosine, %	NA	1.02	2.07
Tryptophan, %	NA	NA	NA
Crude fiber,%	9.45	9.59	0.55
NDF, %[4]	80.60	58.75	13.6
ADF, %[5]	42.80	19.84	1.8
Hemicellulose, %	37.80	43.22	11.8
Ether extract, %	3.35	6.55	1.6
NFE, %	37.14	14.3	NA
Ash, %	8.36	11.6	NA
Ca, mg/kg	NA	0.76	3700
P, mg/kg	NA	4.7	2700
Mg, mg/kg	NA	0.57	1100
Fe, mg/kg	NA	6.8	1,922.00
Mn, mg/kg	NA	0.78	6
Cu, mg/kg	NA	2.64	11
Zn, mg/kg	NA	0.03	38

[1]Values are means of duplicate samples; NA = Not analysed.

[2]SDRBM = sun-dried rumen content blood meal.

[3]Values obtained from from NRC (1994) and NRC (1998).

[4]NDF = neutral detergent fiber.

[5]ADF = neutral detergent fiber.

times and gross energy increased to that comparable to NRC, 1994 value for yellow corn (17.6 vs. 20 kJg^{-1}). The CP was more than half the values for fishmeal and vat-dried blood meal (47 vs. 72 and 77%, respectively) and the total essential amino acid content more than adequate compared with NRC (1994) amino acid requirements for broiler chickens (0-8 weeks of age). The crude fiber content was much lower than that given by Jurgens (1978) for feedstuffs considered as roughages or forages (9.6 vs. 18%). These results indicate a good potential for use as protein supplement in broiler chicken diets. However, the content of the mineral elements was poorer than vat-dried blood meal.

Table 3 shows data on the effect of dietary SDRBM on the growth performance of the broiler chickens at the starter phase (14-35 d), finisher phase (35-49 d), and entire period (14-49 d). The starter dietary treatments did not have significant impact ($p > 0.05$) on average final body weights, body weight gain and feed conversion efficiency. However, birds fed SDRBM at 0, 5, and 10% had higher feed intake ($p < 0.05$) than birds fed 15% SDRBM and feed cost per unit weight gain lower ($p < 0.05$) for all SDRBM diets than the SDRBM-free diet. These results indicate that no advantage was gained by fishmeal over SDRBM diets. Donkoh et al. (1999) observed that inclusion of up to 7.5% solar-dried blood meal in broiler diets allowed the reduction of fishmeal in the diets without affecting growth performance. In both the finisher phase and the entire period, birds fed 15% SDRBM had the lowest ($p < 0.05$) feed intake. This is probably due to increasing fibrousness of the diets as the inclusion level of SDRBM was increased since fiber limits feed utilization in poultry production (Onifade, 1993; Bolarinwa, 1998). Final body weight, body weight gain, feed conversion efficiency, and feed cost per unit weight gain were superior ($p < 0.05$) for birds fed 10% SDRBM compared with all other diets in both the finisher phase and the entire period. Carcass yields were higher ($p < 0.05$) for all SDRBM diets than the 0% SDRBM diet. Mortality was unaffected by dietary treatments. These results emphasize the quality of SDRBM as a good substitute to fishmeal in broiler diets.

The study demonstrated that dietary SDRBM up to 10% was beneficial for growth performance and that total replacement of fishmeal was possible in broiler diets. Further studies that could raise the inclusion level of SDRBM in broiler chicken diets will contribute to a reduction in feed costs and environmental pollution from blood and rumen content.

Table 3. Live performance of broiler chickens fed diets with graded levels of sun-dried rumen content blood meal

	Starter (14-35 d)					Finisher (35-49 d)					Overall (14-49 d)				
	Levels of SDRBM[1] (% diet)					Levels of SDRBM (% diet)					Levels of SDRBM (% diet)				
Parameters	0	5	10	15	SE[2]	0	5	10	15	SE	0	5	10	15	SE
AIB (g/bird)[3]	227.3	226	224.9	212.4		948.2	970.4	982.8	917.3		227.3	226	224.9	212.4	
AFBW (g/bird)[4]	948.2	970.4	982.8	917.3	9.30	1639.2^{a}	1572.4^{ab}	1737.9^{a}	1446.8^{b}	16.50	1639.2^{a}	1572.4^{ab}	1737.9^{a}	1446.8^{b}	16.50
ADG (g/bird)[5]	34.3	35.5	36.1	33.6	0.40	49.4^{a}	43^{b}	53.9^{a}	37.8^{b}	1.20	40.3^{ab}	38.5^{bc}	43.2^{a}	35.3^{c}	0.65
ADFI (g/bird)[6]	81.2^{a}	80.1^{a}	80^{a}	74.5^{b}	0.60	163.8^{a}	155.1^{ab}	154.2^{ab}	148.6^{b}	1.34	110.8^{a}	110.1^{a}	109.7^{a}	104.1^{b}	0.76
FCR[7]	2.37	2.26	2.24	2.22	0.01	3.32^{bc}	3.66^{ab}	2.87^{c}	3.94^{a}	0.06	2.75^{ab}	2.88^{a}	2.55^{b}	2.95^{a}	0.02
Carcass yield (%)											62.0^{b}	66.8^{a}	67.2^{a}	67.5^{a}	0.45
Mortality (number)	1	0	1	0		0	0	0	0		1	0	1	0	
FC/kg (N)[8]	60.8	49.8	49.6	48.2		54.1	51.9	50.9	47.1		57.4	50.9	50.3	47.7	
FC/kg gain (N)	143.9^{a}	112.8^{b}	110.9^{b}	106.9^{b}	1.90	179.8^{ab}	190.5^{a}	146.2^{c}	185.9^{ab}	2.60	157.8^{a}	146.5^{ab}	128.2^{c}	140.7^{bc}	1.8
CP/kg gain[9] (N)											341.8^{a}	330.5^{ab}	312.2^{c}	324.7^{bc}	1.8
Benefit/kg[10]gain (N)											58.2^{c}	69.5^{bc}	87.8^{a}	75.3^{ab}	1.8

^{abc}Means on the same row with the same superscripts are not significantly different (P>0.05).

[1]SDRBM = sun-dried rumen content blood meal.

[2]SE= standard error of means.

[3]AIB = average initial body weight.

[4]AFBW = average final body weight.

[5]ADG = average daily gain.

[6]ADFI = average daily feed intake.

[7]FCR = feed conversion ratio (g feed/g gain).

[8]FC = feed cost (N=Naira).

[9]CP = cost of production/kg gain (N)= FC/kg gain + Total common costs for 49 days (brooded chicks; drugs; equipment; wood shavings; transportation; poultry house repair and maintainnance; labour and miscellaneous-10% of total common costs).

[10] Benefit/kg gain (N) = price of broiler/kg (N) when study was conducted (N400.00) minus cost of production/kg gain (N); 1 US$ = N140.

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