Effects of dietary ammonium sulphate (AS) on the performance and abdominal fat of broilers

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Abstract

Two experiments were designed to investigate the response of broilers to dietary inclusion of ammonium sulphate. In experiment 1, day old chicks were fed diets with 0, 1, 2 or 3 % ammonium sulphate (AS) during the starter phase (0 – 4 weeks). In experiment 2, broilers chicks were raised on a standard diet from 0 – 4 weeks of age and then switched to diets with 0, 1, 2 or 3% ammonium sulphate during the finisher phase (5- 8 weeks). In experiment 1, feed intake was significantly ($P < 0.05$) suppressed by the dietary ammonium sulphate, while weight gain at market age was not significantly affected ($P > 0.05$). However, in experiment 2, both feed intake and weight gain at market age were significantly suppressed ($P < 0.05$) by the dietary ammonium sulphate. There was no significant effect of dietary ammonium sulphate on feed to gain ratio among broilers in any of the two experiments ($P > 0.05$). Dietary ammonium sulphate did not affect broilers liveability at any of the period. Protein retention was comparable ($P > 0.05$) while fat availability was significantly reduced ($P < 0.05$) at 3% inclusion of ammonium sulphate in broilers diets. Abdominal fat was significantly increased ($P < 0.05$) at 2% dietary ammonium sulphate during the starter phase while there was no significant effect ($P > 0.05$) of dietary ammonium sulphate on the abdominal fat during the finisher period. It was concluded that ammonium sulphate can be used as a feed intake suppressant and would be more effective in the broiler starter diet than in the finisher diet.

Keywords: Ammonium sulphate, Feed intake, weight gain Abdominal fat

Introduction

The ever increasing cost of poultry feed has often forced poultry farmers to resort to manual feed restriction in poultry farms. However, such practices requires substantial labour or mechanization. Therefore, it is desirable to identify substance capable of reducing feed intake to incorporate directly into the diet. Provided the substance does not have deleterious effects, it will enable the presentation of feed *ad libitum* while concomitantly allowing feed intake restriction. Several attempts have been made to reduce feed intake in chickens by addition of known feed intake suppressants. These include sulphates and

carbonates of ammonium, calcium, magnesium, potassium (Sibbald and Cave, 1976), non-esterified fatty acids (Cave, 1978) and glycerine (Cave, 1982b). Sibbald and Cave (1976), reported that the feed intake and growth depressing effect of dietary sulphate depend to a large degree on the cation with which it combines; the anion-cation interaction revealed that ammonium was more repelling as the sulphate than as the carbonate salt. However, information on the optimum dietary inclusion level of those feed intake suppressants are scanty. The experiments reported herein was designed to investigate the optimum dietary inclusion level of ammonium sulphate as a feed intake suppressant.

Materials and Methods

Experiment 1

Ninety six day old unsexed Anak broilers were used in this study. The chicks were housed in an electrically heated battery brooder and subjected to the different dietary treatments in Table 1.

Table 1 *Percentage composition of experimental diet (Experiment 1)*

	Starter				Finisher
	1	2	3	4	
Basal ingredients	97.00 ¹	97.00 ¹	97.00 ¹	97.00 ¹	96.30 ²
Ammonium Sulphate (NH ₄) ₂ SO ₄	-	1.00	2.00	3.00	-
Grit	3.00	2.00	1.00	-	3.00
Analysed Nutrient Content					
Dry matter %	95.60	96.01	95.80	95.30	96.30
Protein %	22.31	22.61	22.18	22.43	17.64
Crude fat %	4.20	4.01	4.50	4.30	3.60
Crude fibre %	4.50	3.90	3.70	4.50	4.00
ME Calculated (Kcal/kg)	3036.46	3036.46	3096.46	3096.46	3000.32

Basal ingredients ¹ – Yellow maize 47%, Soybean Cake 31.57%, Brewer Dry grain 4%, Maize offal 5%, Blood meal 3%, Palm oil 3%, Bone meal 2.33%, Oyster shell 0.28%, Salt 0.25%, DL-Methionine 0.1%, Vit.Min premix 0.25%. (Provide per kg of diet, Vitamin A (8000IU); Vitamin D3(1,200IU); Vitamin E (3IU); Vitamin K3 – KASTAB (2mg), Vitamin B2 – Riboflavin (3mg), Vitamin B3 – Nicotinic acid (10mg), Vitamin B5 – Pantothenic acid (150mg), Manganese (Mn), (80mg) Zinc (Zn) (50mg); Copper (Cu)(2mg); Iodine (I) (1.2mg); Cobalt (Co)(0.2mg), Selenium (Se) (0.1mg).

Basal ingredients² (Finisher) -Yellow maize 50%, Soybean Cake 17.47%, Brewers' Dry grain 11%, Maize offal 10%, Blood meal 3%, Palm oil 2.56%, Bone meal 2.02%, Oyster shell 0.26%, Salt 0.25%, DL-Methionine 0.1%, Vit.Min premix 0.25%. (Provide per kg of diet as above.)

Birds were fed a control diets with 1,2, or 3% ammonium sulphate during the starter period (0 – 4 weeks), after which they were fed a standard finisher diet (5 –8 weeks). Thus there were four treatments each with 3 replicates cages of 8 chicks per replicate. Water was supplied to satisfaction throughout the 8-week trial period. At the 3rd and 7th week of the experiment, a metabolic trial was carried out using total collection method. Proximate composition of feed and droppings were determined using the methods of A.O.A.C. (1980). At the end of the feeding trial, 3 broilers were randomly selected

from each replicate pen; weighted and killed by exanguination. The birds were then dissected and eviscerated. Carcass weights were taken. The adipose tissue surrounding the gizzard and intestine, extending within the ischium and surrounding the cloaca, bursal of fabricus and adjacent abdominal muscle were collected and weighted as respective abdominal fat.

Data collected were subjected to analysis of variance using the model for completely randomized design (Steel and Torrie, 1980). Significant means were tested using Duncan multiple range test. (Duncans, 1955).

Dietary ammonium sulphate and broiler performance

Experiment 2

Ninety six unsexed day old Anak broilers were used in this study. The chicks were raised on a

standard starter diet (Table 2) for the starting period (0 – 4 weeks).

Table 2 Percentage composition of experimental diets (Experiment 2)

	Starter	Finisher			
		1	2	3	4
Basal ingredients	97.00 ¹	97.00 ²	97.00 ²	97.00 ²	96.30 ²
Ammonium Sulphate					
(NH ₄) ₂ SO ₄	-	-	1.00	2.00	3.00
Grit	3.00	3.00	2.00	1.00	-
Analysed Nutrient Content					
Dry matter %	95.00	96.30	95.61	95.20	95.73
Protein %	22.31	17.64	17.45	17.35	17.61
Crude fat %	4.20	3.60	3.50	3.70	3.50
Crude fibre %	4.50	4.00	4.20	3.40	4.50
ME Calculated (Kcal/kg)	3036	3000	3000	3000	3000

Basal ingredient ¹ (Starter) – similar to that in Experiment 1

Basal ingredient ² (Finisher) – similar to that in Experiment 1

At 4 weeks of age, the chicks were randomly assigned to the experimental diets. The diets had 0.1, 2 or 3% ammonium sulphate. Thus there were four treatments each with 3 replicate cages of 8 chicks per replicate. Diets and water presented *ad libitum*.

A metabolic trial was undertaken when birds were 6 weeks old, and proximate analysis was carried out on feed and droppings, using the same procedure in experiment 1. Carcass weight and abdominal fat were determined as in experiment 1. Statistical analysis of data collected was carried out using the model for

completely randomized design (Steel and Torrie, 1980). Significant means were separated using Duncan's multiple range test (Duncan, 1955).

Results

The effects of dietary ammonium sulphate on the performance and nutrient utilization of starter broilers is shown in Table 3, while Table 4 shows the corresponding performance and nutrient utilization of finisher broilers on similar diets.

Table 3 Effects of dietary ammonium sulphate on performance and nutrient utilization by starter broilers

Variable	Starter	Finisher			SEM	SIG
	0%	1%	2%	3%		
Feed intake (g)						
0 – 4 week	995 ^a	995 ^a	945 ^a	739 ^b	28	*
5 – 8 week	2987	2833	3137	2713	95	NS
0 – 8 week	3982	3829	4088	3386	93	NS
Weight gain (g)						
0 – 4 week	521 ^a	544 ^a	518 ^a	373 ^b	24	*
5 – 8 week	1027	1020	1177	997	43	NS
0 – 8 week	1548	1564	1692	1370	55	NS
Feed/Gain Ratio						
0 – 4 week	1.93	1.85	1.83	1.99	0.06	NS
5 – 8 week	2.83	2.82	2.67	2.72	0.06	NS
0 – 8 week	2.57	2.48	2.41	2.48	0.04	NS
Mortality (%)						
0 – 8 week	16.67	0.00	22.22	1.85	4.74	NS
Nutrient Utilization (%)						
0 – 4 week						
Protein Retention	66.83	67.54	67.54	68.25	0.90	NS
Fat Availability	76.74 ^a	72.40 ^{ab}	75.24 ^a	69.54 ^b	1.04	*
Fibre Availability	44.45	42.27	44.72	40.47	0.88	NS
5-8 week						
Protein Retention	68.94	70.14	70.19	73.15	0.67	NS
Fat Availability	69.49	69.73	71.51	69.26	0.75	NS
Fibre Availability	43.09	43.39	40.16	44.29	0.89	NS

*Means followed by different superscript in each row differ significantly ($P < 0.05$)

AS = Ammonium

Table 4 Effects of dietary ammonium sulphate on performance and nutrient utilization by finisher broilers

Variable	Dietary level of AS				SEM	SIG
	0%	1%	2%	3%		
Feed intake (g)	2987 ^a	2720 ^a	2503 ^a	2100 ^b	118	*
Weight gain (g)	1027 ^a	973 ^a	843 ^a	657 ^b	51	*
Feed/Gain Ratio	2.83	2.81	2.98	3.07	0.07	NS
Mortality (%)	16.62	0.00	0.00	9.26	4.28	NS
Protein Retention	68.94	68.33	65.42	64.65	0.85	NS
Fat Availability	69.49 ^a	67.48 ^a	66.72 ^a	62.03 ^a	0.52	*
Fibre Availability	43.09	41.53	42.54	44.23	0.75	NS

*means followed by different superscript in each row differ significantly ($P < 0.05$)

AS = Ammonium

Dietary ammonium sulphate and broiler performance

Increasing dietary ammonium sulphate significantly ($P < 0.05$) reduced feed intake and weight gain of broiler during both the starter (Table 3) and finisher (Table 4) periods. These reductions were gradual and became significant at 3% dietary inclusion of ammonium sulphate. In experiment 1, there was no significant residual effects of the treatments at 0 – 4 weeks of age on subsequent feed intake, weight gain, feed/gain ratio or mortality rate from 5 to 8 weeks of age or total weight gain from 0 – 8 weeks of age ($P > 0.05$).

Table 3 and 4 show that increasing dietary ammonium sulphate had no significant effect on protein retention and fibre availability either during the starter or finisher period ($P > 0.05$),

while fat availability was significantly reduced at both periods ($P < 0.05$).

However, in experiment 1, there was no residual effect of dietary ammonium sulphate on protein retention, fat and fibre availability from 5 to 8 weeks of age ($P > 0.05$). The effects of dietary ammonium sulphate on percentage carcass and abdominal fat of starter and finisher broilers are shown in Table 5. Increasing dietary ammonium sulphate significantly increased abdominal fat during the starter period ($P < 0.05$), while it had no significant effect on abdominal fat during finisher period ($P > 0.05$). Carcass percentages were not significantly different during either period ($P > 0.05$).

Table 5 *Effects of dietary ammonium sulphate on percentage carcass and abdominal fat of starter and finisher broilers*

	Dietary level of AS					
Variable	0%	1%	2%	3%	SEM	SIG
Starter Broilers						
Dietary AS (0–4 week)						
Carcass (% liveweight)	86.00	87.01	82.13	82.87	0.76	NS
Abdominal fat						
Absolute Weight (g)	24.3 ^b	27.2 ^b	56.1 ^a	23.5 ^b	4.57	*
% of Carcass weight	2.05 ^b	2.23 ^b	4.31 ^a	2.1 ^b	0.31	*
Finisher Broilers						
Dietary AS (5–8 week)						
Carcass (% liveweight)	86.00	81.64	81.24	81.25	0.78	NS
Abdominal fat						
Absolute Weight (g)	24.3	22.0	30.9	22.4	2.50	NS
% of Carcass weight	2.05	1.81	2.96	2.85	0.21	NS

*means followed by different superscript in each row differ significantly ($P < 0.05$)

AS = Ammonium

Discussion

In both experiments, the reduction in body weight gain of broiler when ammonium sulphate was included in the diets is probably a direct response to the reduced feed intake. The results are in agreement with those of Sibbald and Cave (1976) who also reported a feed intake reduction accompanied by reduced weight gain in broilers. Noticeably, the influence of dietary ammonium

sulphate on feed intake and weight gain was dose dependent and increased as dietary ammonium sulphate increased.

Ammonium sulphate as a feed intake suppressant may be distasteful to chickens. Sibbald and Cave (1976) reported that the feed intake suppressing effect of dietary sulphate depends on a large degree upon the cations with which it combines. The anion-cation interaction

revealed that ammonium was more repelling as the sulphate than as the carbonate salts. It could then be reasoned that the reduced feed intake, hence growth depression observed in the two experiments could be linked to palatability problem of the ammonium sulphate diets. Moran (1982), reported the possibility of chickens sensitivity to tastes. Cave (1978), also reported that palatability is likely a factor in reducing feed intake.

The question of when to initiate feed restriction in broilers appeared to have been at least partially answered in this study. This is based on the fact that the application of equal amount of dietary ammonium sulphate early in life as in the first experiment presumably allowed for compensatory growth which was not the case in the broiler fed dietary ammonium sulphate at the finishing stage. This could then account for the fundamental difference in the market weight observed in the two experiments viz a viz broilers on diets without ammonium sulphate. Percentage mortality was not significant, therefore there is no evidence to suggest that dietary ammonium sulphate was detrimental to the survival of broilers. Cave (1982b) also did not report any significant effect of ammonium sulphate on the mortality of chickens used in his study. Hamilton and Sibbald (1980) also reported that ammonium sulphate, at the levels they used had no effect on the productions, livability or egg shell quality of old or young hens.

Reduction in fat availability in the broiler fed dietary ammonium sulphate could indicate a higher metabolic rate compared with birds on control diets. Similar observation was made by Morgan and Naishmith (1980). The increase in the abdominal fat of broilers at 2% dietary ammonium sulphate when fed at either starter or finisher phases cannot be clearly explained as a lower (1%) and higher (3%) inclusion did not produce any significant increase in abdominal fat compared with the control. In conclusion, it is evident that ammonium sulphate would reduce feed intake in a dose dependent manner when fed both early (0 – 4 weeks) and late (5 – 8 weeks) in life of broilers. However, the study

has shown that ammonium sulphate is better incorporated into the starter diet of broilers, as this will given an opportunity for realimentation. Also, based on the results reported herein, 3% inclusion level of ammonium sulphate is hereby recommended in broiler starter diet.

References

- Association of official analytical chemists.** 1980. 13th Ed. Washington D.C.pg 1 – 47.
- Cave, N.A.** 1978. The influence of non esterified fatty acids on feeding activity of chicks. *Poult. Sci.* 57:1124 (Absts).
- Cave, N.A.** 1982b. Glycerine and fatty acid induced restriction of feed intake. Effects on body weights and hatching egg production of broilers breeder restriction from day of hatching. *Poult. Sci.* 61:125 – 132.
- Duncan, D.B.** 1955. Multiple Range and Multiple F-test. *Biometrics* 11:1 – 42.
- Hamilton, R.M.G and I.R. Sibbald.** 1980. the effect of level and source of ammonium sulphate on feed intake, egg production and egg quality in white leghon pullets and force molted hen. *Poult. Sci.* 99:119 – 127.
- Moran, E.J.Jr.** 1982. Comparative nutrition of fowl and swine gastrointestinal system published by E.T. Moran (Jr). Canada. Pp 78 – 82.
- Steel, R.G.D and Torrie, H.Z.H.** 1980. *Principles and procedures of statistics. Biomedical approach* Mc. Graw Hill book Co. Inc. New York, Toronto London. Pp 101 – 123.
- Sibbald, I.R and N.A. Cave.** 1976. The response of chicks to ammonium, calcium, magnesium, potassium and sodium sulphate and to ammonium and potassium carbonates. *Poult. Sci.* 55:2209 – 2213.

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Short Communication

The chemical composition of *Caesalpinia pulcherima*

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Abstract

The seeds of Caesalpinia pulcherima, a member of the family Leguminosae were analyzed for their chemical composition. Studies also include the fatty acid composition and characteristics of the extracted oil. The results of the analyses revealed that the crude protein and crude fat of the seeds were $33.50\% \pm 1.50$ and $16.80\% \pm 0.20$ respectively. The fatty acid profile indicated that the glycerides of oleic, linoleic and linolenic acid account for 82.46% of the total glycerides. Iodine value and Saponification Number are 104.09 ± 9.8 , 195.0 ± 2.82 respectively, while the unsaponifiable matter showed a high value of $20\% \pm 0.50$.

Keywords: Chemical composition, *Caesalpinia pulcherima*, essential fatty acid.

Introduction

Caesalpinia pulcherima (Pride of Barbados) otherwise referred to as "Eko omode" in Yoruba is one of the most widely grown perennial shrubs used as hedges in South-west Nigeria. The plant is a dicotyledon and a member of the family Leguminosae which constitute the largest flowering plant families comprising about 600 genera. Members of this family are of considerable economic importance as rich sources of protein supplying foods (Oyenuga, 1968; Chang and Satterlee, 1970; Platt, 1980). Apart from protein, legumes are also rich sources of other nutrients such as starch, oils, vitamins and mineral elements (Oyenuga, 1968; Lolas and Markakis, 1975; Ukhun, 1986).

Caesalpinia pulcherima can withstand considerable drought and is highly prolific. The fruit is a pod which when mature and dry will split open exposing the several seeds numbering 22 to 30 in it. Production level is difficult to estimate because its commercial production is yet to commence. The seeds are widely consumed in the raw form by children and the

local inhabitants of the neighbouring Benin Republic. There has not been any reported case of toxicity that may result from the consumption of the raw seeds of *Caesalpinia pulcherima*. The full exploitation of legumes as sources of raw materials for the food industries continues to be a key of research in developing countries where there had been shortage of food over the years.

In Nigeria, much effort had been devoted to the chemical analysis of the unexploited members of the family leguminosae (Oyenuga, 1968; Ukhun and Ifebigh, 1988) with a view to maximizing their uses as raw materials in the food and feed industries. This study was thus undertaken to determine the potentials of the seeds of *Caesalpinia pulcherima* as raw materials in the food and feed industries through new information on its proximate and chemical composition.

Materials and Methods

The seeds of *Caesalpinia pulcherima* (yellow flower variety) used for this study were obtained from mature and ripe fruits of the plants located as hedges on the Federal Polytechnic campus,

Ilaro, Nigeria. The pods were split manually to liberate the seeds and the testa were then removed manually and the kernels ground in a laboratory mortar. The ground seed kernels were then stored at room temperature between 27 – 30°C in airtight containers for subsequent analysis.

Proximate composition

The proximate chemical analysis of the ground seeds *Caesalpinia pulcherima* were carried out using standard procedures as follows: Moisture, was determined by oven methods (AOAC, 2000); Crude protein was also determined by routine Kjeldahl procedure and % protein calculated by multiplying % N by 6.25 (AOAC, 2000); Ash content by the dry ashing technique (AOAC, 2000) and Crude fibre (AOAC, 2000); Crude oil was determined by the soxhlet technique using diethyl ether (Harold *et al.*, 1981); Carbohydrate content was calculated by difference (Kamel *et al.*, 1982).

Characteristics of Oil

Specific gravity and refractive index were determined at 26°C according to AOAC methods (2000) while iodine, saponification number, unsaponifiable matter and free fatty acid were determined according to the A.O.A.C method (2000).

Mineral composition

The ash from the sample was analysed for sodium, potassium, calcium, magnesium, zinc, iron and phosphorus. Sodium, potassium and calcium were determined by flame emission spectrophotometry using Jenway Flame Photometer (AOAC, 2000). Magnesium, zinc and iron were determined using the Atomic Absorption Spectrophotometer (Osborne and Vougt, 1978). Phosphorus was determined by the vanado-molybdate colorimetric method (Harrison, 1950). For each of these parameters, determinations were carried out in quadruplicates and results were expressed as averages for each element.

Fatty acid analysis

The fatty acid analysis was carried out by methylation of the extracted oil (Morrison and

Smith, 1964) followed by gas-liquid chromatography (isothermal) of the methylesters of fatty acids using a Perkin Elmer Sigma 3B gas-liquid chromatograph equipped with a hydrogen flame ionization detector using a commercially prepaced glass column 125 cm, (ID 3.2 mm) packed with 15% DEGS on chromosorb W-60/80 mesh. The injector was maintained at a room temperature of 185°C, while the column and detector were maintained at a temperature of 225°C.

The carrier gas used was H₂ at a flow rate of 35ml/min. identification and quantification of the fatty acids were carried out by comparison of their retention time and peak height respectively with those of the standard fatty acids methyl esters.

Results and Discussion

The main crude protein content (Table 1) of the seeds of *Caesalpinia pulcherima* is 33.50% ± 1.50, a value considered to be reasonably high when compared with the crude protein of other legumes (Table 5) like lima, snap and peas (Johnson, 1974). The crude fat content shows a mean value of 16.8 ± 2.0 (Table 1), thus revealing that the seeds could provide sufficient energy in the diet of livestock to prevent the utilization of protein as a source of energy. The carbohydrate (soluble) level of 33.0% ± 0.20 is adequate as source of energy in the diet of livestock so as to prevent the utilization of protein as a source of energy.

The crude fibre content of 7.6 ± 0.20 (Table 1) is comparable with those of other legumes already studied (Oyenuga, 1968). This is very important from the nutritional point of view as providing bulk in food.

Overall, the saturated fatty acids accounts for 82.4%, while the saturated fatty acids constitute 17.54% of the total fatty acids in *Caesalpinia pulcherima* seed oil. The fatty acid composition varies from 0.83 – 49.33%. these fatty acid can contribute to the essential fatty acid requirements of livestock when consumed.

Chemical composition of *Caesalpinia*

Table 1: Proximate chemical analysis of *Caesalpinia pulcherima*

Component	%level
Moisture	3.80 $\pm$ 0.50
Crude protein	33.50 $\pm$ 1.50
Crude fibre	7.60 $\pm$ 0.20
Crude fat	16.80 $\pm$ 0.20
Ash	5.50 $\pm$ 0.20
Carbohydrate (soluble)	33.00 $\pm$ 0.20

Value are means of four determinations with standard deviations.

The mineral elements of nutritional importance present in *Caesalpinia pulcherima* seeds are shown in Table 2. these elements are abundant in most legumes. The mineral composition varies from 20.66 – 3631.64 mg/100g sample. Sodium and potassium are required for maintenance of the normal osmotic pressure of blood. Calcium and phosphorus are required for proper bone formation and their deficiencies can lead to bone malformation. Magnesium and zinc

constitute prothetic groups of enzyme in body metabolism and their deficiency in rations can lead to retardation of growth in animal. Iron is required for the formation of haemoglobin and its deficiency can lead to anaemia. The comparison of *Caesalpinia pulcherima* with other beans in terms of their calcium and iron contents in Table 5 shows that it is richer in these mineral elements than the other beans.

Table 2: Mineral composition of the seeds of *Caesalpinia pulcherima*

Mineral element	Concentration (mg/100g sample) on dry weight basisl
Sodium	59.03 $\pm$ 16.08
Potassium	3039.94 $\pm$ 56.61
Calcium	79.42 $\pm$ 4.90
Magnesium	457.64 $\pm$ 6.19
Zinc	22.62 $\pm$ 1.96
Iron	50.01 $\pm$ 2.54
Phosphorus	3550.0 $\pm$ 81.64

Values are mean of four determinations with Standard deviation.

Table 3: Physical constants of *Caesalpinia pulcherima*

Component	%level
Iodine value	104.09 $\pm$ 9.80
Saponification number	195.0 $\pm$ 2.82
Unsaponifiable matter	20.0 $\pm$ 0.50
F.F.A (as oleic acid)	5.2 $\pm$ 0.20
Refractive index	1.468 $\pm$ 0.02
Specific gravity	0.907 $\pm$ 0.003
Colour	Golden yellow
Odour	Typical legume odour

Value are means of four determinations with standard deviations.

Table 4: Fatty acid composition of *Caesalpinia pulcherima* seed oil.

Fatty acid	Weight
Saturated:	
Palmitic C 16:0	13.31 $\pm$ 0.70
Stearic C 18:0	4.23 $\pm$ 0.13
Total unsaturated	17.54%
Unsaturated:	
Oleic C 18:1	32.38 $\pm$ 0.32
Linoleic C 18:2	49.08 $\pm$ 0.25
Linolenic C 18:3	1.00 $\pm$ 0.17
Total Unsaturated	82.46%

Value are means of four determinations with standard deviations.

Table 5: Comparison of *Caesalpinia pulcherima* and some beans in terms of their proximate composition

Types of Bean	Protein (gm)	Fat (gm)	Carbohydrate (gm)	Calcium (gm)	Iron (gm)
<i>Caesalpinia pulcherima</i>	33.50	16.80	33.0	79.42	50.01
Lima*					
Immature, cooked	8	1	29	46	2.9
Matured, Cooked	16	1	48	56	5.6
Snap*					
Green, Canned	2	Tr	10	65	3.3
Green, Cooked	2	Tr	6	45	0.9
Pea*					
Great northern and red	15	1	42	74	4.6
With pork, cooked	16	7	54	172	4.4

Source *Johnson (1974)

Conclusion

The results of the proximate analysis show that the seeds of *Caesalpinia pulcherima* can serve as a source of protein concentrate for both human and animal consumption and as a high-energy source for animal and poultry. More work is also needed to establish the different possible uses of the seeds.

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References

- AOAC 2000. Official Methods of Analysis (17th edn), Association of official analytical chemists, Wastington, D.C.
- Chang, K.C. and Satterlee, L.D. 1979. Chemical Nutritional and Microbiological Quality of a protein concentrate from culled dry beans. *J. Food Sci.* 44: 1589.
- Eckey, B.S. 1954. Ed. Vegetable fats and oils. Reinhold Publishing Corporation, New York.
- Kamel, B.S., deMan, J.M and Blackman, B. 1992. Nutritional, fatty acid and oil characteristics of different agricultural

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- seeds. *Journal of Food Technology*, Vol. 17 No.2.
- Lolas,G.M and Markakis,P.** 1975. Phytic acid and other phosphorus compounds of beans (*Phaseolus vulgaris* L). *J. Agricultural Food Chemistry*, 23(1)13.
- Martinex,W.H.** 1979. Functionality of vegetable protein other than soy. *JA,OCS*,56,280.
- Morrison,W.R and Smith,L.** 1964. Preparation of fatty acid methyl esters and Dimethyl acetals from lipids and boron flutride methganol. *J. Lipid Res.* 5, 600-8.
- Norris,F.A and Buswell,R.J.** 1943. *Ind. Eng. Chem., Ed.*, 15, 258 – 9.
- Oyenuga,V.A.** 1968. Ed. *Nigeria's Foods and Feeding Stuffs*. Ibadan University Press, Ibadan, Nigeria.
- Johnson Peterson.** 1974. *Encyclopaedia of Food Technology*, Volume 2(pp98).
- Harold,E., Ronald,S.K. and Ronald,S.** 1981. *Pearson's chemical analysis of Foods*. Longman Scientific and Technical 8th Edition U.K. 20 – 21p.
- Platt,B.S** 1980. Tables of representative value of Foods commonly used in Tropical countries. Medical Research Council Special Report series No. 302,p. 10 (revised edn. Of SrS 253) Her Majesty's Stationary Office, London.
- Ukhun,M.E.** 1986. Efforts of storage and processing on the nutritive value of certain Nigerian foods. *Eperienta*, 42, 948.
- Ukhun,M.E and Ifebigh,E.O** 1988. compositional chemistry of Cassia alata seeds. *Foods chemistry*, 30, 205 – 210.

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