The manufacturer recommends multiple reuse of the catalyst. Reuse of the catalyst will result in cost saving and is advantageous for better control over the end product.

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Fatty Acids, Carbohydrates and Crude Protein in Twenty Cassava Cultivars (*Manihot esculenta Crantz*)

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ABSTRACT

Twenty cassava cultivars (*Manihot esculenta* Crantz) were analyzed for fatty acids, nonstructural carbohydrates and crude protein contents. The main constituent fatty acids were myristic, palmitic, stearic, oleic, linoleic and linolenic. Trace amounts of lauric, myristoleic and palmitoleic acids were detected. Saturated acids ranged from 26.58 to 58.05%. Acid-digestible carbohydrates ranged from 11.82 to 40.70% of the green matter. Reducing and non-reducing soluble oligosaccharides also were determined. Crude protein ranged from 1.39 to 4.70% of the dry matter. Linear regression analyses were made, but no significant correlations were found. Some possible genetic relationships are proposed for certain cultivars.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) tubers contribute a large percentage of the total caloric intake of Brazilian diets (1) and now are used by non-traditional consumers in Japan and China as a complementary source of food (2). In certain cases, such as in Bangladesh, cassava is felt to be a possible solution for basic dietary energy requirements (3).

These observations are due to the fact that cassava is cultivated worldwide. It is grown widely in Northeast Brazil since it is easily adaptable to poor soils and irregular rainfall, and it is economical in terms of both land and labor (4).

Other uses for cassava include the starch industry, cattle feed and alcohol production (5).

Cassava tubers have a basic protein nutrition imbalance in relation to their carbohydrate. Scholz (4) has proposed that the proportion 1:50 represents only 1/10 of the nutritional requirements for a balanced diet. This same author states that two other factors aggravate the problem: lipid imbalance and excessive amounts of fibers in the cassava flour. There are few reports about cassava lipids (6). The reports frequently refer to the ether extract, and as such include not only lipids, but resins, gums, tannins and other compounds extracted from the latex and root skin.

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Although there are some references to carbohydrates, proteins and total lipids, no report on individual fatty acid analysis was found in the literature (6). The purpose of this study was to make comparative analyses of 20 cassava cultivars for their fatty acids, carbohydrates and crude protein.

MATERIALS AND METHODS

Samples

The analyses were made on lyophilized tubers of 20 cassava cultivars from the germplasm bank of the Universidade Federal de Vicosa, Vicosa, Minas Gerias, Brazil. They were cultivated in a completely randomized experimental design with six replications. The 12-month-old plants included the following cultivars: Sem Nome; Manteigao; SFG 2317; SFG 469; Saracura; Mangue mirim; Mawana; JL-8; Roxinha; Caravela; Prato; Desconhecida; Santinha; Variedate I; Veada; Amargoso; Livoca; Ligeirihna; Gostosa; and Vermelhinha. Normal agricultural practices were used in the field.

Fatty Acids

The lipids were extracted from the lyophilized samples, saponified, methylated according to the technique described by Folchi (7), and then chromatographed on a wall coated, open tubular (WCOT) capillary column (6.0 m × 0.25 mm), covered with diethyleneglycolsuccinate. The temperatures were injector 250 C, detector 280 C and column isothermal 180 C. The apparatus was a Varian 3700 with a DFI detector, DDS-111 processor-integrator and potentiometric recorder Linear model 252 A/M/. The gases were nitrogen (250 ml/min), hydrogen (30 ml/min) and synthetic air (30 ml/min). The quantification was made from peak areas and identification done by comparison with standards.

Crude Protein

Crude protein was determined by the Kjeldahl method modified by Teles for cassava to exclude cyanogenic glycoside interference (8).

TABLE I

Percentages of Saturated and Unsaturated Fatty Acids and Crude Protein in 20 Cassava Cultivars (*Manihot esculenta* Crantz)

Cultivars	Total lipids (%)	Fatty acids[a]								Crude protein (% dry matter)
		Saturated (%)				Unsaturated (%)				
		C 14:0	C 16:0	C 17:0	Total	C 18:1	C 18:2	C 18:3	Total	
1. Sem Nome	0.83	–	39.8	8.1	47.9	49.2	2.9	–	52.1	2.61
2. Manteigao	1.04	–	32.8	7.0	39.8	50.1	3.8	6.2	60.1	1.39
3. SFG 2317	2.01	–	56.6	–	56.6	36.6	–	6.8	43.4	2.29
4. SFG 469	2.03	–	47.3	–	47.3	52.7	–	–	52.7	1.98
5. Saracura	0.70	–	58.0	3.2	58.0	24.6	12.6	1.5	42.0	2.47
6. Mangue mirim	1.30	–	32.4	6.5	38.9	48.2	11.3	1.6	61.1	2.34
7. Mawana	1.14	–.80	33.2	–	34.0	46.0	15.3	4.7	66.0	1.44
8. JL-8	1.28	0.96	32.4	6.6	40.0	40.1	14.3	5.6	60.0	2.47
9. Roxinha	0.90	1.02	37.8	7.3	46.2	41.8	9.2	2.7	53.8	3.64
10. Caravela	1.52	–	44.9	2.9	47.8	46.1	4.0	2.2	52.2	1.84
11. Prato	1.72	–	28.0	3.5	31.5	46.3	15.2	6.4	68.5	2.34
12. Santinha	0.80	–	31.8	1.8	33.6	41.9	19.0	5.6	66.4	3.92
14. Variedade I	1.23	–	31.7	1.7	33.4	47.6	13.5	5.5	66.6	2.47
15. Veada	1.42	–	36.6	–	36.6	50.5	12.9	–	63.4	3.10
16. Amargoso	0.92	–	38.6	–	38.6	49.0	12.4	–	61.4	1.70
17. Licova	1.27	–	–	–	–	–	–	–	–	1.57
18. Ligeirinha	1.32	–	38.6	1.4	40.0	51.0	7.1	1.9	60.0	4.10
19. Gostosa	1.84	0.1	41.2	2.4	43.6	43.2	8.9	4.3	56.4	4.10
20. Vermelhinha	0.92	2.0	33.1	2.4	37.5	43.1	11.6	7.9	62.5	4.70

[a]In percentages of total peak areas when considering the six main fatty acids as 100%.

TABLE II

Acid-digestible (ADC), Total Soluble (TSC), Reducing (SRC) and Non-reducing (SNRC) Carbohydrates in 20 Cassava Cultivars (*M. esculenta* Crantz)

Cultivar	ADC[a] (% of green matter)	TSC[a] (mg/g of green matter)	SRC[a] (mg/g of green matter)	SNRC[a] (mg/g of green matter)
1. Sem Nome	27.4	13.1	3.1	10.0
2. Manteigao	31.4	20.1	3.1	17.0
3. SFG 2317	35.3	16.0	1.7	14.4
4. SFG 469	24.9	16.2	4.4	11.8
5. Saracura	25.8	21.7	4.2	17.5
6. Mangue Mirim	33.7	12.4	3.1	9.3
7. Mawana	40.7	14.5	2.7	11.8
8. JL-8	29.8	11.0	2.3	8.7
9. Roxinha	23.5	16.8	4.4	12.4
10. Caravela	29.4	22.2	4.3	17.9
11. Prato	31.4	16.1	2.1	14.0
12. Desconhecida I	11.8	7.4	1.6	5.8
13. Santinha	24.5	22.0	6.5	15.5
14. Variedade I	24.2	18.2	6.9	11.3
15. Veada	39.9	17.7	6.0	21.7
16. Amargoso	31.7	16.5	2.9	13.6
17. Licova	33.0	17.7	2.8	14.9
18. Ligeirinha	26.4	19.2	5.3	13.9
19. Gostosa	32.7	16.0	3.9	12.1
20. Vermelhilnha	32.6	17.8	3.5	14.3

[a]Average of 6 replications (deviation less than 5%).

Carbohydrates

The acid-digestible carbohydrates (starch plus mono- and disaccarides) were determined according to the procedure developed by Teles et al. (9), and the soluble carbohydrates (total, reducing and non-reducing sugars) were analyzed colorimetrically on the alcohol extract (10).

RESULTS AND DISCUSSION

The main constituent fatty acids of the cultivars were myristic, palmitic, stearic, oleic, linoleic and linolenic (Table I). Lauric, myristoleic and palmitoleic acids were detected as trace components of some cultivars. Among the saturated acids, palmitic was predominant, ranging from 26.6 to 58.0%. Among the unsaturated ones, oleic acid showed the highest content, ranging from 36.6 to 52.7%. Linoleic acid was detected in all cultivars except SFG 2317 and SFG 469. Following the experimental statistical design, regression analysis was performed and no significant correlation was found among the various components studied. However, it was noticed that only the cultivars Mawana, JL-8, Roxinha, Gostosa and Vermelhinha had all the six main fatty acids. In the others, myristic was generally absent. Since cultivars SFG 2317 and SFG 469 did not have stearic and oleic acids, a botanical relationship was suspected between them. The same phenomena could be observed in the cultivars Veada and Amargoso, which lacked stearic and linolenic acids.

Considering the six main fatty acids only, the unsaturated fraction ranged from 43.4 to 67.5%. Although apparently very unsaturated, from a nutritional standpoint it is of only minor value, since the total triglyceride contents of the cultivars were all below 2%.

Crude protein ranged from 1.4 to 4.7% (Table I) of the dry matter, which is in accordance with the literature (2). Again, no significant correlation was found between protein and individual fatty acid contents.

The starchy characteristic of the cassava tubers is substantiated (Table II). The acid digestible carbohydrates in the green matter ranged from 11.8 to 40.7%. The total soluble carbohydrates ranged from 7.35 to 27.7 mg/g of green matter. More information about the oligosaccharides is needed for a better understanding of the carbohydrate metabolism of this euphorbiaceous plant.

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A Quantitative Comparison of the Yields of Radiolysis Products in Various Meats and their Relationship to Precursors

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ABSTRACT

A detailed analysis has been made of the composition of radiolysis products formed in beef, pork, ham, and chicken. The yields of the various compounds are related linearly to irradiation dose, and the fat, fatty acid and triglyceride composition of the meats.

INTRODUCTION

The fact that various meats yield similar compounds in comparable amounts upon irradiation has long been established (1). A series of studies with meats (1-6) and model compounds (2-4, 7-12) has shown that the origin of the radiolytically induced components can be attributed to precursors in the meat such as the fats and proteins. Moreover, mechanisms for the reaction pathways have been adduced or proposed (7-9, 13), but the evidence in support of the hypotheses has been mainly qualitative. Recently, a quantitative study of the reaction pathways leading to radiolysis products in ethyl palmitate has been completed (14). In this study, a quantitative relationship is shown for the yields of the various radiolysis products in meat and the amount of their putative precursors.

EXPERIMENTAL

Preparation of Meats for Irradiation

Preparation of Chicken Samples. Broiler carcasses were separated into white meat and dark meat and skins with attached fat, and then frozen. Chicken rolls were formed by mixing 82% light meat and dark meat and 18% skins. To this mixture was added 0.75% salt (NaCl) and 0.3% sodium tripolyphosphate. The meat and additives were thoroughly mixed for ca. 20 min in a vacuum mixer and then stuffed into regenerated cellulose casings of appropriate size. The chicken rolls were enzyme inactivated by heating to an internal temperature of at least 68 C and not more than 74 C. The rolls were then spray washed, chilled and stored under refrigeration until packaged. Before packaging the casings were stripped off and the rolls ground twice and packed into 404 x 309 tin cans. After vacuum sealing, the cans were frozen pending irradiation.

Preparation of Beef Samples. Fresh, raw beef was deboned, trimmed and cut into chunks. The beef chunks were then mixed with 0.75% salt and 0.3% sodium tripolyphosphate in a vacuum mixer for 20 min. After mixing the beef was stuffed into casings, enzyme inactivated, ground, canned and stored in the same manner as chicken (vide supra).

Preparation of Ham Samples. Fresh, raw pork hams were mechanically pumped with curing brine to a 12% level, then skinned, deboned, trimmed and cut into 100 to 500 g chunks. The meat chunks and an additional 3% brine were mixed for 15 min to a tacky consistency followed by vacuum mixing for an additional 20 min.

Brine Composition

Water	25.5 Kg
Sodium tripolyphosphate	600.0 g
Salt (sodium chloride)	4.8 Kg
Sodium ascorbate	55.0 g
Sodium erythrobate	55.0 g
Sodium nitrate	10.0 g
Sodium nitrite	5.0 g

The mixed ham was then stuffed into casings, enzyme inactivated, processed, canned and stored as was the chicken (vide supra).

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