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CHANGES IN NUTRIENT AND ANTINUTRIENT CONTENTS OF SWEET POTATO (*Ipomea batatas*) PEELS SUBJECTED TO SOLID SUBSTRATE FERMENTATION

A. O. Ojokoh

Department of Microbiology, Federal University of Technology, Akure (Nigeria)

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ABSTRACT

Sweet potato (*Ipomea batatas*) peels was fermented using traditional and controlled fermentation by solid substrate fermentation method.The following isolates were isolated from the fermentation, *Staphylococcus epidermidis*, *Lactobacillus* sp., *Aerobacter aerogenes*, *A. cloacae, Micrococcus luteus, Aspergillus niger, A. flavus, Saccharomyces cerevisiae, Rhizopus stolonifer* and *Fusarium* sp. The result of the proximate analysis revealed that there was an increase in protein content of the fermented peels with *A.niger* fermented sample having the highest protein content (11.93%) compared to the unfermented sample (3.92%). There was increase in fat and ash contents and decrease in carbohydrate fibre and mineral contents of the fermented samples. *A.niger* fermented sample had the lowest phytate content while *S. cerevisiae* fermented sample had the least tannin content when compared to the unfermented.The changes in pH was uniform while the changes in total titratable acidity was not uniform.

Keywords: Nutrient, isolates, *Ipomea batatas (*Sweet potato) and fermentation.

INTRODUCTION

Sweet potato (*Ipomea batatas*) is one of the world's most widely grown and valuable staple crops and farmers in more than 100 countries in tropical, subtropical and warm temperature areas rely on it for its ability to produce high yield on marginal land with little investment (Hortan *et al.,* 1989). It has been estimated that over six million tones of sweet potato was produced in Africa or about 5% of the total for developing countries of the world (FAO, 1989). One of the greatest advantages of root and tuber crops, particularly in areas where land is scarce, is their productivity per unit area and time. Sweet potato, a short seasoned, fast growing crop, top the list in terms of potential dry matter and edible energy per day. Although not normally considered as a source of protein the crop compare very well with the alternatives in terms of edible protein per day.

Sweet potato tubers contain free sugar as well as starch, which give them a readily digestible form being converted to maltose during cooking. The tuber is rich in carotene particularly the yellow varieties, minerals and B complex vitamins (19mg/100g).

Solid substrate fermentation is a process by which the substrate is fermented with sufficient amount of moisture but without the presence of excess of free water. Solid-state fermentation has focused on the production of feed, hydrolytic enzymes, organic acid, gibberellins, flavours and biopesticides.

For the last 15 years the Orstom group has been working on solid substrate fermentation process for improving the protein content of starchy substrates using fungi especially *Aspergillus* group in order to transform starch and mineral salt into fungi protein. The peels of sweet potato are regarded as waste and usually discarded and allowed to rot. Since these peels could make up to 10% of the tuber, they constitute an important potential resource if properly harnessed by biosystem.

The use of microbial protein enriched foods for animal will increase their productivity and this in turn will make meat and its product more available and cheaper. The effect of fermentation on the nutrient and antinutrient content of sweet potato peels is reported in this study.

MATERIAL AND METHODS

Material

Sweet potato tubers used were obtained from Oja Oba market in Akure

Sample preparation

The tubers were peeled and the peels washed properly. A 400g of the peel was placed in a container with a cover and allowed to ferment for 72 hours at room temperature. Controlled fermentation was also carried out using pure strains of *Aspergillus niger, Saccharomyces cereviseae* and *Rhizopus stolonifer* isolated from the traditional fermentation. A 400g portion of sample was inoculated with 30ml of each isolate separately.

Microbial Analysis

The method according to Akinrelee, (1990) was used based on plate dilution technique. Oxoid nutrient agar and potato dextrose agar were used for the isolation of bacteria and fungi. Aliquots of the sample and nutrient were mixed and poured aseptically into sterile Petri dishes for incubation at 30°C for bacteria and 25°C for fungi. The number of colonies appeared in each plate was counted after 48h of incubation and classified by microscopic examination of colony morphology after separation and growth on slants.

Physiochemical Changes

The pH of the sample was measured each day with a Cambridge direct reading pH meter. Total titratable acidity (TTA) was determined on 5ml aliquot of the sample against 0.01N NaOH using phenol red as indicator.

Chemical analysis

Proximate analysis of the sample was performed according to AOAC (1990) procedures for ash, crude fibre, fat, moisture and protein using a nitrogen to protein conversion factor of 6.25. Carbohydrate was determined by difference.

Mineral analysis

The nutritionally essential elements Na, Ca, Mg, K, Fe and Zn were determined using atomic absorption spectrophotometer ASS.

Antinutrient analysis

The tannin content were analyzed by the methods of Makker *et al.,* (1993), while the phytate content was determined using Wheeler and Ferrel (1974) method.

Results

Microbial isolates from the fermented sweet potato peels consisted bacteria *(Staphylococcus epidermidis, Lactobacillus* sp., *Aerobacter aerogenes, Aerobacter cloacae and Micrococcus luteus)* and fungi *(Aerobacter niger, Aerobacter flavus, Saccharomyces cerevisiae, Fusarium* and *Rhizopus stolonifer.*

Data on the pH values of the samples showed that the pH decreased through out the fermentation (Table -1).

Table -1: Changes in pH during fermentation of sweet potato peel at different intervals of fermentation

Samples	Qhr	12hrs	24hrs	36hrs	48hrs	60hrs	72hrs
Naturally fermented	6.37	5.19	4.30	4.49	3.65	3.92	3.50
Aspergillus niger	5.00	4.20	3.92	3.66	3.20	2.67	2.65
Scerreriae	5.20	4.90	4.37	4.16	4.00	3.65	3.15
Rhizopus stolonifer	6.60	5.00	4.90	4.32	4.10	3.45	3.20

Table - 2: Changes in total titrable acidity during sweet potato peel fermentation at different intervals

Samples	Hours of fermentation						
	Qhrs	12	24	36	48	60	72
Naturally fermented	0.036	0.068	0.18	0.38	0.50	0.36	0.32
Aspergillus niger	0.037	0.80	0.56	0.89	0.76	0.78	0.72
S. cerevisiae	0.78	0.52	0.43	0.76	0.65	0.70	0.76
Rhizopus slolonifer	0.75	0.57	0.58	0.57	0.77	0.77	0.77

Table - 3: Proximate composition of the various samples of sweet potato peels %

Samples	Ash	Moisture	Protein	Fat	Fibre	Carbohydrate
Unfermented	5.06	9.31	3.92	3.27	16.86	63.58
Naturally fermented	7.25	9.96	4.93	2.20	14.39	59.28
Rhizopus stolonifer	10.27	5.10	8.87	6.89	6.45	60.12
Aspergillus niger	7.29	5.97	11.93	9.17	8.26	59.67
Saccharomyces cerevisiae	6.95	7.13	9.87	8.53	9.25	58.27

Table - 4: Mineral composition of the various samples of sweet potato peels (Reading in ppm)

Sample	Ca	Na	K	Mn	Fe
Unfermented	284.35	283.58	347.82	6.10	25.99
Naturally fermented	333.10	391.60	312.82	5.37	28.47
Rhizopus stolonifer	180.75	233.38	276.58	3.15	19.42
Aspergillus niger	199.47	232.88	254.45	1.56	12.74
Saccharomyces cerevisiae	201.64	233.56	176.32	2.10	11.99

The changes in TTA did not follow the usual trend of increasing in all samples (Table -2). The proximate analysis (Table -3) showed that the sample fermented with *A. niger* had the highest of protein and fat content compared to other samples there was a decrease in the fibre and carbohydrate contents in all the samples. There was no considerable change in the ash and mineral contents (Table -4).

Table -5 shows the phytate and tannin contents of the fermented samples. They were lower that of the unfermented sample.

Table - 5: Anti-nutritional composition of the various samples of sweet potato Peels

Sample	Phytate mg/100g	Tannin mg/100g
Unfermented	3046.19	300
Naturally fermented	1805.15	245
Rhizopus stolonifer	2087.21	270
Aspergillus niger	1297.45	260
Saccharomyces cerevisiae	1635.92	215

Discussion

The result of the proximate composition of the fermented sweet potato peels shown in Table -3 indicated that there was an increase in the protein and fat contents of the peels.

The increase was highest in peels fermented with *A. niger* (11.93% and 9.17%). The increase in protein in the *A. niger* fermented sample could be attributed to the great enzymatic activities of this fungus. Kuo *et al.,* (1985) reported that protein increase could result from slight protein synthesis by the proliferation of the microorganisms used and a synthesis of enzyme proteins or from a rearrangement of the composition following the degradation of other constituents. The increase in fat may be due to the fact that the microorganisms, which fermented the peels, may have produced microbial oils during the course of fermentation, which consequently increases the fats content (Kao and Robinson, 1978). Weete and Ghandi (1992) stated that *A. niger* can increase the fats content of a sample despite not being an oleaginous fungus the decrease in the carbohydrate and fibre contents could be attributed to their utilization by fermenting organisms as energy source (Dike, 2001).

Results of the mineral analysis showed decrease in the mineral contents except in a few

cases. Raimbault (1998) reported that during fermentation fungi utilize mineral salts for metabolic activities. The changes and pH and TTA could be attributed to the production of organic acids from available nutrients by fermenting microorganisms (Okafor, 1978). There was a decrease in phytate and tannin content in the fermented samples than that of the unfermented. *A. niger* was more efficient in phytate reduction than other isolates used. The decrease may be due to the presence of hydrolytic enzymes (phytase) in microorganisms (especially in fungus like *A. niger*) involved in the fermentation (Wang, 1985). *S. cerevisiae* fermented sample had the lowest tannis content. The decrease could be attributed to the activities of microbial enzymes coupled with the fermentation process.

This result agrees with earlier report by Ojokoh *et al.* (2001) that *Saccharomyces cerevisiae* was capable of reducing the levels of tannin in calyx.

It was therefore concluded that *A. niger* could increase the protein and fat contents and reduce the phytate content, while *Saccharomyces cerevisiae* could reduce the tannin content of sweet potato peels making the fungi good solid substrate fermentation for enhancing the nutrient content of sweet potato peels for livestock feed.

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