Current Research in Nutrition and Food Science Vol. **2**(2), 106-110 (2014)

Proximate Composition, Antinutrient Content and Functional Properties of Soursop Flour as Influenced by Oven and Freeze Drying Methods

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http://dx.doi.org/10.12944/CRNFSJ.2.2.08

(Received: August 12, 2014; Accepted: August 26, 2014)

ABSTRACT

The effect of Oven and freeze drying methods on the proximate composition, anti-nutrient and selected physical attributes of soursop flours were determined using standard methods. The fruit pulp was frozen at -30 and freeze dried at -40 for 72hrs while oven drying was performed at 70 for 48hrs. Oven drying significantly ($p \leq 0.05$) lowered the fat (7.30±0.23%), moisture (12.40±0.29%) and carbohydrate (40.70±0.12%) content of soursop flour while freeze drying significantly ($p \leq 0.05$) lowered the protein (18.72±0.10%), fibre (12.30±0.23%), ash (6.30±0.17%) and energy (212.704±0.10%) content of the flour. The oven dried flour had higher phytate (0.03±0.10%) and oxalate (0.03±0.00%) content while the freeze dried flour had higher tannin (0.52±0.00%) content. The physical attributes of the flours however revealed that the freeze dried flour significantly ($p \leq 0.05$) had higher values for viscosity (32.50±0.29%), water absorption capacity (57.30±0.17%), swelling index (50.10±0.06%), solubility (22.30±0.17%), oil absorption capacity (24.60±0.23%) and emulsion capacity (24.60±0.23%) while the oven dried flour had higher values for bulk density (421.20±0.12%) and foam capacity (25.30±0.17%). Freeze dried soursop flour had better physical attributes, lower nutrient and anti-nutrient content.

Key words: Anti-nutrients, Soursop, Physical attributes, Proximate composition, Freeze drying.

INTRODUCTION

Soursop (*Annona muricata*) belongs to the family *Annonaceae* which has several fruit bearing species amongst which are the custard and sugar apple, however, soursop is the best known and has the most delectable flavour. Soursop fruit is an oval or irregular shaped fruit, 15-30 cm long, with sparse soft green curved spines, white cotton like mesocarp that has a stringy and sour taste, containing shiny black seeds, pleasing flavour and aroma[1]. Soursop fruit consists of 67.5% pulp, 20% skin, 8.5% seeds and 4% core pits. The nutrient composition of the fruit showed that 81.9-93.6% is carbohydrate (glucose and fructose), 278mg potassium, 27mg phosphorus, 14mg calcium, 3.3g fibre and 0.3g/100g fat. The fruit contains moisture 81.5%, fat 0.87%, protein 1.0%, ash 0.80%, carbohydrate 16.83%[1]. *Annona* fruits are relatively poor sources of proteins and vitamins. Their high mineral content makes them ideal dietary sources of electrolytes while their high fibre content make them ideal food that could be harnessed in the control of cholesterol absorption hence protect against coronary heart disease risks. The high fibre content could also be harnessed in the control of blood glucose levels in normal and diabetic individuals thereby protecting man against excessive weight gain and obesity and its associated diseases. Its low sodium content makes it ideal food material for prevention and management of hypertension. The consumption of 100g of the fresh fruit has been reported to provide 13% of dietary fibre requirement of man per day. Soursop is the most versatile *annona* fruit for industrial purpose because it does not oxidize easily and there is a large recovery of pulp from the fruit during processing[2].

Soursop fruits are generally consumed as fresh fruits (as salads and desserts) but are also widely used in semi-processed and processed products such as candies, custard, ice cream, sherbets, jelly, tarts, syrup and nectar. The fresh fruit does not travel well, therefore the need to process it into a form that preserves the nutrients to the greatest extent and improves shelf life[2]. This however, can be overcome by dehydration of the fruits to improve shelf-life, nutrient content, distribution and packaging. Dehydration of the fruit will help diversify and increase its utilization in the food industry, create employment opportunities, improve Nigeria's food security, diversify her agricultural sector and increase her Gross Domestic Product (GDP) from non-oil sector of the economy. The flour that would be obtained from further processing of the dehydrated fruits would go a long way in reducing the cost of baked products arising from high cost of importation of wheat flour into the country. Also the effect of dehydration methods on the nutrient composition, anti-nutrient/toxicant content and physical attributes of flours produced from grains, cereals, pulses, legumes, tubers/roots and green leafy vegetables have well been documented[3, 4, 5]. It was therefore necessary to carry out a research on the effect of oven and freeze dehydration methods on the proximate composition, anti-nutrient/toxicant content and functional properties of soursop (*Annona muricata*) flour.

Materials and methods

Fresh soursop fruit were purchased from Railway market, one of the markets located in Makurdi, Benue State, Nigeria. The fruits were then transported to Nutrition laboratory in the Department of Home Science and Management and refrigerated until needed for processing into flour. The refrigerated fruits were transported to International Institute of Tropical Agriculture (IITA), Ibadan where they were oven and freeze dried.

Soursop flour production:

The fresh soursop fruits were washed using clean tap water and peeled with a stainless kitchen knife. The peeled fruits were then sliced and had their seeds removed. The sliced pieces were then ground into a paste with the aid of a kitchen blender (Sonik, model: SB-735, Japan) and frozen (Hot-Air oven, model: EG517, UK) at -20. The frozen paste was then freeze dried at -40 to a constant weight and ground into flour. To produce the oven dried soursop flour however, the fruits after seed removal were spread in a single layer on oven trays and dried at 50 to a constant weight. The dried fruits were then ground into flour using a kitchen blender (Sonik, model: SB-735, Japan). The flours obtained were then used for the various determinations.

Nutrients and anti-nutrient determination:

The moisture, crude fibre, ash and available carbohydrate content were determined using the AOAC[6] method. Crude protein and fat content

Table 1: EFfect of Freeze and Oven Drying Methods on the Proximate Composition of Soursop Flour

Sample	Moisture (%)	Protein (%)	Fat (%)	Fibre (%)	Ash (%)	Carbohydrate (%)	Energy (Kcal) (%)
FDS	12.40	18.72	7.30	12.30	6.30	42.98	2124.7010
	±0.29	±0.10	±0.17	±0.23	±0.17	±0.01	±0.
ODS	8.10	21.30	2.30	16.20	11.40	40.70	2871.60
	±0.06	±0.17	±0.12	±0.12	±0.23	±0.12	±0.12
FLSD0.05	0.82	0.56	0.58	0.72	0.8	0.32	0.58
Cv (%)	3.52	1.24	5.31	2.22	4	0.34	0.01

Means are values of three replicate determinations; $FLSD_{0.05}$ = Fisher's Least Significant Difference at 5% level of probability, Cv= Coefficient of Variation, FDS=Freeze dried soursop, ODS=Oven dried soursop were determined using the method of AOAC[7]. The Spectrophotometric method of Brunner[8] was used for saponin determination; Swain[9] method was used in the determination of tannin content, Oberlease *et* al[10] method for phytate, Robertson[11] method for oxalate while Onwuka[12] method was used in the determination of cyanogenic glycosides.

Physical attributes determination:

Viscosity of the flours was determined according to the method of Rao and Anantheswena[13]. Bulk density, foam and gelatinization capacity by Narayana *et al*[14], water absorption capacity, oil absorption capacity, emulsion capacity and swelling power by Beuchat[15] while wettabillity was determined by Okezie and Bello[16] method.

Statistical analysis:

Data were subjected to analysis of variance (ANOVA) using SAS version 16 software (SAS Institute Inc., Cary, NC, USA) at $p \leq 0.05$. Means were separated using Fisher's least significant difference Test.

RESULTS AND DISCUSSION

The results of the proximate composition (moisture, protein, fat, fibre, ash, carbohydrate, energy) of the soursop flours are presented in Table 1. Significant ($p \leq 0.05$) differences were observed between the proximate parameters of the two soursop flours. The low moisture content of the flours implied that they would have good storage qualities. The higher protein, fibre, ash and energy content of the oven dried flour could be attributed to its lower moisture content. The decrease in moisture content of a food material has been reported to bring about concentration in its nutrients[4]. The low fat and carbohydrate content of the oven dried flour could be attributed to the high drying temperature (70) and long time interval (48hrs) to which the fruit pulp was subjected to which may have caused decomposition of these nutrients during the drying process. However, fruits generally are not good sources of fat except avocado pear, African pear and oil palm fruits. The difference in the energy content of the flours could be attributed to the differences in their protein, fat and carbohydrate content. The moisture and fat content of the oven dried soursop flour were comparable with those of mango mesocarp flour while the protein, fibre, ash and energy content of soursop flour were higher than those reported for mango mesocarp flour. However, the carbohydrate content of mango flour was higher than that of soursop flour. This could be attributed to the high fibre content of soursop fruit. The proximate parameters of the freeze dried soursop flour were all higher than those reported for mango mesocarp flour except carbohydrate content[17].

The anti-nutrient and toxicant profile however, revealed that saponin was not detected in the flours while the phytate, tannin, oxalate and cyanide content were very low (Table 2). This implied that the high mineral content of the fruit when consumed would be bioavailable for the physiological needs of man. Anti-nutrients (phytate, saponin, tannin, oxalate) in food materials have been reported to form complexes with several mineral elements, thereby making them biologically unavailable for human absorption and utilization. The continuous intake at high doses of anti-nutrients over

Table 2: Effect of Freeze and Oven Drying Methods on the Anti-nutrient and Toxicant Content of Soursop Flour

Sample	Saponin (%)	Phytate (%)	Tannin (%)	Cyanide (%)	Oxalate (%)
Oven dried soursop	ND	0.03±0.10	0.03±0.02	0.02±0.06	0.03±0.00
Freeze dried soursop	ND	0.02±0.01	0.52±0.00	0.02±0.00	0.02±0.00
$F\text{-}LSD_{0.05}$		N_S	0.048	N_S	0.008
Cv(%)		40	7.72	12.4	11.78

Means are values of three replicate determinations; ND = Not detected; F-LSD0.05 = Fisher's least significant difference at 5% level of probability; CV = Coefficient of variation; Ns = Not a prolonged period of time has also be implicated in several micro-nutrient deficiencies across the globe. Significant differences ($p \leq 0.05$) were observed in the tannin and oxalate content of the oven and freeze dried flours. The high tannin values in the freeze dried flour may be an indication of the susceptibility of tannins to hot temperatures while oxalates may be more susceptible to cold temperatures.

All the assessed functional properties of the oven and freeze dried soursop flour were significantly ($p \leq 0.05$) different. The oven dried flour had lower viscosity, water absorption capacity, swelling power, solubility, oil absorption capacity and emulsion capacity while the freeze dried soursop flour had lower bulk density and foam capacity. The low viscosity of the oven dried flour could be ascribed to its lower carbohydrate content and could be utilized in the production of complementary foods[18]. Viscosity is an important functional property that affects the mouth feel, textural quality of foods such as beverage and batter and design of the processing.

Freeze drying significantly ($p \leq 0.05$) decreased the bulk density of the freeze dried flour while oven drying caused its increase. This implied that lesser packaging material would be required for the freeze dried flour, as bulk density gives an indication of the relative volume of packaging material required. Nutritionally however, the oven dried flour would be preferred in the formulation of new food products because of its higher nutrient content. Padmashree *et al*[19] had observed that higher bulk density is desirable for the greater ease of dispensability and reduction of paste thickness. Water absorption characteristics represent the ability of a product to associate with water under conditions where water is limiting[4]. The water absorption capacity of the flours ranged from 42.80% to 57.30% with the oven dried flour having the least value while the freeze dried flour had the highest value. The higher water absorption capacity of the freeze dried flour could be attributed to its higher swelling of exude fibre and carbohydrate content[14]. Swelling power indicates the water holding capacity of starch, which has generally been used to demonstrate differences between various types of starches[20]. The swelling power of the flours varied significantly ($p \leq 0.05$) from 33.10% to 50.10%. The variation in the swelling properties of the flours could be attributed to differences in their carbohydrate and fat content. Chinma *et al*[8] reported swelling powers in the range of 16.16% to 29.36% for cassava starch while that of defatted starches from cowpea and soybean in the range of 14.25 to 28.10%.

From Table 3, freeze dried soursop flour had significantly ($p \leq 0.05$) higher solubility. The lower solubility value for oven dried soursop flour could be due to lower starch granule swelling which does not permit the exudation of amylase. This organization of the starch granule was observed to affect swelling behavior and invariably solubility. The oil absorption capacity of the flours ranged from 18.60% to 24.60% with the oven dried flour having the least value and the freeze dried flour with the highest value. The lower oil absorption capacity of the oven dried flour could be due to the preponderance of hydrophilic

Table 3: Effect of Freeze and Oven Drying Methods on the Physical Attributes of Soursop Flour

Sample	Viscosity (%)	Bulk density(%)	Water absorption capacity(%)	Swelling index (%)	Solubility (%)	Oil absorption Capacity (%)	Foam capacity(%)	Emulsion Capacity
FDS	32.50 ±0.29	335.40 ±0.23	57.30 ±0.17	50.10 ±0.06	22.30 ±0.17	24.60 ±0.23	14.50 ±0.29	24.60 ±0.23
ODS	27.20 ±0.12	421.20 ±0.12	42.80 ±0.23	33.10 ±0.17	20.10 ±0.06	18.60 ±0.17	25.30 ±0.17	13.70 ±0.12
FLSD0.05	0.86	0.72	0.82	0.51	0.51	0.81	0.94	0.72
Cv (%)	1.27	0.08	0.71	0.54	1.05	0.64	2.07	1.65

Means are values of three replicate determinations, FLSD0.05 = Fisher's Least Significant Difference at 5% level of probability, Cv= Coefficient of Variation, FDS=Freeze dried soursop, ODS=Oven dried soursop chains in its protein moieties resulting in reduced oil affinity. The freeze dried flour however, may have contained more hydrophilic protein molecules which showed superior binding of lipids, as evidenced in its higher fat content. Since oil acts to retain flavor and increase the mouth feel of foods, oil absorption is an important property in food products formulations.

The foam capacity of the flours were significantly ($p \leq 0.05$) different with the freeze dried soursop flour having the lowest foam capacity. This could be due to the denaturation of its protein by the cold heat processing. Narayana and Rao[14] had reported that heat processing of legumes such as wing bean diminishes its protein solubility by 18% due to denaturation and thus reduces the foam capacity. From Table 3, the freeze dried soursop flour had significantly ($p \leq 0.05$) higher emulsion capacity than the oven dried soursop flour. The higher emulsion of the freeze dried flour could be as a result of its higher viscosity and moisture content. Efficiency of emulsification varies with the type of protein, its concentration, pH, ionic strength, viscosity of the system, temperature and method of preparation; also the rate of oil addition, sugars and water content[21, 5].

Oven drying of soursop fruit significantly lowered its moisture content to levels that would better preserve and extend its shelf life. The lower moisture content of the oven dried flour resulted in its higher nutrient content. The freeze and oven dried flours had low anti-nutrient content. The freeze dried flour had better viscosity, water absorption capacity, swelling power, solubility, oil absorption capacity and emulsion capacity. The oven dried soursop flour however, had better bulk density and foam capacity.

ACKNOWLEDGEMENT

We are most grateful to the management of IITA, Ibadan, Nigeria most especially the Food processing and Preservation unit for availing us the opportunity to use their laboratories and equipments in the course of drying the samples.

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