Food Chemistry **26** (1987) 307–314

Composition of Some Recommended Nigerian Commercial Cottonseed Varieties

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(Received 3 April 1987; accepted 6 May 1987)

ABSTRACT

Three Nigerian commercial cottonseed varieties, Samaru 71 (S71), Samaru 72 (S72) and Samaru 77 (S77), and composite cottonseed from three locations, Funtua (CSF), Mallumfashi (CSM) and Kano (CSK) were assayed for proximate, mineral and amino acid composition. Crude protein averaged 37·4% for the varieties and 36·2% for the composite seed. The oil content ranged from 33·6% to 35·1% for the varieties, and averaged 32·7% in the composite seed. Crude fibre, ash and nitrogen-free extracts did not vary between or within seed type. The mineral levels were relatively high, and phosphorus was the most abundant, averaging 1·34% and 1·28% in the varieties and composite seed, respectively. The mineral levels were generally lowest for S72 and CSM within their respective seed categories. Amino acid levels obtained for both cottonseed types were higher than, or comparable with, those reported by other workers for cottonseed elsewhere. Amino acid levels were, in general, lower in composite seed than in the seed varieties. Varietal and locational factors appeared to influence the chemical components in cottonseed.

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Food Chemistry 0308-8146/87/$03·50

INTRODUCTION

Breeding for improved varieties of cottonseed in Nigeria and perhaps many other countries has traditionally emphasised improvement in agronomical traits such as lint yield (kg/ha), ginning percentage (lint as % of seed cotton), oil, disease resistance, earliness index (weights of first two picks as % of final yield), among others (Faulkner, 1974). The Nigerian cottonseed improvement began with a single variety, Samaru 26J, which was grown in all cotton zones. It was later replaced by two new varieties, Samaru 71 and Samaru 72; and during the 1981 growing season, another variety, Samaru 77, replaced Samaru 72 on the basis of the former's superior agronomical traits. Relatively little attention has generally been given to the chemical constituents of the seed as traits to be bred for. The food value of cottonseed products, which are consumed by human beings and used in livestock feeding all over the world, relates directly to the quantitative content of essential nutrients such as amino acids and mineral elements in the seed. Environmental and varietal factors have been reported to significantly affect nitrogen and oil content of cottonseed (Stansbury *et al.*, 1956) and negative correlations have been found between nitrogen and oil percentages in cottonseed kernels. Such relationships are extremely useful to cotton breeders, growers, as well as processors. Determination of these relationships requires chemical analyses; the information does not appear to be documented in the case of Nigerian varieties of cottonseed. The present study was therefore undertaken to obtain data on the chemical composition of the commercial varieties of cottonseed which are recommended for growing throughout the cotton zones in Nigeria. The composition of composite cottonseed from three different locations was also determined.

MATERIALS AND METHODS

Cottonseed samples

The cottonseed used in this investigation was obtained from three commercial varieties of cotton: Samaru 71 (S71) grown in the Northern Nigerian Cotton Growing Zone comprising Sokoto, Kaduna, Kano and northern parts of Niger States; Samaru 72 (S72) grown in Bauchi, Borno and Gongola States, the Eastern Cotton Growing Zone; Samaru 77 (S77) grown in Plateau, Benue, Kwara and Southern Niger States, representing the Southern Cotton Growing Zone. The seeds were supplied, undelinted and undressed, by the Fibre Breeding Section, Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria. In addition to these commercial seed varieties, composite cottonseeds were collected from ginneries located at Funtua (CSF), Mallumfashi (CSM) and Chalawa, Kano (CSK), the locations accounting for 90% of cotton grown in Nigeria. The seed samples were separately decorticated and dehulled in our laboratory by cracking in a mortar and then manually separating the meats (kernels) from the hulls and linters. The cleaned kernels were placed in screw-top Kilner Dual Purpose Glass Jars, from which a portion was ground and similarly placed for storage in an air-cooled room until analysed.

Chemical analysis

The samples were analysed for moisture, oil, crude protein (total nitrogen × 6·25), crude fibre, ash and nitrogen-free extractives, using the official AOAC (1975) methods. The mineral elements were determined using the atomic absorption spectrophotometer, Perkin-Elmer 209. Phosphorus was, however, determined by the phosphovanadomolybdate colorimetric method (AOAC, 1975). In order to determine the total amino acids, 100 mg portions of the samples were hydrolysed in 6N HCl and refluxed at 110°C for 24 h. The residues of 10-ml portions of the evaporated hydrolysates were dissolved in 0·2M citrate buffer (pH 2·2) and eluted using a Perkin-Elmer Amino Acid Analyser (Model LKB 4400). Methionine sulphoxide was eluted in the standard to detect the peak for methionine produced from the oxidation of this amino acid. Using molar relationships, a factor of 0·84 was used to convert methionine sulphoxide to methionine. Tryptophan was determined by the method of Miller (1967).

RESULTS AND DISCUSSION

The proximate composition of Nigerian commercial and composite cottonseed appears in Table 1. Dry matter, crude protein, ether extract, crude fibre and ash averaged 92·3%, 37·4%, 34·5%, 2·9% and 5·7%, respectively, for the seed varieties and 94·2%, 36·2%, 32·7%, 2·99% and 6·33% for composite seed. Samaru 77 contained somewhat less protein, but more oil than either S71 or S72. These data appear to portray the negative relationship that has been reported between the oil and nitrogen contents of cottonseed (Stansbury *et al.*, 1956). To the oilseed processors, the oil content of cottonseed is the most important factor used when selecting the seed for processing. In this regard, S77 would appear to be the most suitable among the Nigerian commercial cottonseed varieties, and it would seem to be a justifiable basis, at least in part, for its replacing S72. When considered as a

TABLE 1

Proximate Composition of Nigerian Commercial Cottonseed Varieties and Composite Cottonseed

	Varieties					*Composites*				
	S71	*S72*	*S77*	*Mean ± SD*	*CV%*	*CSF*	*CSK*	*CSM*	*Mean ± SD*	*CV%*
Dry matter (%)	92·3	92·0	92·7	92·3 ± 0·38	0·41	93·7	94·0	94·8	94·2 ± 0·55	0·58
Crude protein (%)	38·0	38·0	36·3	37·4 ± 0·97	2·95	36·7	36·1	36·0	36·2 ± 0·41	1·12
Ether extract (%)	34·7	33·6	35·1	34·5 ± 0·79	2·29	34·8	32·3	31·0	32·7 ± 1·91	5·84
Crude fibre (%)	2·85	3·05	2·78	2·89 ± 0·14	4·85	2·94	2·93	3·10	2·99 ± 0·10	3·19
Ash (%)	4·50	6·50	6·00	5·67 ± 1·04	18·4	5·75	6·75	6·50	6·33 ± 0·52	8·22
Nitrogen-free extracts (%)	20·0	18·9	19·8	19·5 ± 0·60	3·05	19·9	22·1	23·4	21·8 ± 1·80	8·25

TABLE 2

Mineral Composition of Nigerian Commercial Cottonseed Varieties and Composite Cottonseed

	Varieties					*Composites*				
	S71	*S72*	*S77*	*Mean ± SD*	*CV%*	*CSF*	*CSK*	*CSM*	*Mean ± SD*	*CV%*
Magnesium (%)	0·34	0·31	0·38	0·34 ± 0·04	10·3	0·33	0·31	0·42	0·35 ± 0·06	16·7
Calcium (%)	0·10	0·06	0·10	0·09 ± 0·02	25·7	0·08	0·04	0·12	0·08 ± 0·04	50·0
Zinc (ppm)	130	94	107	110 ± 18·2	16·5	99	92	124	105 ± 16·4	15·6
Copper (ppm)	31·5	15	22	22·8 ± 8·28	36·3	20	20·5	27	22·5 ± 3·91	17·4
Iron (ppm)	305	225	165	232 ± 70·2	30·7	130	685	165	327 ± 310·8	95·2
Manganese (ppm)	37	25	20	27·33 ± 8·74	32·0	20	30	30	26·7 ± 5·77	21·7
Sodium (ppm)	131	167	180	159 ± 25·4	15·9	180	162	189	177 ± 13·8	7·77
Potassium (%)	1·09	0·50	0·81	0·80 ± 0·30	36·9	1·04	0·87	1·31	1·07 ± 0·22	20·7
Phosphorus (%)	1·42	1·18	1·42	1·34 ± 0·14	10·3	1·20	1·07	1·58	1·28 ± 0·27	20·7
Chloride (ppm)	305	405	525	412 ± 110	26·8	410	390	240	347 ± 92·9	26·8

protein feed material, S71 and S72 varieties would seem to be most suitable as they both showed an average crude protein content of 38·0%.

The protein and oil levels in these commercial cottonseed varieties are approximately comparable with reported values by workers elsewhere (Stansbury *et al.*, 1956; King *et al.*, 1961; Van Etten *et al.*, 1967; Lawhon *et al.*, 1977). Protein content did not vary appreciably among the seed from the various locations; however, the overall average of 36·2% was somewhat lower than that of 37·4% obtained for the seed varieties. The oil distribution in composite seed was also generally lower than that in the pure varieties of seed. The locational variations in oil and protein are consistent with findings by Pons *et al.* (1953) and Stansbury *et al.* (1956) which showed that environment had a significant effect on the oil and nitrogen contents of cottonseed, and that the oil content in the seed was positively correlated with rainfall and negatively correlated with temperature.

Crude fibre, ash and nitrogen-free extracts contents obtained for cottonseed samples under investigation did not show any variation either due to varietal or locational factors.

The mineral composition of Nigerian cottonseed is shown in Table 2. Phosphorus was the most abundant mineral element in both seed types, and averaged 1·34% and 1·28% in the varieties and composite seed, respectively. Among the major minerals, calcium and phosphorus were least abundant in S72 while identical levels were found in S71 and S77. Sodium and chloride levels were highest in S77 and lowest in S71. The results also show that, except for sodium and chloride, all the mineral elements were found at lower levels in S72 than in the other two varieties. On the basis of chemical composition, this would appear to be another factor which would tend to support the replacement of S72 by S77 in all cotton growing in the country.

The variability in the mineral elements among the cottonseed varieties was highest for potassium, copper, manganese, iron, chloride and calcium, in that order, while magnesium and phosphorus were the most uniformly distributed. Judging by the coefficient of variability values, several of the mineral elements did show a great deal of variability between both the cottonseed varieties and that from the different locations. It appears as though varietal differences, expressed by the capability of the plants to absorb mineral elements from the soil, do exist, just as differences in soil type do affect the availability of the mineral elements to plants generally. Varietal and environmental factors have been reported to significantly influence the mineral, especially phosphorus, content of cottonseed (Stansbury *et al.*, 1953).

The amino acid composition of the seed under assay is presented in Table 3. Very little difference was observed in the levels of the individual amino acids within the seed varieties. Methionine, serine, tyrosine and cystine, in

TABLE 3
Amino Acid Composition of Nigerian Commercial Cottonseed Varieties and Composite Cottonseed (g/16 gN)

Amino acids	*Varieties*					*Composites*				
	S71	*S72*	*S77*	*Mean* ± *SD*	*CV%*	*CSF*	*CSK*	*CSM*	*Mean* ± *SD*	*CV%*
Lysine	5·36	6·02	5·10	5·49 ± 0·48	8·66	4·78	4·89	5·10	4·92 ± 0·16	3·30
Histidine	3·25	3·60	3·20	3·35 ± 0·22	6·51	3·03	2·79	3·26	3·03 ± 0·24	7·76
Arginine	13·1	14·6	13·0	13·6 ± 0·91	6·68	12·0	11·7	13·5	12·4 ± 0·96	7·76
Aspartic acid	9·90	12·5	9·49	10·6 ± 1·63	15·3	8·26	9·06	9·55	8·96 ± 0·65	7·27
Threonine	3·88	4·03	3·60	3·84 ± 0·22	5·68	3·53	3·48	3·60	3·54 ± 0·06	1·70
Serine	7·60	6·62	6·68	6·97 ± 0·55	7·88	9·72	6·45	8·10	8·09 ± 1·64	20·2
Glutamic acid	21·3	24·5	20·9	22·2 ± 1·98	8·90	14·7	18·5	17·2	16·8 ± 1·95	11·6
Proline	3·57	3·84	3·78	3·73 ± 0·14	3·80	3·58	3·34	3·68	3·53 ± 0·17	4·95
Glycine	4·83	5·42	4·69	4·98 ± 0·39	7·78	4·40	4·39	4·60	4·46 ± 0·12	2·66
Alanine	4·42	4·68	4·37	4·49 ± 0·17	3·71	4·16	4·21	4·11	4·16 ± 0·05	1·20
Cystine	1·34	1·52	1·27	1·38 ± 0·13	9·35	1·46	1·19	1·17	1·44 ± 0·24	16·7
Valine	5·36	5·77	4·91	5·35 ± 0·43	8·04	4·85	4·52	5·02	4·80 ± 0·25	5·30
Methionine	1·15	1·81	1·41	1·46 ± 0·33	22·8	0·50	1·36	1·37	1·08 ± 0·50	46·2
Isoleucine	3·81	4·00	3·62	3·81 ± 0·19	4·99	3·53	3·58	3·75	3·62 ± 0·12	3·19
Leucine	6·88	7·57	6·61	7·02 ± 0·50	7·05	6·22	6·40	6·63	6·42 ± 0·21	3·20
Tyrosine	3·41	4·16	3·99	3·85 ± 0·39	10·2	2·81	3·92	3·88	3·54 ± 0·63	17·8
Phenylalanine	6·07	6·94	6·30	6·44 ± 0·45	7·00	5·64	6·18	6·10	5·97 ± 0·29	4·88
Tryptophan	1·06	1·00	1·10	1·05 ± 0·05	4·79	0·98	0·90	1·11	1·00 ± 0·11	10·6

that order, however, showed considerable variability in the composite seed obtained from the different locations. Also the average amino acid levels were generally lower in the composite seed than in the pure varieties. Locational (environmental) effect on amino acid levels of cottonseed is likely to be due to variations in nitrogen uptake by the cotton plants grown in the various locations, and all factors affecting total protein content of the seed are likely similarly to affect the individual amino acid contents of the seed. The total amino acid values obtained for the Nigerian cottonseed are comparable with, or higher than, those reported for cottonseed in other countries (Van Etten *et al.*, 1967; Lawhon *et al.*, 1977).

The data presented in this study show that Nigerian cottonseed contains desirable levels of the chemical components that are required for industrial and food use of seed. The oil content is enough, particularly in S77, to attract oilseed processors' attention, while crude protein, amino acids and mineral elements are contained at levels that would allow for their adequacy in products like cottonseed meal for livestock feeding. Cottonseed kernels are being utilised in various forms as food for human consumption, such as Incaparina, a mixture containing 38% cottonseed flour, with 58% corn flour (Shaw, 1967), textured cottonseed protein (Cabrera *et al.*, 1979) and various flour types reported by El Sayed *et al.* (1978). Some use is being made of cottonseed in certain preparations of food for man in Sokoto, Kwara and Plateau States of Nigeria. For such food use, Lawhon *et al.* (1977) have reported that the cottonseed should be high in protein (which is also high in essential amino acids), low in gossypol, low in oil (for nut use) and high in oil (for flour use), among other characteristics. The free gossypol content of Nigerian cottonseed was reported by Ikurior & Fetuga (1984) to range from 1·14% to 1·34%. These levels have been considered to be low enough to allow for the safe use of the seed kernels for human feeding.

It is hoped that the availability of the information contained in this paper will enable human and livestock nutritionists in Nigeria and elsewhere in the world to exploit, more meaningfully, the food use of cottonseed.

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