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Physiochemical Properties and Antinutrient Content of Fermented Popcorn and Groundnut Composite Flours Using Pure Strains.

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Abstract

Popcorn and groundnut composite flours were fermented using pure strains of *Rhizopus nigricans* and *Saccharomyces cerevisiae* by solid substrate fermentation method. There was decrease in pH with increase in total titrable acidity in all the samples. The result of the proximate analysis revealed that there was an increase in protein content in the fermented sample with10.0g groundnut flour + 10.0g popcorn flour having the highest protein content (27.89%) compared to the unfermented samples (7.49 and 24.69%) respectively. There was increase in fat and crude fibre contents and decrease in carbohydrate and ash contents of the fermented samples. The effect of fermentation on the antinutritional content showed that there was a decrease in the content of phytic acid,oxalate and tannin.

Keywords: Popcorn flour, groundnut flour, fermentation, physiochemical properties and antinutrient

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Introduction

Popcorn *Zea mays averta* is an *extreme* form of flint corn with a higher percentage of hard starch (75.0%) with 7.5% protein and low in fat (1.0%). It *is* similar to other corn species with the kernel consisting of three major structural parts: pericarp, germ and endosperm. Depending on the popcorn variety, the pericarp can be thick or thin. The pericarp is a tough protective layer surrounding the kernel and participates in the popping action. It serves as a pressure vessel enclosing and containing the endosperm. It is also an important factor in popcorn quality. The germ contributes the least to popping phenomenon. Popping does not alter the germ chemically or physically (Paliwal, 2000b).

The botanical name for groundnut, *Arachis hypogaea* Linn, was derived from two Greek words, Arachis meaning a legume and hypogaea meaning below ground, referring to the formation of pods in the soils. Groundnut is an upright or prostrate annual plant. It is generally distributed in the tropical, sub-tropical and warm temperate Zones. Ethnological studies of the major Indian tribes of South America documented the widespread culture of groundnut and provided indirect evidence for the domestication long before the Spanish conquest. When the Spaniards returned to Europe they took groundnut with them. Later traders were responsible for spreading the groundnut to Asia and Africa were it is now grown between the latitudes 40^0N and 40^oS (Pattee and Young, 1982).

There are a number of roles that microorganisms can play in food processing, either positive or negative. The positive effects are generally regarded as part of the fermentation processing namely product preservation; flavour development and reduction of antinutrient while the negative effects include spoilage of food products and contamination by pathogenic microorganisms.

Since popcorn and groundnut are popular as a snack food in the Western part of Nigeria the present investigation was carried out to study changes in the physiochemical properties and antinutrient content of popcorn and groundnut composite flours when subjected to solid substrate fermentation using pure isolates.

Materials and Methods

Collection of Samples: The popcorn and groundnut samples used in this study were obtained from Igbona market Osogbo, Osun State.

Fermentation of Popcorn and Groundnut Composite Flour: The popcorn grains and groundnut seeds were thoroughly cleaned and screened to remove broken and cracked grains or seeds and other foreign materials before grounding into flour with a hammer mill. The popcorn flour and groundnut flour were weighted and mixed in different proportion as follows: 12.5g groundnut flour + 7.5g popcorn flour; 10.0g groundnut flour + 10.0g popcorn flour; 7.5g ground nut flour + 12.5g popcorn flour.

A 40ml of sterile water was added to each sample in a conical flask to form damp composite. The mouth of each conical flask was plug with cotton wool and covered with aluminum foil. They were sterilized in an autoclave at 121^0C for 15 minutes and allowed to cool down.

Sterile wire loop was used to pick colonies of *Sacchromyces cerevisiae* and transfered into sterile water in a test tube. Sterile inoculating pin was used to pick spores of the *Rhizopus nigricans* and also used to inoculate sterile water in test tube. The mixture was mixed gently. Sterile needle and syringe were used to draw 5ml from the inoculated water and each composite sample was inoculated with 1ml of the sterile water seeded with *Sacchromyces cerevisae* and *Rhizopus nigricans*. The composite samples were allowed to ferment at room temperature for 72 hours

Physiochemical Changes: A mixture of 10 g sample and 90 ml distilled water was used for pH determination as described by Mensah et al. (1995). Total titratable acidity was determined by titrating 20 mL of the same sample against 0.1 M Sodium hydroxide (Antony and Chandra, 1997).

Chemical Analysis: The moisture, fibre, protein (N X 6.25), fat and ash contents of the samples (fermented and unfermented) were determined using relevant methods described previously (AOAC 1995). Phytate and tannin (hydrolysable form) were determined using AOAC (1995) methods while oxalate content was by the titrimetric method (AOAC, 1995).

Elemental Analysis: The solution of ash dissolved in a drop of trioxoni-trate (V)acid made up to 50ml with deionized water was analysed for Ca and Mg using the atomic absorption spectrophotometer, Na and K using a flamephotometer, and P using UV-Visible spectrophotometer after making ammonium vanadate molybdate complex at 436 nm using established procedures of Perkin-Elmer (1982).

Statistical Analysis: Data were analyzed by one-way analysis of variance (ANOVA) using SPSS version 11.5 (SPSS, Chicago IL., UAS). Differences among the means were tested using Ducan's multiple –range tests. Values of $P<0.05$ were considered significant.

Results and Discussion

The changes in pH and total titratable acidity of all the samples during the 72 hrs of fermentation are shown in Tables 1 and 2 . Fermentation lowered the pH of all the samples showing that acidification increased with increasing period of fermentation due to increased production of TTA. Matthew *et al*. (1995) reported that the increasing acidity during cassava fermentation was a result of the activities of microorganisms which convert the carbohydrates into organic acids.

The proximate composition (%) of the samples is shown in Table3. The fermented sample with 7.5g groundnut flour and 12.5g popcorn flour (sample B) recorded the highest value of (27.89 $\pm$ 0.06)%. The highest increase in protein may be due to the activities of the microbial strains which might have secreted some extra cellular enzymes (proteins) (Ojokoh, 2005b) The decrease in the protein content of sample A (12.5g groundnut flour + 7.5g popcorn flour) and sample C (10g groundnut flour + 10g popcorn flour) compared to 24.69$\pm$0.05% in the unfermented groundnut sample is similar to the work of Oladele and Oshodi (2008) who recorded decrease value for fermented Jatropha cathatica and Jatropha curcas. The decrease in crude protein in samples A and C may be due to the activities of microorganisms which might have lead to breakdown of spine amino acid with liberation of ammonia (Oladele and Oshodi, 2008). Increase in crude fat values was observed for the fermented samples compared to the unfermented sample. The increase in fat may be due to the fact that the microorganisms which fermented the samples may have produced microbial oils during the course of fermentation which consequently increased the fat content (Ojokoh, 2005a). The decrease in ash content in all fermented samples may be due to the fact that some minerals which are part of some biological macromolecules were released into the solution from such structures (Yagoub and Abdalla, 2007)

The crude fibre values surprisingly increased for the fermented samples. The fermentation process involves the conversion of materials to the peculiar needs of microorganism which include the bacterial cell wall. As the microorganisms were not separated from the biomass, the increase in fibre could be due to such conversion of materials to peptidoglycan by the microorganisms (Eze and Ibe 2005).

Table 1: Changes in pH during fermentation of the samples

Sample	0hr	72hrs
A	6.5	4.8
B	6.2	5.0
C	6.8	5.6

Key:
Sample A 12.5g groundnut flour + 7.5g popcorn flour; Sample B 7.5g groundnut flour + 12.5g popcorn flour; Sample C 10.0g groundnut flour + 10.0g popcorn flour

Table 2: Changes in titratable acidity (g/ml) during fermentation of the samples

Sample	0hr	72hrs
A	1.1	3.2
B	1.5	3.8
C	1.3	4.1

Key:
Sample A 12.5g groundnut flour + 7.5g popcorn flour; Sample B 7.5g groundnut flour + 12.5g popcorn flour; Sample C 10.0g groundnut flour + 10.0g popcorn flour

Table 3: Proximate Composition of the Samples (%)

Parameter	Groundnut flour unfermented	Popcorn flour unfermented	Popcorn and groundnut flours fermented		
			A	B	C
Moisture	4.49±0.01	10.72±0.05	4.71±0.01	9.68±0.05	2.35±0.01
Crude Protein	24.69±0.05	7.49±0.02	19.96±0.05	27.89±0.06	13.77±0.05
Crude fat	5.50±0.01	1.01±0.01	20.60±0.20	24.67±0.10	25.76±0.06
Ash	4.54±0.04	0.75±0.01	1.88±0.02	0.34±0.02	3.69±0.03
Crude fibre	4.21±0.01	1.32±0.01	11.19±0.05	14.87±0.02	12.85±0.05
Nitrogen free Extractive	61.06±0.20	74.06±0.50	41.91±0.20	22.55±0.05	41.58±0.05
Energy (kcal/100g)	437.20	348.50	477.10	483.50	489.50

Key: Sample A 12.5g groundnut flour + 7.5g popcorn flour; Sample B 7.5g groundnut flour + 12.5g popcorn flour; Sample C 10.0g groundnut flour + 10.0g popcorn flour

Carbohydrate content also decreased on fermentation. This is obviously due to the fact that they were used up as the sources of energy during fermentation.

The reduction in the anti-nutrients content in fermented samples (Table 4) compared to the unfermented samples could be as a result of microbial activities. This result agrees with earlier report by Ojokoh (2005a) that *Saccharomyces cerevisiae* was capable of reducing the levels of antinutrinutrients in calyx. The result of the mineral analysis (Table 5) showed that fermentation increased the content of some vital elements such as Sodium, Potassium and Phosphorus. This observed increase in mineral composition may be due to the contribution from fermentation microorganisms. Raimbault (1998) reported that during fermentation fungi utilize mineral salts for metabolic activities. It was therefore concluded that fermentation of popcorn and groundnut composite flours could increase the protein and mineral contents and reduce the antinutrients making the sample a good substrate for solid state fermentation for the enhancement of the nutritional benefit for man and livestock.

Table 4: Antinutrients composition of the samples

Parameter	Groundnut flour unfermented	Popcorn flour unfermented	Popcorn and groundnut flours fermented		
			A	B	C
Phytic acid(mg/100g)	1.35±0.05	1.25±0.02	0.58±0.02	0.82±0.02	1.15±0.05
Oxalate(%)	2.94±0.02	2.70±0.05	2.16±0.01	2.17±0.01	2.52±0.02
Tannin (%)	2.50±0.02	2.58±0.01	1.95±0.01	0.95±0.02	2.44±0.04

Key: Sample A 12.5g groundnut flour + 7.5g popcorn flour; Sample B 7.5g groundnut flour + 12.5g popcorn flour; Sample C 10.0g groundnut flour + 10.0g popcorn flour

Table 5: Mineral composition of the samples (ppm)

Parameter	Groundnut flour unfermented	Popcorn flour unfermented	Popcorn and groundnut flours fermented		
			A	B	C
Na	189.20±0.01	103.89±0.05	350.00±0.05	660.00±0.20	250.00±0.50
K	152.00±0.02	112.01±0.01	317.00±0.20	384.00±0.50	546.00±0.06
Mg	101.20±0.02	89.13±0.03	34.00±0.50	39.00±0.10	36.00±0.02
Ca	75.10±0.10	60.00±0.05	23.00±0.01	23.00±0.01	22.00±0.03
P	380.00±0.50	300.00±0.50	308.00±0.05	380.00±0.25	350.00±0.10

Key:
Sample A 12.5g groundnut flour + 7.5g popcorn flour; Sample B 7.5g groundnut flour + 12.5g popcorn flour; Sample C 10.0g groundnut flour + 10.0g popcorn flour

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