Studies on the Nutrient Composition of *Rhynchosia venulosa* (Munkoyo Roots) and Physicochemical Changes in Munkoyo Roots and Maize Porridge Mixture during Preparation of Munkoyo Beverage

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Nutrient composition of two widely used munkoyo varieties (i.e., yellow and white) and their water extracts has been determined and they are similar. Crude protein and sugars are almost completely extracted from both varieties, but the rate of extraction of minerals is different. Free amino acids of both varieties have also been determined. The yellow variety contains more total and essential amino acids than the white one. Studies on physical changes in munkoyo roots/extract and maize porridge mixture during the preparation and maturation up to 48 h of munkoyo beverage by the traditional method have also been carried out. Formal value, free amino acids, soluble solids, total and reducing sugars, and acidity increase while pH decreases. Fat and ash remain constant, and alcohol is not formed under the experimental conditions. An increase in reducing sugars and free amino acids indicates the presence of amylolytic and proteolytic enzymes, respectively, in the roots.

INTRODUCTION

Munkoyo is one of the favorite indigenous beverages among the local population. It is prepared by mixing together the warm maize porridge and munkoyo roots and/or extract and allowing it to mature overnight. The mixture becomes sweet and thin with the simultaneous development of peculiar munkoyo flavor during this time period.

Some work has been carried out on the nutrient composition of munkoyo beverage prepared in different areas of Zambia (Lovelace, 1977), but no information is available on the nutrient composition of munkoyo roots and the physicochemical changes in the munkoyo roots and maize porridge mixture during the preparation of munkoyo beverage.

In this paper nutrient composition of yellow and white munkoyo roots and their water extracts has been studied. Studies on physicochemical changes that take place in munkoyo roots/extract and maize porridge mixture during the preparation of munkoyo beverage have also been carried out with the hope of gaining insight into the chemistry and biochemistry of the process.

EXPERIMENTAL SECTION

Materials and Methods. Munkoyo roots and breakfast food (i.e., maize flour) were purchased from the local market. All the reagents used were of analytical grade; AOAC (1975) methods were used for the determination of nutrients. Total and free amino acids were determined by paper chromatography (Elahi and Khan, 1973). Ninhydrin reagent was prepared by dissolving 0.5 g of commercial ninhydrin in 100 mL of acetone.

PROCEDURE

Preparation of Munkoyo Root Samples for Analysis. After the bark was removed, the roots were beaten to threads and allowed to dry at room temperature. The roots of both varieties were cut into small pieces and mixed well separately to prepare composite samples for nutrient analysis.

Preparation of Extract for Analysis. A 25-g portion of each composite sample was soaked in 500 mL of water separately for 2 h. After this period it was filtered and the residue washed with water. The volume of filtrate was adjusted to 500 mL in a volumetric flask. The nutrient composition of roots and extracts has been included in Table I.

Extraction of Free Amino Acids. A composite sample (20 g) of each variety was stirred separately in 70% ethanol (100 mL) for 2 h and centrifuged. The supernatant layer was decanted, and the residue was repeatedly washed with more 70% ethanol until the washings gave negative test with ninhydrin. All the ethanol extracts were combined and evaporated to dryness under reduced pressure.

Purification of Amino Acids. The residue was dissolved in a minimum volume of distilled water and passed through a column of Amberlite resin IR-120 (H^+). The column was eluted with water until the eluate gave negative test with Fehling's reagent, which showed the complete removal of sugars. Amino acids were eluted from the column with 2 N ammonium hydroxide until the eluate was negative to ninhydrin reagent. The eluate was then evaporated to dryness under reduced pressure and dissolved in a known volume (1 mL) of distilled water that was used for both qualitative and quantitative determinations.

Qualitative Analysis. Amino acids were separated by descending one-dimensional paper chromatographic technique on Whatman No. 3 paper using the following solvents: (1) butanol:acetic acid:water = 5:1:4°; (2) phenol:propanol:water = 5:1:1°; (3) propanol:water = 70:30. The munkoyo samples were spotted along with the standard amino acids, and the chromatogram was run for 18 h after which period it was taken out, dried, and sprayed with ninhydrin reagent. The spots were made visible by heating at 70 °C for 10 min. Identification of amino acids was made according to R_f values, and ninhydrin color reactions were compared with those of standard amino acids.

Quantitative Analysis. Chromatography was carried out as described above by spotting a known volume of each sample, and the ninhydrin color spots were cut out from the papers and extracted in test tubes in a known volume of 95% ethanol. Spectrophotometric readings were recorded at 570 nm (at 470 nm for proline) on a Spectronic 20 spectrophotometer against a blank eluted from one of the papers.

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Table I. Nutrient Composition of Munkoyo Roots and Extracts

munkoyo var	moisture, %	protein, %	fat, %	ash, %	fiber, %	reducing sugars, %	total sugar as reducing sugars, %	nonreducing sugars, %
yellow[a]	7.6/99.5	4.8/0.20	0.5/...	2.8/0.08	76.8/...	2.85/0.13	5.1/0.22	2.45/0.11
% extraction		83		57		91	86	90
white[a]	7.4/99.3	5.1/0.22	0.54/...	2.7/0.1	75.1/...	2.7/0.13	4.5/0.20	1.7/0.08
% extraction		85		74		96	90	95

[a] The denominator indicates the percentage of nutrients in the extract.

Table II. Determination of Free Amino Acids in Different Varieties of Munkoyo Roots

	amino acids,[a] mg/g											
munkoyo var	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
yellow	7.3	5.5	6.6	7.9	8.7	9.0	2.5	8.1			7.0	62.6
white	6.3	5.5				6.6		9.0	7.4	3.8	6.9	45.5

[a] Key: I, proline; II, valine; III, lysine; IV, tryptophan; V, glutamic acid; VI, alanine; VII, arginine; VIII, serine; IX, asparagine; X, threonine; XI, unknown; XII, total.

Table III. Changes in Physicochemical Properties of Maize Porridge during Preparation of Munkoyo Beverage

	time, h														
	I[a]			II			III			IV			V		
physicochem prop.	0	24	48	0	24	48	0	24	48	0	24	48	0	24	48
pH	6.65	4.60	4.05	6.55	5.35	4.20	6.60	5.95	5.80	6.60	5.60	6.00	6.50	5.50	5.70
acidity[b]	0.50	2.35	3.40	0.60	1.90	3.00	0.45	0.55	0.60	0.30	0.45	0.35	0.30	0.50	0.40
formal value[b]	0.30	0.50	0.55	0.35	0.55	0.55	0.30	0.35	0.35	0.25	0.25	0.20	0.30	0.25	0.25
total solids, %	9.27	9.84	9.20	9.43	9.60	9.32	10.80	10.00	10.25	0.45	0.45	0.39	0.45	0.48	0.40
total sol solids, %	7.50	7.80	8.00	7.40	7.60	7.80	3.10	3.20	3.40	0.40	0.35	0.35	0.40	0.38	0.35
ash, %	0.13	0.14	0.14	0.23	0.22	0.21	0.12	0.11	0.13	0.05	0.04	0.04	0.07	0.06	0.06
total free amino acids[c]	1.05	1.31	1.40	0.95	1.25	1.40	0.80	0.90	0.80	0.95	0.10	0.95	1.05	1.13	1.11
reducing sugars as glucose, %	2.00	3.09	3.65	1.84	2.83	3.52	0.12	0.13	0.13	0.13	0.12	0.13	0.14	0.13	0.12
total sugars as glucose, %	3.26	3.25	4.06	3.24	3.20	3.73	0.27	0.27	0.20	0.22	0.28	0.20	0.22	0.24	0.23
crude fat, %	0.24	0.26	0.21	0.19	0.23	0.23	0.22	0.15	0.18	0.14	0.16	0.13	0.10	0.12	0.10

[a] Key: I, white munkoyo beverage; II, yellow munkoyo beverage; III, maize porridge; IV, white munkoyo extract; V, yellow munkoyo extract. [b] Units: mL of 0.1 N NaOH/10 mL of sample. [c] Units: mg/100 g of alanine.

The concentration of individual amino acids was then estimated in terms of alanine from a standard curve prepared for it. The results of qualitative and quantitative determinations have been included in Table II.

Preparation of Munkoyo Beverage. (*i*) *Preparation of Maize Porridge.* Maize porridge was prepared by adding breakfast food (400 g) little by little to hot water (1 L) and boiled for 15–20 min to get properly cooked porridge.

(*ii*) *Preparation of Munkoyo Extract.* Munkoyo roots (100 g), each of yellow and white munkoyo varieties, were soaked in water (225 mL) separately 2 h prior to use and filtered. (*iii*) *Mixing of Porridge and Extract.* Munkoyo extract (400 mL), each of white and yellow munkoyo, was added to flask 1 and flask 2, each containing porridge (530 g). Similarly, water (400 mL) was added to flask 3 containing porridge (530 g) while water (530 mL) was added to each of flasks 4 and 5 containing munkoyo extract (400 mL) of white and yellow munkoyo roots, respectively.

All the mixtures were mixed well, and samples were withdrawn immediately and kept frozen before analysis. The rest of the mixtures were allowed to mature at room temperature, and samples were withdrawn after 24 and 48 h. All the determinations were made according to AOAC (1975) methods. The results are shown in Table II.

DISCUSSION

Table I shows that the yellow roots contain more total and nonreducing sugars than the white ones. The crude potein, fat, ash, and reducing sugars contents are similar in both varieties. The composition of the extracts is similar, except in nonreducing sugars which are present in greater amounts in yellow than the white roots.

It is interesting to note that in both varieties the crude proteins and sugars are almost completely extracted. This shows that proteins are mostly in the form of water-soluble proteins and/or free amino acids. The extraction of minerals is higher in the white variety than the yellow one. Fat and fiber being insoluble are not extracted.

Table II shows that the yellow variety contains more total and individual amino acids than the white one. Yellow variety has nine while the white has seven. Asparagine and threonine are present in the white variety, but spots corresponding to these free amino acids were not obtained with the extract from the yellow variety. Yellow variety contains more essential amino acid, including lysine which is deficient in maize. Alanine and serine are the most abundant amino acids in yellow and white roots, respectively.

It is evident from Table III that pH decreases up to 48 h in samples I–III while in samples IV and V the decrease after 24 h is followed by an increase. Acidity increases in sample I–III up to 48 h. Changes in pH and acidity are much more pronounced in samples I and II (i.e., the munkoyo samples), which show the production of some acidic compounds during the maturing period. The characterization and estimation of these compounds would be carried out. Formal value and total free amino acids gradually increase up to 48 h in samples I and II but in samples III–V these are almost constant. The increase in formal value and total free amino acids may be attributed to the presence of some proteolytic enzymes in the munkoyo extracts that bring about the hydrolysis of protein. It is interesting to note from Table III that the munkoyo extracts (samples IV and V) contribute 0.4% soluble solids and the porridge (sample III) 3.1% but mixtures at time zero have 7.5 % soluble solids. This sudden and considerable increase in soluble solids in the mixtures may be attributed to the immediate action of enzymes in the extracts on the maize flour components during mixing and freezing the mixtures. Further increase in soluble solids of samples I and II is very slow.

Soluble solids increase in samples I–III up to 48 h while in samples IV and V these tend to decrease. Ash and fat content remain almost unchanged in all the samples. Reducing and total sugars increase in samples I and II up to 48 h while in samples III–V these remain almost constant. This increase in sugars of samples I and II may be due to the presence of some amylolytic enzymes in the munkoyo extract that brings about the degradation of starch and possibly oligosaccharides into simple sugars. Alcohol is not formed in any of the samples.

From these results it may be concluded that the amylolytic and proteolytic enzymes are present in munkoyo roots as enzymes in maize are destroyed during porridge formation. These enzymes bring about all these changes during maturing of munkoyo beverage.

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LITERATURE CITED

Association of Official Agricultural Chemists, "Official Methods of Analysis", 12th ed.; AOAC: Washington, DC, 1975.

Elahi, M.; Khan, N. *J. Agric. Food. Chem.* **1973**, *21* (4), 743.

Lovelace, G. B. A. Paper Presented at Symposium-workshop on Indigenous Fermented Foods, Bangkok, Thailand, 21–26 Nov, 1977.

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