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Further studies on the use of solar-dried blood meal as a feed ingredient for poultry

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ABSTRACT

Two studies, using broilers and laying hens, were conducted to further determine the nutritive value of solar-dried blood meal (SDBM). In experiment 1, diets containing 0, 30, 60 and 90 g SDBM kg^{-1} were fed *ad libitum* to 240 two-week-old broiler chickens for a period of 6 weeks. The level of SDBM had no significant effect on feed intake, body weight gain, feed conversion efficiency, carcass yield, or mortality. In experiment 2, 144 brown egg layers of 26 weeks of age randomly allotted into four groups were fed diets containing 0, 15, 30 and 45 g SDBM kg^{-1} for 20 weeks. The inclusion of graded levels of SDBM in layer diets positively influenced feed intake ($r=0.95$; $P<0.05$), body weight gain, egg weight, yolk colour, and Haugh unit score. Hen-day egg production and feed conversion efficiency were, however, unaffected. There were neither health-related problems nor deaths associated with the amount of SDBM in the diet. It is concluded that dietary SDBM up to 45g kg^{-1} had a positive effect on layer performance and that in broiler diets, partial replacement of other protein sources (fish meal and copra cake) with SDBM is possible.

KEY WORDS: solar-dried blood meal, performance, broilers, laying hens

INTRODUCTION

Fish meal is an important constituent of poultry diets because of its high protein content and good amino acid profile. In most developing countries, however, its use in poultry diets is constrained by its high cost with consequent high prices of meat and eggs. There is, therefore, the need for a continuous search for new dietary protein ingredients.

Research data indicate that blood meal is of high nutritional value to poultry and pigs when fed in combination with other protein sources (King and Campbell, 1978; Ilori et al., 1984; Dafwang et al., 1986). A study conducted by Donkoh et al. (1999) with broiler chickens indicated that the inclusion of solar-dried blood meal (SDBM) in diets up to 75 g kg^{-1}, allowed the level of fish meal to be reduced from 190 to 100 g kg^{-1} without any adverse effect on growth performance. More work is needed, however, in order to be able to make firm recommendations on incorporating SDBM in broiler chickens' diets. Moreover, there is paucity of information on the use of blood meal in layer diets.

Two studies were, therefore, conducted to assess the extent to which SDBM can further reduce the quantity of fish meal included in broiler diets and to determine the effects of graded levels of SDBM on the performance of laying hens.

MATERIAL AND METHODS

Source of blood and processing method

The blood used in the study was obtained from the Meat Science Unit of the Department of Animal Science, University of Science and Technology, Kumasi. The processing method, which employs the combination of heating and solar-drying techniques, as well as the chemical and amino acid composition of SDBM, have been described in detail by Donkoh et al. (1999).

Experiment 1

A control diet and diets containing 30, 60 and 90 g SDBM kg^{-1} were prepared. The diets were formulated to be isoproteic and isoenergetic (Table 1).

Two hundred and forty unsexed 14-day-old commercial broiler chickens were individually weighed and allocated randomly to the four dietary treatments. Each treatment was replicated three times. Starting weights of broiler chicks averaged 190 g. The birds were placed and reared in deep litter pens. Treatment diets were administered from 2-8 weeks of age. Broilers consumed feed and water *ad libitum* throughout the experimental period. Chickens were vaccinated against Gumboro and Newcastle diseases. They were protectively medicated for coccidiosis at 3 days of age and again during the third week using sulphadimidine sodium 33% *via* the drinking water.

Broilers were individually weighed on a weekly basis. Weight gain, feed consumption and feed conversion efficiency (adjusted for mortality) were measured for the 2-8 week period. Records of mortality were also kept. All sick and dead chickens were sent to the Veterinary Laboratory for post-mortem examination.

TABLE 1

Composition of experimental broiler diets

	Level of solar-dried blood meal, g kg^{-1} diet			
	0	30	60	90
Ingredients, g kg^{-1}				
maize	580	580	580	580
solar-dried blood meal	0	30	60	90
fish meal	200	160	130	90
copra cake	60	55	45	30
wheat bran	130	145	155	175
oyster shell, ground	10	10	10	10
dicalcium phosphate	10	10	10	10
vitamin/mineral premix[a]	5	5	5	5
NaCl	5	5	5	5
Chemical analysis, g kg^{-1} DM				
crude protein	210.0	214.4	216.2	218.9
crude fibre	35.7	36.0	36.8	37.3
crude fat	40.9	39.2	37.6	35.7
lysine	12.3	13.1	13.8	14.3
methionine	5.4	5.2	5.1	5.0
isoleucine	10.0	9.0	8.3	8.0
Ca	13.1	12.8	11.9	11.0
P	9.9	9.2	8.5	7.8
ME_n, MJ kg^{-1} [b]	11.58	11.65	11.76	11.82

[a] vitamin-mineral premix supplied (kg^{-1} diet): vit. A, 10,000 IU; vit. D, 2000 IU; vit. E, 10 IU; vit. K, 3 mg; riboflavin, 4.4 mg; cobalamin, 0.05 mg; panthothenic acid, 8 mg; niacin, 16.5 mg; choline, 175 mg; folic acid, 0.5 mg; Mg, 2.3 mg; Fe, 30.5 mg; Zn, 50 mg; Co, 0.27 mg

[b] calculated from the National Research Council (1994)

At the end of the experiment (56 days of age), four broilers from each of the 12 replicates were randomly selected, starved of feed for 18 h to empty their crops, killed by cutting the jugular vein, exsanguinated, defeathered and eviscerated. Carcass yield was calculated from eviscerated weight and liveweight.

Experiment 2

One hundred and forty-four AF Bosbek commercial brown egg layers, 26 weeks old and averaging 1.76 kg, were randomly assigned in equal numbers to four experimental diets containing 0, 15, 30 and 45 g SDBM kg^{-1}. The composition and calculated analysis of these diets are shown in Table 2. The birds were housed individually in battery cages, each measuring 40 x 33 x 41 cm. Each row of 12

TABLE 2

Composition of experimental layer diets

	Level of solar-dried blood meal, g kg^{-1}			
	0	15	30	45
Ingredients, g kg^{-1}				
maize	550	550	550	550
fish meal	140	115	100	85
solar-dried blood meal	0	15	30	45
wheat bran	220	230	230	230
oyster shell	75	75	75	75
dicalcium phosphate	10	10	10	10
vitamin/mineral premix[a]	2.5	2.5	2.5	2.5
NaCl	0.25	0.25	0.25	0.25
Chemical analysis, g kg^{-1}				
crude protein	17.12	17.00	17.31	17.65
crude fibre	4.43	4.57	4.23	4.16
crude fat	3.63	3.76	3.13	3.79
ash	13.64	13.73	13.86	13.91
lysine	0.91	0.94	0.99	1.06
methionine	0.40	0.37	0.36	0.34
Ca	4.12	3.76	3.86	3.61
P	0.91	0.83	0.80	0.76
ME_n, MJ kg^{-1} [b]	10.94	10.70	10.54	10.40

[a] vitamin-mineral premix supplied (kg^{-1} diet): vit. A, 7500 IU; vit. D_3, 2200 IU; vit. E, 9.5 IU; vit. K, 1.7 mg; riboflavin, 2.5 mg; cobalamin, 0.05 mg; panthothenic acid, 6 mg; niacin, 20 mg; choline, 240 mg; folic acid, 0.5 mg; Mg, 2.3 mg; Fe, 45 mg; Cu, 5.5 mg; Mn, 55 mg; Zn, 50 mg; I, 0.8 mg; Co, 0.2 mg

[b] calculated from the National Research Council (1994)

individual cages, with a common feeding trough, constituted a replicate, and there were three replicates per treatment, giving 36 birds per treatment. The birds were dewormed before the start of the trial. Feed and water were given *ad libitum*. The experiment lasted 20 weeks.

Feed consumption, body weight gain, feed-to-egg ratio, yolk colour score, Haugh unit score and shell thickness were measured on a weekly basis, while egg production and egg weights were measured daily. Yolk colour score was assessed by visual comparison of the fresh yolk with a Roche colour fan. Egg shell thickness was measured using an Ames thickness measure, measurements being taken at the equatorial plane of the egg after the shell membranes had been removed. Haugh unit scores were measured using the Haugh unit measure (KAW Company, Trenton, NJ). A total of 1920 eggs were used in studying yolk colour, Haugh unit score and shell thickness (480 eggs per treatment).

Statistical analysis

The dietary treatment effects for all the traits measured for both trials were analysed. The data were subjected to regression analysis to show the effect of including SDBM on broiler and layer performance. Differences between means were determined by the use of the Duncan's multiple range test (Steel et al., 1997) and considered significant if $P<0.05$. The computations were performed using the general linear models procedure of SAS (1987).

RESULTS AND DISCUSSION

Experiment 1

The summary of the results for the broiler feeding trial is presented in Table 3. Average feed consumption per bird for the 6-week experimental period ranged from 3.62 to 4.03 kg. The non-significant effect of SDBM inclusion in the diet on feed intake suggests that broiler chickens will consume diets containing up to 90 g SDBM kg^{-1}.

Weight gains of chickens fed on the control diet containing no SDBM did not differ markedly from those given the diets containing 30, 60 and 90 g SDBM kg^{-1} for the experimental period of 6 weeks. The efficiency with which feed was converted to gain (feed conversion efficiency) was unaffected by dietary inclusion of SDBM. Birds receiving 90 g SDBM kg^{-1} had a better feed: gain ratio than those on the control diet and the other SDBM-based diets. SDBM contains a very high level of leucine but its isoleucine content is relatively low. There is evidence that a high

TABLE 3

Effect of solar-dried blood meal on performance of broiler chickens over the period from 2 to 8 weeks of age[a]

Indices	Level of solar-dried blood meal, g kg^{-1}				SEM	r
	0	30	60	90		
Feed intake, kg	3.80	4.03	3.71	3.62	0.02	-0.63
Body weight gain, kg	1.87	1.95	1.84	1.88	0.02	-0.22
Feed conversion efficiency	2.08	2.67	2.02	1.93	0.06	-0.42
Carcass yield, % of LBW	79	80	79	80	0.4	0.44
Mortality, %	3.70	3.70	2.78	3.24	0.22	-0.67

SEM – standard error of mean

[a]n = 60 birds for each dietary treatment, with 3 replications per treatment

LBW = live body weight

r = correlation coefficient

level of leucine may elevate the isoleucine requirement of chickens and turkeys (D'Mello and Lewis, 1970; D'Mello, 1975; NRC, 1994; McDonald et al., 1996). The similar growth performance attained by birds fed on the SDBM-based diets, as compared with those on the SDBM-free diet, despite the possible undesirable amino acid interactions (leucine-isoleucine antagonism) associated with feeding blood meal to animals, may be attributed to the complementary effects of using fish meal, copra cake and SDBM together. The benefit of feeding several different protein sources of diverse amino acid profiles to overcome this anomaly, as evidenced by the results of the present study, suggests isoleucine or any other essential amino acid deficiency should not have existed in the SDBM-based diets. Parkhurst and Mountney (1988) have indicated that several different protein sources give a more adequate amino acid balance than one alone. Confirmation of the complementary effects of using blood meal, in combination with other protein sources, is provided by several authors for the pig (Wahlstrom and Libal, 1977), laying hens (Dafwang et al., 1986) and broiler chickens (Donkoh et al., 1999).

The level of SDBM in the diet, similarly as in the study of Donkoh et al. (1999), did not have any impact on carcass yield of broilers.

Mortality among broilers fed the SDBM-containing diets was similar to that on the SDBM-free diet. Post-mortem autopsies indicated no specific causes for deaths attributable to SDBM. The results of the previous study by Donkoh et al. (1999) and that herein reported indicate a positive feeding value of SDBM for broiler chickens.

Experiment 2

The general performance of the laying hens fed diets containing graded levels of SDBM are shown in Table 4, along with data for birds fed the SDBM-free (control) diet for comparison. Feed intake by laying hens was significantly ($P<0.05$) influenced by the level of SDBM in the diets. Feed intake tended to increase as the level of SDBM increased; however, feed intake by laying hens did not differ significantly between those fed the 30 g and 45 g SDBM kg^{-1} diet. Contrary to this study, Dafwang et al. (1986) reported no significant differences in feed intake of medium type brown layers fed on diets containing fish meal or blood meal or a combination of both ingredients.

There were statistical differences in body weight gains during the period of 26 to 46 weeks of age between the laying hens fed the SDBM-free diet and those that contained varying amounts of SDBM. Those fed the 30 and 45 g SDBM kg^{-1} diets gained more than birds fed the SDBM-free diet and the 15 g SDBM kg^{-1} diet.

Layers fed the 30 g SDBM kg^{-1} diet had the highest egg production rate of 64.7% and consumed less feed per dozen eggs; the differences between groups were, however, not significant. This probably indicates that solar-dried blood meal

TABLE 4

Effect of solar-dried blood meal on performance of laying hens from 26 to 46 weeks of age[a]

Indices	Level of solar-dried blood meal, g kg^{-1}				SEM	r
	0	15	30	45		
Daily feed intake, g	106.9	109.1	111.2	111.4	0.52	0.95*
Initial body weight, kg	1.63	1.58	1.62	1.68	0.06	
Body weight gain, kg	0.09	0.09	0.14	0.19	0.03	0.94*
Hen-day egg production, %	60.8	61.9	64.7	61.5	1.00	0.37
Feed/dozen eggs	2.07	2.07	2.02	2.13	0.04	0.37
Egg weight, g	56.0	56.8	56.3	57.6	0.35	0.79*
Yolk colour score	1.00	1.13	1.20	2.00	0.07	0.88*
Haugh unit score	89.5	89.1	90.7	91.6	2.11	0.89*
Shell thickness, mm	0.34	0.37	0.36	0.36	0.01	0.51
Mortality	0	0	0	0	-	

SEM – standard error of mean

[a] n = 36 laying hens for each dietary treatment, with 3 replications per treatment

* $P < 0.05$

may be included in layer diets at 30 g kg^{-1} to obtain higher egg production and feed efficiency. There is not much published information on the use of blood meal in layer diets. Vogt et al. (1976) had earlier reported that blood meal had no clear effect on laying performance when used as a supplement to feather meal. Dafwang et al. (1986) also reported that lower levels of fish meal (25 g kg^{-1} diet) and blood meal (22 g kg^{-1} diet) were as good as higher levels (50 g and 44 g kg^{-1} diet, respectively). The results of that study also indicated some beneficial complementary effects on egg production and feed efficiency when both fish meal and blood meal were present in the ration.

The effects of dietary treatments on egg quality are shown in Table 4. Dietary treatments had a significant ($P<0.05$) effect on egg weight, with birds on the 45 g kg^{-1} diet having the highest egg weight. The egg shell thickness was, however, similar. The internal quality of the egg (the Haugh unit values and the yolk colour scores) increased with increasing concentration of dietary SDBM. Dafwang et al. (1986) observed no significant effect on Haugh units by the use of blood meal in place of fish meal in layer diets.

No mortalities were recorded during the course of this study. In addition, there were no health-related problems attributable to the inclusion of varying amounts of SDBM in diet. Dafwang et al. (1986) noted that the absence of both fish meal and blood meal from layer diets tended to result in increased incidences of cannibalism and consequently increased mortality. The next highest mortality was in the group fed the diet containing blood meal alone. The diet that contained the combination of blood meal and fish meal gave the lowest mortality.

It may be concluded that SDBM, in combination with other protein sources, can be used in broiler and layer diets to cut down on the use of fish meal without sacrificing performance.

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STRESZCZENIE

Dalsze badania nad zastosowaniem wysuszonej na słońcu mączki z krwi jak składnika mieszanek dla drobiu

Przeprowadzono dwa doświadczenia, na broilerach i nioskach, celem oznaczenia wartości pokarmowej mączki z krwi, wysuszonej na słońcu (SDBM). W doświadczeniu 1 240 dwutygodniowym broilerom podawano przez 6 tygodni diety zawierające 0, 30, 60 lub 90 g SDBM/kg, przy stałym dostępie do wody. Nie stwierdzono wpływu skarmianych dawek na ich pobranie. Przyrosty m.c., wykorzystanie paszy i wydajność rzeźna były podobne we wszystkich grupach. Udział SDBM w diecie nie miał też wpływu na śmiertelność kurcząt. Na podstawie uzyskanych wyników wyciągnięto wniosek, że udział SDBM w diecie może wynosić do 90 g/kg. W doświadczeniu 2, 144 nioski w wieku 26 tygodni, znoszące jaja o brązowych skorupach, podzielono losowo na cztery grupy, i żywiono przez 20 tygodni dietami zawierającymi 0, 15, 30 i 45 g SDBM/kg^{-1}. Paszę i wodę podawano do woli. Wraz ze wzrostem udziału SDBM w diecie wzrastało pobranie paszy ($r = 0{,}95$; $P<0{,}05$), przyrosty m.c., ciężar jaja, zabarwienie żółtka, grubość skorupy jaja oraz wartość jednostek Haugha. Wykorzystanie paszy (ilość paszy na tuzin jaj; $r = 0{,}37$) oraz produkcja jaj na kurę dziennie ($r = 0{,}37$) nie zależały od dawek SDBM. Nie stwierdzono także wpływu SDBM na stan zdrowia ani śmiertelność kur.

Podsumowując wyniki badań stwierdzono, że udział SDBM w diecie do 45 g/kg^{-1} wpływa korzystnie na wyniki produkcyjne niosek, i że można nią zastąpić inne pasze białkowe (mączkę rybną lub makuch z kopry).