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Natural Protein Fortification of Cassava (*Manihot esculenta*, Crantz) Products (Flour & Gari) using Baker's Yeast Solid Media Fermentation

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In an attempt to enhance the nutritional quality of cassava products (flour & gari), Baker's yeast was used in the fermentation (solid media) of cassava pulp. The mash obtained was subsequently processed into flour and gari (the forms in which cassava products are popularly consumed in Nigeria) and analyzed. The protein (flour, 10.90%; gari, 6.30%) and fat (flour, 4.50%; gari, 3.00%) contents of the products were high. Conversely, the tannin (flour, 0.2%; gari, 0.1%) and cyanide (flour, 9.5mg / kg; gari, 9.1mg / kg) contents were low, though, the cassava flour had higher protein, fat, tannin and cyanide contents than gari. The results indicated that Baker's yeast, a cheap and non-pathogenic saprophyte, could be used in enhancing the nutritional potentials of cassava products by increasing nutrients (protein and fat) and decreasing antinutrient contents (tannin and cyanide). However, nutrient increase was higher in cassava flour while the antinutrient decrease was higher in gari.

Key words: Baker's yeast, Protein, Fat, Tannin, Cyanide, Cassava products.

Introduction

Cassava is often considered an inferior food because the tuber is low in protein, essential minerals and vitamins (Onwueme 1978; Aletor 1993). However, in many cassava-growing areas, its use as food helps to alleviate problems of hunger and thus, its importance in terms of food security in these areas cannot be over emphasized (Aletor 1993). The processes for upgrading the protein value of cassava using solid substrate fermentation have been developed in some countries such as Canada where *Aspergillus fumigatus* has been used (Read and Gregory 1975) and Burundi (Vlavonou 1988) and Nigeria (Akindahunsi *et al* 1999a) where *Rhizopus oryzae* was used in enriching cassava product with protein. This study is a continuation of our study on nutrient enrichment and detoxification of cassava products using cheap, non-pathogenic and saprophytic fungus, *Saccharomyces cerevisae.*

Materials and Methods

Cassava tubers were collected from the Research farm of the Federal University of Technology, Akure, Nigeria. The chemicals used, sodium hydroxide, sulphuric acid, potassium dihydrogen phosphate, citric acid and magnesium sulphate pentahydrate were the products of Eagle Scientific Limited, Nottingham, England, while the urea, tannic acid, ferric chloride and ammonium thiocyanate and petroleum ether (40-60°C) were the products of BDH Chemicals Limited, Poole, England. In addition, glass distilled water was also used.

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Cassava tubers were peeled, crushed, and pressed using hydraulic press. The pressed pulp was later subjected to fermentation (Vlavonou 1988). Pure strain of Baker's yeast was sub-cultured and inoculated (1:100) into 1kg of the mash (cassava pulp) as the starter culture and 730ml nutrient solution containing urea (80g), $MgSO_4$. $2H_2O$ (7g), KH_2PO_4 (13g) and citric acid (20g) and then allowed to ferment for 3 days. The product obtained was subsequently, processed into flour and gari. The gari was produced by pressing the fermented pulp by using a locally fabricated mechanical press and then fried in a hot metal dish to gari (Adewusi *et al* 1999).

*Sample analysis.*The proximate composition (ash, fat, crude fibre and carbohydrate) of the micro-fungi fermented cassava products was evaluated using the standard AOAC (1984) method and the protein content was determined using the Micro-Kjeldhal method (N x 6.25). The tannin content was determined using Makkar *et al* method (1993) while the cyanide content was determined using the method of De Bruijn (197I). The Na, Zn, Ca, Mg, K and Fe contents were determined on aliquots of the solutions of the ash by established Flame Atomic Absorption Spectrophotometric procedures using a Perkin-Elmer Atomic Absorption Spectrophotometer (Model 372) (Perkin-Elmer 1982).

Analysis of data. The data were analysed by students t-test (Zar 1984).

Results and Discussion

The results of the proximate analysis revealed that the protein contents of the Baker's yeast fermented cassava products were high (flour 10.90 ± 0.1; gari 6.30 ± 0.2). This unusual high protein content could be attributed to the ability of the Baker's yeast to secrete some extracellular enzymes (protein) into the cassava mash during their metabolic activities on the cassava mash and fermentation of the cassava by the fungi. The multiplication of the fungi in the cassava in the form of single cell proteins could also provide explanation for the increase in the protein content of fermented cassava products (Akindahunsi *et al* 1999a; Okafor 1998). However, the protein content of the flour is significantly (P > 0.05) higher than that of the gari. This could be attributed to the method of preparation of each of the products. During the processing of gari which entails pressing, sieving and frying of the fermented cassava, some of the protein may have leached off while pressing and burnt off while frying (Akindahunsi *etal* 1999a). It is documented that pre-processing, processing and post-processing methods of preparation of cassava products determine the quality of the products (Akindahunsi *et al* 1999a). The protein content of the product as shown in Table 1, compared favourably with the protein content of *Rhizopus oryzae* fermented cassava products (Akindahunsi *et al* 1999a).

The reason for the unusual high fat content of the cassava products could not be categorically stated. However, there could be possible transformation of carbohydrate to fat (Lehninger 1987) while Akindumila and Glatz (1998) reported that certain fungi can produce microbial oil during the course of fermentation. The decrease in carbohydrate could be attributed to the possible transformation of some of the carbohydrate which the organism possibly use as its carbon source to some other metabolites such as protein or fat (Lehninger 1987).

The mineral contents (Zn, Mg, Fe, Ca, Na and K) of the Baker's yeast fermented cassava products (Table 2) were considerably low when compared to other food crops such as fruit, mushroom, yam tubers and vegetables (Akindahunsi and Oboh 1998, 1999b; Ola and Oboh 2001). However, the gari had a significantly higher (P > 0.05) Fe, Mg, Ca and Na contents than the cassava flour. This could be the result of the fact, that some of the metals in the frying pan used may have leached into gari (Akindahunsi *et al* 1999a).

Table 1
Proximate composition* of Baker's yeast fermented cassava products (flour and gari)

Sample	Flour	Gari
Protein	10.90 ± 0.1	6.30 ± 0.2
Fat	4.50 ± 0.2	3.00 ± 0.2
Crude fibre	3.20 ± 0.1	4.30 ± 0.4
Carbohydrate	77.90 ± 0.3	84.50 ± 0.3
Ash	3.50 ± 0.1	1.90 ± 0.0

*Values refer to mean ±SD (dry weight) of three replicates.

Table 2
Mineral composition* of Baker's yeast fermented cassava products (gari and flour)

Sample	Flour	Gari
Zn	4.90 ± 0.2	4.8 ± 0.1
Mg	32.40 ± 0.2	34.1 ± 0.3
Fe	2.20 ± 0.1	2.8 ± 0.1
Ca	11.00 ± 0.1	13.8 ± 0.1
Na	29.60 ± 0.2	30.8 ± 0.1
K	38.40 ± 0.3	36.9 ± 0.1

*Values refer to mean ± SD (dry weight) of three replicates.

Table 3
Tannin (%) and cyanide (mg / kg) contents* of Baker's yeast fermented cassava products (gari and flour)

Sample	Flour	Gari
Cyanide	9.5 ± 0.2	9.1 ± 0.2
Tannin	0.2 ± 0.0	0.1 ± 0.0

*Values refer to mean ± SD (dry weight) of three replicates.

The levels of antinutrients (cyanide and tannin) are shown in Table 3. Tannins affect nutritive value of food products by forming a complex with protein (both substrate and enzyme) thereby inhibiting digestion and absorption. They also bind Fe, making it unavailable and recent evidence suggests that condensed tannins may cleave DNA in the presence of copper ions. It also imparts a dull colour to the processed products, which affects their market value. The tannin contents of the Baker's yeast fermented cassava products flour (0.2 ± 0.0), gari (0.1± 0.0) were very low when compared with the usual tannin content of cassava products (0.4 - 0.5%) (Hahn 1992). It is worth noting that the tannin content of the flour was significantly (P > 0.05) higher than that of the gari, which indicates that the processes of garrification could also decrease the tannin content of cassava products. The tannin levels compared favourably with the 0.2% tannin content reported by Akindahunsi *et al* (1999a) for *Rhizopus oryzae* fermented cassava products. The products could also be considered to be safe with regard to tannin poisoning since the levels reported in this study are far below the critical value of 0.7- 0.9% (Aletor 1993).

The levels of the residual cyanide present in both the cassava flour (9.5 ± 0.2) and gari (9.1 ± 0.2) were very low when compared with the usual cyanide content of cassava products in Nigeria (gari, 19.0mg / kg; fufu, 25mg / kg) and the cyanide content of *Rhizopus oryzae* fermented cassava products (flour, 17.2mg / kg; gari, 13.5mg / kg). This shows that Baker's yeast is capable of utilizing cyanogenic glucosides and the breakdown of the products and explains why it is one of the natural flora involved in cassava fermentation during gari processing (Oke 1968; Akindahunsi *et al* 1999a). The cyanide levels are far below the detrimental level of 30 mg / kg (Akinrele *et al* 1962). These products could therefore be considered safe with regard to cyanide poisoning. Thus from this study, it could be concluded that Baker's yeast, a cheap, non-pathogenic and saprophyte anaerobe, would efficiently increase the protein content of cassava products and reduce the level of tannin and cyanide.

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