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Nutrient Composition of Millet (*Pennisetum typhoides*) Grains and Malt

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Millet grains were germinated for 84 h and kilned at 45 °C to obtain a malt product. Analyses of vitamins, phytate, oxalate, tannins, total phenols, and calcium were conducted to determine the nutritional value of the grains and the malt. The levels of vitamins were higher in the malt than in the grains. Slight increases in protein and total phenol were observed in the malt, while lipid, phytate, and oxalate levels decreased during malting.

Millet (*Pennisetum typhoides*) is one of the widely cultivated crops in Nigeria and in Savannah regions immediately south of the Sahara. It is used as a cereal food and in the production of locally brewed alcoholic beverages (Nielson, 1965; Oyenuga, 1968; Oke, 1977).

There is an emphasis on the improvement of nutritive value of foods in the developing countries where the contribution of cereal protein is significant in the general protein shortage. The desire to use local cereals as malting material in the industries has enhanced the importance of millet in the economy.

The purpose of this study was to determine the nutrient composition of millet grains and malt and to assess their nutritional value. Several studies (Hiatt, 1972; Fordham, et al., 1975; Hamilton and Vanderstoep, 1979) have shown that nutritional values of seeds are increased during germination.

MATERIALS AND METHODS

Millet (*Pennisetum typhoides*) was obtained from a local market in Benin City, Nigeria. Grains were hand selected for approximately equal size. The seeds were surface sterilized with 1% sodium hypochlorite solution for 10 min at room temperature and steeped in sterile distilled water for 12 h. The hydrated grains were subsequently transferred to sterile Petri dishes lined with two circles of sterile 9-cm Whatman's No. 1 filter paper, containing 2 mL of sterilized distilled water (Aisien and Ghosh, 1978). Germination was in the dark at 25 °C for 84 h. Germinated grains were kilned at 45 °C and then ground to pass a 20-mesh screen.

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Table I. Proximate Analysis of Millet Grain and Its Malt[a]

	grain	malt[b]	soaking medium[c]
moisture, %	10.2	4.3	98.7
protein, %	8.6	11.8	t
lipid, %	7.5	2.5	nd
ash, %	4.1	3.2	0.07
lignin, %	1.3	4.4	nd
fiber, %	10.4	18.6	nd
carbohydrate, %	53.9	48.5	t

[a] Analyses were made in duplicate, and results are expressed on a dry weight basis. [b] Results are absolute yields. [c] t, trace amounts (less than 0.02%); nd, not detected.

Proximate Analysis. The moisture content was determined by drying the samples at 130 °C to constant weight (AOAC, 1975). Ash was determined by weighing the residue of charred (570 °C for 6 h) sample. The micro-Kjeldahl method was used to determine nitrogen (AOAC, 1975). Crude protein was calculated by multiplying % *N* by 6.25. Fat was extracted with petroleum ether. Lignin was determined by the method of Kornshchikov (1968). Carbohydrate content was determined as starch by the method of Hassid and Neufeld (1964).

Estimation of Vitamins. Riboflavin and niacin were assayed by the chemical methods recommended by the American Association of Cereal Chemists (1962). Thiamin determination was by the chemical assay method involving

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Table II. Tannins, Total Phenols, Oxalate, Phytic Acid, and Calcium Levels in Millet Grain and Malt[a]

	grain	malt[b]
tannin, %	1.6	0.83
total phenol, %	0.325	0.485
total oxalate, %	0.619	0.433
soluble oxalate, %	0.502	0.068
phytic acid, %	0.264	0.045
total calcium, mg/100 g	20.4	16.8
soluble calcium, mg/100 g	2.4	14.12

[a] Analyses were made in duplicate, and results are expressed on a dry weight basis. [b] Results are absolute yields.

alkaline oxidation of thiamin to thiochrome (Association of Vitamin Chemists, 1951). Ascorbic acid was determined by the 2,4-dinitrophenylhydrazine procedure (Gyorgy and Pearson, 1967). Vitamin A and carotenes were determined by the method described by the Association of Vitamin Chemists (1951).

Determination of Phytate, Oxalate, and Phenolic Compounds. Phytic acid was determined by the method of McCance and Widdowson (1935). The method of Munro and Bassir (1969) was used to determine oxalate and calcium. Tannins were extracted with 1% HCl in methanol and estimated colorimetrically (Burns, 1971). Tannins were expressed as catechin equivalents. Total phenol was determined as chlorogenic acid (Swain and Hillis, 1959).

RESULTS AND DISCUSSION

Microbiological tests on plate cultures using sabourand's agar showed no fungal or other contaminants at different stages of germination.

The proximate composition of the grains and malt of millet is summarized in Table I. The decrease in moisture content was the result of the kilning of germinated grains. The lipid content in the malt was found to be relatively lower than that in the grains, while there was an increase in the protein content of the malt. The observed increase in lignin and fiber content of malt was probably due to the fact that a large fraction of lipid reserve and some carbohydrates present in the grain were used during germination, so that there was more lignin in the malt than the grains. This apparent increase in lignin possibly contributed to the rise in total phenols (Table II).

Like barley (Piendl and Voss, 1979), niacin was found to be the major vitamin of millet grains and malt (Table III). The level of this vitamin showed a one-third decrease in the malt. Other vitamins increased on malting to levels high enough to meet (from 100 g of malt) the potential daily requirement of man (National Academy of Sciences, 1973).

Tannins and phenolic constituents of millet have been reported to adversely affect the availability of protein in the diet (Ramachandra et al., 1977). The levels of tannins decreased in millet on malting (Table II).

The marked decrease in oxalate (Table II) indicates that germinating millet grains actively metabolizes oxalate (Giovanelli and Tobin, 1964). The water-soluble oxalate is believed to constitute the major toxic fraction (Eka, 1977). If this is the case, then toxicity due to oxalate in millet malt is likely to be very low indeed since the level of water-soluble oxalate is negligible. The decrease in phytic acid level of millet malt contributes to making millet malt a good source of nutrients.

Table III. Some Vitamins of Millet Grain and Its Malt[a]

	grain	malt[b]	soaking medium[c]
riboflavin, IU/100 g	0.187	0.498	0.002
thiamin, mg/100 g	0.053	0.203	0.005
ascorbic acid, mg/100 g	0.413	7.2	0.01
vitamin A, IU/100 g	3.0	7.0	nd
carotene, IU/100 g	1.5	13.3	t
tocopherol, IU/100 g	1.912	9.64	t
niacin, IU/100 g	36.2	24.7	1.73

[a] Analyses were made in duplicate, and results are expressed on a dry weight basis. [b] Results are absolute yields. [c] t, trace amounts (less than 0.002 unit/100 g); nd, not detected.

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