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Some Aspects of the Biochemistry and Nutritional Value of the Sweet Potato (*Ipomea batatas*)

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ABSTRACT

*Forty-nine varieties of sweet potato (*Ipomea batatas*) were analysed for their proximate chemical composition, gross energy values and levels of anti-nutritional factors. Results obtained showed marked varietal differences among the different sweet potato tubers. This is indicated by the high percentage coefficient of variation obtained and the rather wide range of values between varieties. Notably, crude protein ranged between 1·39% and 9·4%, ether extract between 0·38% and 3·03%, and crude fibre between 3·84% and 5·89%. Gross energy levels in the tubers were generally high and values obtained ranged from 11·85 for TIS 8266 to 23·29 kJ/g dry matter for TIS 8163. The anti-nutritional factors detected in the sweet potato varieties included phytates, oxalates and tannins. Mean values obtained were 9·93 mg/100 g for phytate, 2·79 mg/100 g for phytate-phosphorus, 0·71% for tannins, 0·45% for water-soluble oxalate and 0·71% for total oxalate. The nutritional implications of these findings are discussed.*

INTRODUCTION

The application of nutritional science to humans or groups of farm animals and the search for novel high quality but cheap sources of protein and energy, is founded upon volumes of literature containing chemical analysis of food and feeds. However, it has been suggested that, more than anything else, lack of information on the composition and utilization of the many and

TABLE 1
Agronomic Characteristics of Varieties of Sweet Potato Tubers

Variety	*Size*	*Shape*	*Skin colour*	*Flesh colour*	*Fresh yield (t/ha)*	*DM yield (t/ha)*	*Mean weevil score*[a]	*Mean virus score*[a]
TIB 4	Medium to large	Long	Light orange	Light orange	9·50[b]	2·90[b]	1·5[b]	2·7[b]
TIS 2498	Medium	Long	Light red to red	White	37·70[b]	11·20[b]	0·0[b]	0·0[b]
TIS 2534	Medium	Long	Red	White	32·20	9·50[b]	0·0[b]	0·5[b]
TIS 6179	Large	Oblong	Light brown	White	NA	NA	NA	NA
TIS 8143	Medium	Oblong	Light brown	White	NA	NA	NA	NA
TIS 8163	Medium	Oblong and long	Light brown	Pop	NA	NA	NA	NA
TIS 8250	Large	Oblong	Light orange	Light orange	NA	NA	NA	NA
TIS 8266	Medium	Long	Light red	White	21·60[d]	NA	NA	NA
TIS 8401	Medium	Long	Light red	White	33·80[b]	10·00[b]	0·0[b]	0·5[b]
TIS 8407	Medium	Oblong and long	Light brown	Light yellow	34·50[b]	10·40[b]	0·7[b]	1·7[b]
TIS 8409	Large	Oblong	White	Light yellow	24·80[b]	10·40[b]	0·5[b]	1·0[b]
TIS 8441	Large	Long	White	White	—	—	—	—
TIS 8504	Large	Oblong	Light brown	White	35·7[b]	10·10[b]	0·5[b]	0·5[b]
TIS 8524	Large	Long	Light red to red	White	38·60[b]	10·40[b]	0·5[b]	0·5[b]
TIS 9101	Large	Oblong	White	Yellow	25·5[c]	7·60[c]	0·0[c]	0·0[c]
TIS 9102	Medium	Long	Red	White	14·5[c]	5·50[c]	0·0[c]	0·0[c]
TIS 9132	Medium	Oblong to long	Light red	White	23·3[c]	7·70[c]	1·0[c]	1·0[c]
TIS 9172	Large	Oblong to long	Light brown	Yellow	15·50[c]	3·00[c]	0·0[c]	1·0[c]
TIS 9232	Large	Oblong	White	Light yellow	26·40[c]	6·80[c]	2·0[c]	3·0[c]
TIS 9265	Large	Oblong to long	White	Light yellow	33·10[c]	7·10[c]	5·0[c]	0·0[c]
TIS 9291	Medium to large	Oblong	Light red	White	20·80[c]	7·10[c]	1·0[c]	1·0[c]
TIS 9465	Large	Oblong	Light red	Light yellow	19·90[c]	6·10[c]	0·5[c]	0·0[c]
TIS 70357	Small	Oblong to long	Light brown	Light yellow	21·8[d]	—	—	—
TIS 70399	Medium	Oblong	Light brown and white	White and yellow	26·8[d]	—	—	—
TIS 70683	Medium	Oblong	Light red	White	—	—	—	—

TIS 71102	Medium to large	Oblong	White	Yellow	NA	NA	NA	NA
TIS 71354	Medium	Oblong	Light red	White	NA	NA	NA	NA
TIS 80/832	NA	NA	NA	NA	NA	NA	NA	NA
TIS 80/525	Medium	Long	Light red	White	NA	NA	NA	NA
TIS 80/592	Large	Oblong	White	Light yellow	NA	NA	NA	NA
TIS 80/632	Medium to large	Oblong	Light brown	Yellow	NA	NA	NA	NA
TIS 80/723	Large	Oblong	White	Light yellow	NA	NA	NA	NA
TIS 80/727	Large	Oblong	White and light red	Light yellow and yellow	NA	NA	NA	NA
TIS 80/733	Large	Oblong	White	Light yellow	NA	NA	NA	NA
TIS 81/145	Large	Long	White	Light yellow	NA	NA	NA	NA
TIS 81/255	Medium	Long	Light brown	Pop and yellow	NA	NA	NA	NA
TIS 81/286	Medium	Oblong to long	Light red	White	NA	NA	NA	NA
TIS 81/403	Medium	Oblong	Light red	White	NA	NA	NA	NA
TIS 81/446	Large	Oblong	Light red	White	NA	NA	NA	NA
TIS 81/471	Large	Oblong	Light red	White	NA	NA	NA	NA
TIS 81/530	Medium	Long	Light brown and light red	White	NA	NA	NA	NA
TIS 81/663	Medium	Long	Light red	Light yellow	NA	NA	NA	NA
TIS 81/666	Medium	Oblong	Light red	White	NA	NA	NA	NA
TIS 82/0083	NA	NA	NA	NA	NA	NA	NA	NA
TIS 82/0132	NA	NA	NA	NA	NA	NA	NA	NA
TIS 82/0201	Large	Oblong to long	Light red	White	NA	NA	NA	NA
TIS 82/0264	Medium	Oblong to long	Light orange	Yellow	NA	NA	NA	NA
TIS 82/0361	NA	NA	NA	NA	NA	NA	NA	NA
TIS 82/240	NA	NA	NA	NA	NA	NA	NA	NA

[a] $= \frac{\text{Number of tubers weeviled or virused}}{\text{Total number of tubers per unit area}} \times \frac{100}{1}$

[b] = Advanced yield trials in four replications.

[c] = Advanced yield trials in two replications.

[d] = IITA trials for 1982.

NA = Not available.

Source: IITA annual reports for 1981 and 1982.

varied protein and energy sources indigenous to the tropics is the major problem in Nigeria, rather than a real shortage.

A large number of materials with potential for use as human and livestock food and feed components abound in Nigeria. Extensive breeding studies with tuber crops have resulted in the availability of improved varieties which combine excellent agronomic characteristics with early maturity, good yield potential and high harvest index. These new varieties must be continually evaluated, first chemically and then biologically, for their overall nutritional characteristics.

The study reported here is part of a systematic investigation designed to characterize about 49 new varieties of sweet potato (*Ipomoea batatas*) sold in Nigerian markets. They are tropical varieties and there is a growing need for their use in human and animal feeding with the increasing demand and high cost of grains.

MATERIALS AND METHODS

Forty-nine varieties of sweet potato (*Ipomoea batatas*) obtained from the International Institute of Tropical Agriculture, Ibadan, Nigeria, were used in this study. The agronomic characteristics of the 49 varieties in terms of size, shape, stem colour, flesh colour, fresh yield (tonnes per hectare) and dry matter yield (tonnes per hectare) are shown in Table 1. Also shown in the table are weevil and virus scores indicating the level of resistance of different varieties to these organisms. They were harvested, washed, sliced with a mechanical slicer and oven-dried at 40·5°C for 3 days. They were then milled in a portable hammer mill and stored in air-tight bottles for chemical analysis.

Analytical procedures

All analyses were done in duplicate and the results were expressed on a dry matter basis after correcting for residual moisture. The proximate compositions of the samples were determined according to standard methods (AOAC, 1975). The phosphovanado molybdate method was used for the estimation of total phosphorus (AOAC, 1975). For the determination of phytic acid, the method proposed by Young & Greaves (1940) was used while polyphenolic compounds were estimated by the method of Ford & Hewitt (1979), and expressed as 'Tannin index'. The gravimetric method of Dye (1956) was used in total and soluble oxalate determinations.

TABLE 2
Dry Matter Proximate Composition (%DM) and Gross Energy Values (kJ/%DM) of some Varieties of Oven-Dried Sweet Potato Tubers

Variety	*Dry matter*	*Crude protein*	*Crude fibre*	*Ether extract*	*Ash*	*NFE*	*Gross energy*
TIB 4	27·76	6·79	4·42	0·88	5·23	82·68	16·76
TIS 2498	30·90	4·22	4·23	0·75	3·21	87·60	12·55
TIS 2534	26·14	4·37	5·19	0·69	4·82	84·93	20·23
TIS 6179	28·86	2·94	4·53	0·73	3·62	88·19	15·72
TIS 8143	30·70	2·64	4·06	0·99	3·26	88·86	14·31
TIS 8163	30·00	2·13	3·75	0·53	3·39	90·21	23·29
TIS 8250	17·82	3·62	4·00	0·97	3·58	87·84	17·69
TIS 8266	29·86	3·98	4·97	0·78	2·06	88·22	11·85
TIS 8401	34·02	3·98	4·38	0·79	4·65	87·20	22·90
TIS 8407	21·72	3·96	4·17	0·87	4·54	86·46	16·63
TIS 8409	29·34	5·60	5·48	0·93	6·33	81·66	16·18
TIS 8441	27·48	4·34	4·87	0·96	2·84	86·99	15·47
TIS 8504	28·04	4·79	3·73	0·75	2·18	91·55	18·36
TIS 8524	24·96	7·22	4·96	1·41	3·54	82·87	16·69
TIS 9101	26·16	4·16	4·92	0·69	5·64	87·59	21·74
TIS 9102	38·18	6·56	5·63	1·05	4·44	82·32	18·42
TIS 9132	27·60	6·68	4·65	0·33	5·26	83·08	19·63
TIS 9172	36·54	2·67	3·69	3·03	3·55	87·06	18·27
TIS 9232	28·64	3·53	5·89	1·05	3·28	88·25	17·11
TIS 9265	27·86	4·65	4·93	0·92	2·98	89·52	16·41
TIS 9291	32·40	7·23	3·83	0·94	1·47	86·53	16·70
TIS 9465	31·00	2·53	3·55	1·09	5·61	87·22	16·90
TIS 70357	35·14	5·68	4·97	1·03	7·33	80·99	17·45
TIS 70399	35·42	4·64	3·93	1·04	4·25	87·94	17·80
TIS 70683	29·84	6·18	4·32	0·69	4·38	84·43	18·40
TIS 71102	26·82	3·71	5·08	0·87	4·68	87·66	17·50
TIS 71354	29·08	5·03	4·82	0·72	4·81	84·62	16·81
TIS 80/832	24·00	5·58	4·63	0·38	4·22	85·19	15·95
TIS 80/525	26·80	2·42	3·89	0·58	3·29	89·82	16·76
TIS 80/592	27·50	3·36	3·75	0·81	3·68	89·40	14·70
TIS 80/632	22·90	2·47	3·76	0·84	4·35	89·58	14·80
TIS 80/723	30·00	4·89	3·78	0·54	4·62	86·17	18·70
TIS 80/727	23·81	3·81	4·07	0·55	3·82	87·75	18·36
TIS 80/733	30·30	5·00	3·81	0·44	3·92	86·82	19·15
TIS 81/145	27·91	1·92	3·65	0·67	6·28	87·48	16·41
TIS 81/255	28·88	3·99	5·82	1·16	5·22	83·81	16·65
TIS 81/286	28·72	5·92	3·58	0·90	4·36	85·24	16·39
TIS 81/430	25·92	6·83	3·61	0·65	5·35	83·56	15·88
TIS 81/446	26·08	8·60	4·05	0·90	3·27	83·18	14·71
TIS 81/471	25·00	1·39	3·45	0·74	5·84	88·58	18·78
TIS 81/530	33·33	9·47	3·71	0·36	3·13	83·38	17·15
TIS 81/663	24·51	2·90	4·14	0·94	3·81	88·21	8·98
TIS 81/666	25·00	4·98	3·48	0·58	3·11	87·85	12·25
TIS 82/0083	36·36	5·00	6·36	0·73	2·63	85·28	17·99
TIS 82/0132	25·45	6·61	3·99	0·77	2·57	86·06	17·99
TIS 82/0201	26·74	2·43	3·55	1·06	1·96	82·00	18·87
TIS 82/0264	27·45	2·05	5·52	1·96	4·93	85·54	18·36
TIS 82/0361	33·33	5·98	4·56	1·33	3·24	84·88	16·88
TIS 82/240	26·43	2·16	4·22	0·78	2·44	89·40	18·71
Mean	28·54	4·51	4·37	0·88	4·04	66·58	17·30
Std. Error (SE)	±0·57	±0·26	±0·10	±0·06	±0·17	±0·37	±0·32
Std. Deviation (SD)	4·01	1·84	0·73	0·42	1·22	2·57	2·24
CV (%)	14·05	40·80	16·70	47·73	30·19	4·24	12·95

RESULTS

Proximate and energy compositions

The proximate and energy compositions of the 49 varieties studied are shown in Table 2. There is a mean dry matter value of 28·54 ± 0·573 with a range of 17·82% for TIS 8250 to 36·84% for TIS 9172. Crude protein varied between 1·39 and 9·47%, being highest in TIS 81/530 and lowest in TIS 81/471. A mean value of 4·37 ± 0·014 was obtained for crude fibre and, with the exception of TIS 82/0083 with 6·36%, all varieties ranged between 3·48% and 5·89%. Ash was exceedingly high in TIS 70357 (7·33%), followed by TIS 8409 (6·33%) and TIS 81/145 (6·28%) while values obtained for TIS 9291 (1·47%) and TIS 82/0201 (1·96%) were rather low. With the exception of TIS 8266, TIS 81/666 and TIS 2498, gross energy values were uniformly high among all varieties.

Antinutritional factors

The data for phytin, phytin-phosphorus and total phosphorus contents of the sweet potato varieties are shown in Table 3. Phytin was highest in TIS 80/733 and lowest in TIS 2498, TIS 6179, TIS 70399, and TIS 81/471. The range obtained was from 4·98 to 15·2 mg/100 g. Phytin-phosphorus was comparatively lower than phytin and values obtained ranged between 1·4 and 4·80 mg/100 g. Particularly low values were obtained in TIS 2498, TIS 6179, TIS 8409, TIS 70399, TIS 71102, TIS 81/471 and TIS 81/666 all of which contained much lower phytin-phosphorus values than the mean value of 2·79 mg/100 g. Total phosphorus varied between 39·0 mg/100 g for TIS 80/723 and TIS 82/0361 to 182 mg/100 g for TIS 80/592, with a mean value of 95·5 mg/100 g. Phytin phosphorus represented 0·99 to 9·71% of total phosphorus with an average value of 3·45%.

Tannin index, water-soluble oxalate and total oxalate contents are shown in Table 4. The ranges are: for Tannin index, 0·02–0·28; for water-soluble oxalate, 0·04–1·34% and for total oxalate, 0·09–1·77%. Soluble oxalate as a percentage of total oxalate showed considerable variability as indicated by the rather high percentage coefficient of variation (37·1%). Varieties TIS 9265, TIS 8401 and TIS 9132 are particularly noteworthy as containing high levels of soluble oxalate relative to the amount of total oxalate present in the sweet potato samples.

DISCUSSION

The results showed that there were marked varietal differences in the proximate composition and levels of antinutritional factors in the varieties

TABLE 3
Phytin and Phytin Phosphorus Content (mg/100 g DM) of some Varieties of Oven-Dried Sweet Potato Tubers

Variety	*Phytin content (mg/100 g)*	*Phytin phosphorus (mg/100 g)*	*Total phosphorus (mg/100 g)*	*Phytin P as percentage of total P*
TIB 4	8·45	2·38	137·0	1·74
TIS 2498	4·98	1·40	126·0	1·11
TIS 2534	8·87	2·50	176·0	1·42
TIS 6179	4·98	1·40	93·0	1·51
TIS 8143	7·17	2·02	110·0	1·84
TIS 8163	13·1	3·69	38·0	9·71
TIS 8250	7·85	2·21	118·0	1·87
TIS 8266	12·3	3·45	111.0	3·11
TIS 8401	8·88	2·50	86·0	2·91
TIS 8407	8·02	2·26	103·0	2·19
TIS 8409	6·75	1·90	144·0	1·32
TIS 8441	10·1	2·86	78·0	3·67
TIS 8504	10·1	2·86	116.0	2·47
TIS 8524	10·6	2·98	110·0	2·71
TIS 9101	13·9	3·93	106·0	3·71
TIS 9102	13·5	3·81	124·0	3·07
TIS 9132	9·72	2·74	105·0	2·61
TIS 9172	7·17	2·02	86.0	2·34
TIS 9232	8·87	2·50	95·0	2·62
TIS 9265	8·45	2·38	114·0	2·09
TIS 9291	12·3	3·45	97·0	3·56
TIS 9465	10·6	2·98	96·0	3·10
TIS 70357	7·85	2·21	166·0	1·33
TIS 70399	4·98	1·40	141·0	0·99
TIS 70683	10·6	2·98	144·0	2·07
TIS 71102	6·89	1·94	152.0	1·28
TIS 71354	10·6	2·98	88.0	3·39
TIS 80/832	13·5	3·80	67·0	5·67
TIS 80/525	13·9	3·93	182·0	2·16
TIS 80/592	14·4	4·05	47·0	8·62
TIS 80/632	13·5	3·81	103·0	3·70
TIS 80/723	12·3	3·45	39·0	8·85
TIS 80/727	8·88	2·50	97·0	2·58
TIS 80/733	15·2	4·28	48·0	8·92
TIS 81/145	9·72	2·74	123·0	2·23
TIS 81/255	7·17	2·02	73·7	2·74
TIS 81/286	10·2	2·38	67·0	3·55
TIS 81/430	11·4	3·21	95·0	3·38
TIS 81/446	12·7	3·57	47·0	7·60
TIS 81/471	4·98	1·40	81·8	1·71
TIS 81/530	8·87	2·50	72·0	3·47
TIS 81/663	12·3	3·45	115·0	3·00
TIS 81/666	6·75	1·90	76·0	2·50
TIS 82/0083	10·6	2·98	83·0	3·59
TIS 82/0132	10·1	2·86	71·9	3·98
TIS 82/0201	11·4	3·21	48·0	6·69
TIS 82/0264	10·6	2·98	82·0	3·63
TIS 82/0361	8·87	2·50	39·0	6·41
TIS 82/240	12·3	3·45	62·0	5·56
Mean ($\bar{X}$)	9·93	2·79	95·5	3·45
Standard Error (SE)	±0·383	±0·108	±4·76	±0·314
Std. Deviation (SD)	2·68	0·76	33·30	2·20
CV (%)	26·99	27·24	34·89	63·77

TABLE 4

Tannin Index and Oxalate (%DM) Content of some Varieties of Oven-Dried Sweet Potato Tubers

Variety	*Tannin*	*Water soluble oxalate (%)*	*Total oxalate (%)*	*Soluble oxalate as percentage of total oxalate*
TIB 4	0·03	0·04	0·17	23·5
TIS 2498	0·02	0·64	0·84	76·2
TIS 2534	0·04	0·52	0·92	56·5
TIS 6179	0·05	0·29	0·56	51·8
TIS 8143	0·07	0·62	0·86	72·1
TIS 8163	0·08	0·09	0·23	38·7
TIS 8250	0·03	0·73	0·92	79·4
TIS 8266	0·12	0·038	0·09	41·3
TIS 8401	0·11	1·08	1·21	89·3
TIS 8407	0·08	0·48	1·12	42·9
TIS 8409	0·23	0·34	0·93	36·6
TIS 8441	0·06	0·15	0·32	46·9
TIS 8504	0·09	0·63	1·02	61·8
TIS 8524	0·11	0·37	0·84	44·1
TIS 9101	0·08	0·68	0·96	70·8
TIS 9102	0·08	0·42	0·67	62·7
TIS 9132	0·05	1·02	1·38	87·0
TIS 9172	0·03	0·23	0·58	39·7
TIS 9232	0·17	0·38	0·88	43·2
TIS 9265	0·02	0·68	0·72	94·4
TIS 9291	0·09	0·48	0·63	76·2
TIS 9465	0·10	0·70	0·98	71·4
TIS 70357	0·28	1·00	1·31	58·9
TIS 70399	0·05	0·62	0·96	64·6
TIS 70683	0·05	0·17	0·29	58·6
TIS 71102	0·08	0·69	1·34	51·5
TIS 71354	0·05	0·08	0·23	33·9
TIS 80/832	0·04	0·34	1·04	32·7
TIS 80/525	0·10	0·27	0·42	64·3
TIS 80/592	0·05	0·067	0·12	55·8
TIS 80/632	0·09	0·41	0·73	56·2
TIS 80/723	0·03	0·21	0·63	33·4
TIS 80/727	0·04	0·61	0·86	70·9
TIS 81/733	0·03	0·34	0·48	70·8
TIS 81/145	0·02	0·32	0·48	66·7
TIS 81/255	0·02	0·63	0·91	69·9
TIS 81/286	0·03	0·09	0·17	52·9
TIS 81/430	0·05	0·39	0·81	48·2
TIS 81/446	0·16	0·82	1·23	66·7
TIS 81/471	0·07	0·36	0·51	70·6
TIS 81/530	0·09	0·78	1·11	70·3
TIS 81/663	0·07	0·34	0·61	42·0
TIS 81/666	0·05	0·64	0·93	68·8
TIS 82/0083	0·06	0·25	1·02	24·5
TIS 82/0132	0·02	0·09	0·33	27·6
TIS 82/0201	0·06	0·07	0·11	63·6
TIS 82/0264	0·10	1·34	1·77	75·7
TIS 82/0361	0·043	0·65	0·84	77·4
TIS 82/240	0·02	0·10	0·48	20·4
Mean ($\bar{X}$)	0·07	0·45	0·71	57·2
Std. Error (SE)	0·01	0·04	0·05	2·59
Std. Deviation (SD)	0·05	0·30	0·36	18·2
CV (%)	70·42	66·67	50·70	31·74

of sweet potato studied. The dry matter levels of the tubers were generally low, showing a high moisture level in sweet potato, and this probably explains the early spoilage usually experienced during sun-drying of sweet potatoes. The values obtained for crude protein are slightly higher than values reported by Walter & Caltigani (1981) but compare favourably with those of Oyenuga (1968). They also compare with the protein levels reported for oven-dried unpeeled sweet potato tubers (Fetuga & Oluyemi, 1978).

Crude fibre varied between 6·36 and 3·45% and when this range of values is compared with those of white yam (Ologhobo, 1985), yellow yam (Ologhobo, 1985), cocoyam (Oyenuga, 1968), the sweet potato varieties contain fairly high levels of crude fibre. These levels are, however, only likely to have small effects on digestibility.

Phytates form complexes with metallic cations, especially phosphorus, calcium, magnesium, iron, zinc, and reduce their availability in the intestinal tract (Rackis, 1974). The values obtained for phytin and phytin-phosphorus as a percentage of total phosphorus, however, indicate that the varieties of sweet potato studied do not contain any substantial amount of their phosphorus bound with phytin and it is therefore available for nutritional purposes.

Not much information appears to exist on the toxic effect of tannins in monogastrics. However, tannins have been reported to have strong interactions with proteins and divalent metals and the insoluble complexes formed may play a role in the antinutritional effects of tannin-containing feeds (Tarmir & Alumof, 1970). This observation cannot, however, hold for sweet potato. According to Chang & Fuller (1964), tannins do not affect the nutritional potential of plants unless at very high levels, often 10% or more of the dry weight. Tannin obtained in this study varied between 0·02 and 0·38 and these values compare favourably with those reported for pulses, especially the white-flowered varieties (Oyenuga, 1968); they are much lower than the levels encountered in most plants, particularly those of sorghum, barley and rice (Ford & Hewitt, 1979). Tannin in these varieties of sweet potato cannot be of any nutritional significance.

Curl & Nelson (1940) identified oxalic acid as one of the organic acids in sweet potato but did not show interest in their levels or in their varietal differences. Oxalic acid in diets may lead to poor calcium utilization, presumably because of the formation of calcium oxalate which is poorly absorbed (Oyenuga, 1968). The variation obtained with respect to total and soluble oxalate contents in the varieties investigated may be due to differences in the physiological rate of oxalate production and the different rates of uptake of metallic cations from the soil. The high soluble oxalate as a percentage of total oxalate reported in most of the varieties studied, indicates a low level of insoluble oxalate and shows that a greater proportion of the oxalates are in the form of soluble oxalates. Although oxalate–protein binding has not been reported in the literature, there is the possibility that, at a certain pH, dissociation may take place and the resulting oxalate ion may react and form complexes with the amino group of basic amino acids. This may render amino acids unavailable and reduce the quality of the protein contained in the sweet potato.

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