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Yield And Proximate Properties Of Sweetpotato Food Stabilizer As Influenced By Method Of Drying And Flour Source

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Abstract
A Stabilizer is an additive to food which helps to preserve its structure. Food stabilizers can be polysaccharides extracted from food crops which when applied, smoothen the texture of the food and give it a certain consistency. No two stabilizers are exactly the same and the effectiveness of any food stabilizer to perform this role is a function of its source and method of preparation. This study evaluated the yield and proximate properties of food stabilizer made with flour extracted from two different root portions (flesh and peels) of two species (Yellow and White) of sweet potato (Ipomoea batatas) under different drying methods (Sun-drying, Oven-drying and Air-drying). The results obtained showed that method of drying, portion of the root and sweet potato species used all affected the yield and proximate properties of the extracted food stabilizer. Irrespective of root portion used, air drying gave the highest mean % moisture content of 6.529 and 6.332 and highest mean % yields of 49.760 and 50.695 in both white and yellow sweet potato species respectively across the three drying methods evaluated. Regardless of drying method and species, using the flesh portion of sweet potato for the extraction of stabilizer gave superior yield outcomes relative to peel. Highest total ash content of 1.125 % was obtained in yellow-fleshed sweet potato using oven drying while the least total ash content of 0.735 % was recorded in the white-fleshed species using Sun drying method. Also, drying in the oven produced a higher response in terms of crude fiber content of the stabilizer regardless of root portion and sweet potato species. Stabilizer extracted from flesh portion consistently gave higher moisture and total ash contents relative to the one extracted from peel regardless of drying method and sweet potato species used.

Keywords : Extraction; food stabilizer; flour purification; sweet potato; thickener.

Introduction

Food stabilizers are hydrocolloids that maybe carbohydrate polymers, (chem Total, 2011), they are capable of causing a large increase in a solution's viscosity, even at small concentrations (Wikipedia, 2014) and increases pseudo plasticity of aqueous solution.

Food stabilizers that are complex carbohydrate derived from plants sources, water soluble are called hydrocolloids (Chaplin, 2014). They help give many of the food we eat their characteristic shape or consistency (IFAC, 2014).

Tuber crops produce a substantial part of the world's food supply. On global basis approximately 45 percent of root and tuber crop production are consumed as food (FAO, 2014), with the remainder used as animal feed or for industrial processing for products of such as starch ,distilled spirit and range of minor product (David,2005).

Tubers crops are Africa's main staple foods. These crops include sweet potato (*Ipomoea batatas*), yam (*Dioscorea* Spp.), cocoyam (*Colocasia esculenta*) etc. They contribute significantly to income generation, sustainable development and household food security especially in low income countries which are, namely located in the tropical regions (IHC, 2014). Nigeria is the largest producer of yam and cocoyam in the world and the largest producer of sweet potato in sub-Sahara Africa (Amadi *et al*., 2011). Tuber crops are produced in large quantities in Nigeria, crop losses of between 30 percent to 50 percent are common shortly after harvest (Taiwo, 2014). The high moisture content of the crops renders them perishable but processing transforms them into value added products with enhanced shelf life. Root and tuber crops are flexible in their cultivation under a mixed farming system, hence they can contribute diversification for creation of new opportunities in food chain supply and post-harvest utilization as food stabilizer

(Vinod & Sashidhar, 2009). They are added to control the functional properties of aqueous foodstuff (Phillip &Williams, 2009). Most important in these properties include viscosity and prevention of ice recrystallization and organoleptic properties (Ferry *et al*., 2006).

Technologies innovation leads to the introduction of various food additives into food substance such as ice cream, bread, sauce and so on the notable one being the thickener and stabilizing agent (Kendall, 2013). Most commercial food product contains food stabilizers, hydrocolloids or food gums like guar gum, locust beam gum, carrageenan, xanthan gum, gelatin cellulose etc. (Ice cream Greek, 2014).

Sweet potato (*Ipomoea batatas*) is in the botanical family *Convolvulaceae* along with common plant such as bind weed and morning glory (Loebenstein &Thotappsilly, 2009). As a drought resistant crop, it provides good ground cover and can grow on soils with limited fertility (Amadi *et al*., 2011). Sweet potato is one of the major tuber crops in Nigeria. Its tremendous capacity for producing high yields, up to 85 tonnes/hectare have been recorded on experimental plots (FAO, 2014) and can be harvested twice in a year (Yang, 1982). They serve as a starchy root vegetable because they grow underground (Chandler, 2014). Sweet potato like any tuber crop faces post-harvest challenges, however the ability of the roots to become suberized at high temperature and humidity in the classical during process gives the crop potential for extended storage. Sweet potato can be eaten boiled, fried or floured roasted when sliced, dried and processed into flour. It gives flour that remains in good condition for long time (FAO, 2014). In Nigeria, it is eaten as a substitute for yams (*Dioscorea* spp) as a result of lower cost of production (Odebode *et al*., 2008). Sweet potato can be used in production of starch, glucose alcohol and also serves as thickeners and stabilizer for domestic and industrial uses, such as soup preparation, ice cream, dough conditioning in bread making etc. (Collins, 1993; Agbo & Ene, 1994).

There is growing interest for the processing of sweet potato for human and industrial uses even though it is considered as "poor man's food" or a survival crop in many parts of Latin America, Africa and Asia (Collins, 1989; Watson, 1989; Austin, 1988). This notwithstanding over 50% of the output still goes for human consumption in fresh form.

Sweet potatoes are eaten as a seasonal vegetable, its leaves or "tips" are a delicacy in some part of Africa and Asian countries (Scott *et al*., 2000). Sweet potato processing for human consumption is also remarkably diverse and widespread (Woolfe, 1992). About 5-10% annual production of sweet potato in Asia is processed into noodles, starch, chips and candies (Tang *et al*., 1990). Sweet potatoes vary in taste, size, shape and texture, although all are smooth-skinned with roots, its fresh can be white, orange, yellow, purple, red, pink and violet, the skin colour varies among, yellow, red, orange and brown.

Sweet potato has high nutrient content which include vitamin A, C, B2, B6, and E. It is an important supplementary source of essential vitamins and minerals (such as potassium, copper, manganese, iron) (Loebenstein & Thottapilly, 2009). Sweet potato is very low in saturated fat, cholesterol and sodium, also a significant source of dietary fibre as its pectin content can be as high as 5 percent of the fresh weight or 2.0 percent of the dry matter at harvest (Collins & Walter, 1982). The orange- and red-flashed forms of sweet potatoes are particularly high in beta-carotene, the vitamin A precursor.

South-America uses the juice of red sweet potato to combine with lime juice to make dye for cloth (Loebenstein & Thottappilly, 2009). Furthermore, studies have proved that sweet potato may be a good food for diabetes as it helps to stabilize blood sugar levels and to lower insulin resistance (Answer.com, 2008). Its roots and leaves are believed to treat illness as asthma, night blindness, and diarrhea and to detoxify the body system since it can bind to heavy metals (Loebenstein & Thottapilly, 2009).

Post-harvest losses of tuber crops mostly due to the high moisture content of the crops that renders them perishable is a very crucial setback in the storage of these crops. This makes them unavailable all through the year. Also in the peeling of the tubers of these crops there is much peeI loss which result to reduced flour yield. However, processing fresh and peels of these tuber crops into value added product such as food stabilizers is one of the ways of preventing post-harvest waste of these crops. Therefore, food stabilizers extracted from locally available tuber crops is highly imperative in the country.

Presently, there are scarcity of good quality food stabilizers in the country. The sources of food stabilizers available to the food processor is highly limited to a few imported ones. Exploration of producing good quality food stabilizers from flour of flesh and peels of *Ipomoea batatas* (white and yellow flesh sweet potato) will not only create varieties of food stabilizers but make them available at very cheap rate and also provide alternative way of generating income for the farmers and consumers. The objective of this study is to compare food stabilizers extracted from flour of flesh and peels of *Ipomoea batatas* (white and yellow flesh sweet potato), by determining the yield of the extracted purified food stabilizers from flour of flesh and peels of the above mentioned tuber crops and evaluating the proximate properties.

Materials and Methods

Source of material

White and yellow flesh sweet potato (*Ipomoea batatas*), were obtained from sweet potato pilot farm of National Root Crop Research Institute Umudike Abia state, Nigeria.

Sample preparation of the fresh tubers

Each of the sweet potato tuber samples (white and yellow flesh) was washed, peeled and chopped into smaller units of about 5-6 cm long (Ofori & Hahn, 1994). The peels and flesh were divided into three (3) portions each. Each of the three portions were dried to constant weight using sun, air and oven drying method respectively.

Flour production

The chips of fresh sweet potato flesh and peel samples that were sun, air and oven dried to a constant weight respectively were milled into fine powder using Thomas Willey mill and Binatone blender model BLG-401. Each of the samples flour was obtained from the fine powder by sieving with 150µm aperture sieve. They were placed in plastic bag and stored in air-tight plastic container.

Defatting of the flesh and peels flour (cold method)

The peels and fresh flour samples were defatted as described by Size-Tao and Sathe (2004). The flour samples were soaked with n-hexane to ratio of 1:10 (w/v) for 24 hours. It was then filtered using filter paper and the residue (defatted samples) obtained.

Extraction and purification of the defatted flour samples

The extraction and purification was done by the methods of Oladipo and Nwokocha (2011); Onwueluzo *et al*. (1993). 120g of fresh and peels of the defatted samples were dispersed in 800 ml of distilled water in 1000 ml beaker and the supernatant was decanted. The content left in the beaker was passed through muslin cloth. Each of the residue was re-constituted with 500 ml distilled water and sieved again with muslin cloth. Excess cold 99.9% ethanol was added to the residue. The precipitate formed was collected as a residue when the content in the beaker was filtered using muslin cloth. The crude food stabilizer was scooped into 500 ml beaker using table spoon. The crude extract was purified by dissolving in distilled water, homogenized and gradually precipitated with twenty (20) percent Ammonium sulphate and then washed with distilled water.

The residue after washing was placed in 500 ml beaker and precipitated with excess cold 99.9% ethanol. This procedure was done severally until the washing was negative to biuret test. The precipitate extracts were dewatered and was oven dried at 60oC for 48 hours. Food stabilizers from yellow and white fleshed of sweet potato *Ipomoea batatas* is shown in plate1.

Plate 1: Food stabilizers from yellow and white fleshed of sweet potato *Ipomoea batatas*

Proximate Properties

Proximate properties (moisture, crude fiber, ash, crude protein, fat) of the extracted purified food stabilizers was determined using standard methods described by Association of Official Analytical Chemistry (AOAC, 2010). The percentage carbohydrate was estimated by difference (Miller & John, 1990; Onwuka, 2005).

Data Analysis

Data obtained was subjected to Analysis of Variance (ANOVA) to determine the significance and the means separated by DUNCAN Multiple Range Test, a Statistical Analysis System (SAS) software.

Results and Discussion

Percentage yield of food stabilizer extracted from flesh and peel flour of yellow and white flesh sweet potato

Percentage yield of food stabilizer extracted from flesh and peel flour of yellow and white flesh sweet potato is shown in table 1. There were significant ($P<0.05$) differences in the percentage (%) yield of both the flesh and peel samples. The percentage yield of flesh samples ranged from 47.866 in WFSP Oven- dried to 62. 338% in YFSP Air- dried, while the peel samples ranged from 36.844 in YFSP Oven- dried to 46.561% in WFSP Air- dried. Comparing the percentage yield based on drying method of flour of the experimental materials air-dried flesh and peels flour yielded the largest quantity, while oven-dried flesh and peels flour produced the smallest quantity. The p- value shows significant differences between the yield of the flesh and peel food stabilizer based on each drying method.

Table 1: Percentage (%) yield of extracted food stabilizer from the experimental materials

Coded samples	Flesh yield (%)	Peel yield (%)	p- value
WFSP Oven- dried	47.866^{f}	40.651^{b}	0.000
WFSP Sun- dried	49.691^{e}	44.069^{c}	0.000
WFSP Air- dried	52.958^{d}	46.561^{a}	0.000
YFSP Oven- dried	60.70^{c}	36.844^{f}	0.000
YFSP Sun dried	61.560^{b}	38.160^{e}	0.000
YFSP Air- dried	62.338^{a}	39.829^{d}	0.000

Means in the same column with different superscript are significantly different ($P < 0.05$).

While p-values indicate the level of significant difference along the rows.

Note:

WFPFO	- White fleshSweetpotato flesh oven-dried
WFPFS	- White fleshSweetpotato flesh sun-dried
WFPFA	- White fleshSweetpotato flesh Air-dried
WFPFO	- White fleshSweetpotato Peel Oven-dried
WFPFS	- White fleshSweetpotato Peel Sun – dried
WFPFA	- White fleshSweetpotato Peel Air-dried
YFPFO	- Yellow fleshSweetpotato flesh oven-dried
YFPFS	- Yellow fleshSweetpotato flesh sun – dried
YFPFA	- Yellow fleshSweetpotato flesh Air –dried
YFPFO	- Yellow fleshSweetpotato Peel Oven-dried
YFPFS	- Yellow fleshSweetpotato Peel Sun – dried
YFPFA	- Yellow fleshSweetpotato Peel Air-dried

These screening test tend to show that food stabilizer can be extracted from both flesh and peels of the selected tuber crops studied. Flours from flesh tuber crops yielded more food stabilizers than the flour from peels. However, from the result recorded, drying method for the production of each flour (flesh and peel of the experimental materials) affected the percent yield, and the two species produces different percent yield respectively. Air-dried samples seemed to be the most suitable drying method, of the two species.

The proximate composition of flesh and peel food stabilizer samples.

The proximate composition of Flesh samples is show in Table 2 The moisture content of the flesh samples ranged from 5.481 to 6.531% with yellow flesh oven dried sample (YFSP) having the lowest (5.481%). However, there were no significant differences between flesh samples YFSP (6.531%) and WFSP air dried (6.477%). YFSP flesh oven dried (1.350%) had the highest in ash content with WFSP oven dried (1.020%) having the lowest. The highest Crude fibre and Carbohydrates in flesh samples were inWFSP oven dried (4.366%) YFSP air dried (94.406%) respectively.

Table 2: Peel Samples Proximate Composition

Coded samples	Moisture (%)	Ash (%)	Crude fibre (%)	Carbohydrates (%)	Fat (%)	Crude protein(%)
WFSP Oven dried	5.977^{bc}	1.020^{d}	4.366^{ab}	88.637^{d}	-	-
WFSP Sun dried	6.227^{bc}	1.077^{cd}	$3.266b^{cd}$	89.430^{bcd}	-	-
WFSP Air dried	6.477^{ab}	1.230^{b}	3.970^{abc}	88.323^{cd}	-	-
YFSP Oven dried	5.481^{c}	1.350^{a}	1.310^{ef}	91.859^{ab}	-	-
YFSP Sun dried	5.787^{bc}	1.130^{c}	1.260^{ef}	91.823^{ab}	-	-
YFSP Air dried	6.531^{a}	1.200^{b}	1.290^{ef}	90.97^{ab}	-	-

Means in the same column with different superscript are significantly different ($P < 0.05$).

Table 3: Peel Samples Proximate Composition

Coded samples	Moisture (%)	Ash (%)	Crude fibre (%)	Carbohydrates (%)	Fat (%)	Crude protein(%)
WFSP Oven dried	5.683^{abc}	0.600^{c}	2.511^{a}	90.748^{ab}	-	-
WFSP Sun dried	6.141^{ab}	0.400^{c}	2.50^{a}	91.417^{a}	-	-
WFSP Air dried	6.581^{a}	0.500^{c}	2.513^{a}	90.407^{ab}	-	-
YFSP Oven dried	5.664^{abc}	0.900^{ab}	2.312^{b}	91.124^{a}	-	-
YFSP Sun dried	5.989^{ab}	0.815^{b}	2.100^{d}	91.096^{b}	-	-
YFSP Air dried	6.132^{ab}	0.940^{ab}	2.215^{c}	90.713^{ab}	-	-

Means in the same column with different superscript are significantly different ($P < 0.05$)

Table 3 showed the proximate composition of peel samples. The moisture content of the peel samples ranged from 5.683 to 6.581%. YFSP air dried (0.940%) ranked the highest in ash content, having no significant differences ($p<0.05$) with %. YFSP oven dried (0.940%) and sun dried (0.815%). The lowest were in White fresh sweet potato peel sun dried (0.400%).

White fresh sweetpotato peel air dried (2.513%) ranked the highest in crude fibre content, while White fresh sweet potato peel sun dried ranked the highest in Carbohydrates (91.417%).

The moisture content of both the flesh and peel samples are within the permitted level ≤13% (Nebraska Wheat board, 2009), which is lower compared to acacia gum (13.8%), koudagogu gum (15.2%), koraya gum (16.52%) (Janaki & Sashidhar, 1997). The low moisture content below 12% is very favourable to food processors, and manufacturers, because there will be reduction in the growth of microorganism on the finished product, therefore, preservatives may not be required (Scott, 1991). The ash contents were lower than purified locust bean gum (2.06%) (Sidley, 2013) and cashew gum (1.2%) (Kwabena *et al*., 2010; Raquel *et al*., 2002). The resulting values recorded in crude fibre content were lower than lIfvingia gabonensis gum (5.3%) (Ikoni *et al* 2012), cashew gum (4.8%) (Kwabena *et al*., 2010), never the lees could be comparable to Gelatin (2.56%) (Atuonwu *et al*., 2010) and Delonix regia food gums (0.37%) (Okenwa & Nwokocha, 2014).

There were no fat and protein contents after their determination. These portray thorough defatting during processing and complete removal of protein content during purification process of the extracted crude food stabilizer.

Conclusion

This study showed that food stabilizers could be extracted from yellow and white flesh sweet potato. There were noticeable differences between the samples in the yield and proximate composition evaluated.

The results as outlined in this work suggest the usefulness of these insolated food stabilizer in food design, manufacturing and formulation. Oven-dried and air-dried methods could be used in drying of fresh tuber crops for extraction and purification of food stabilizers.

These food stabilizers could replace some existing one and also increase their availability. These will aid in reduction of post-harvest losses or waste of these tuber crops, and enhance sustainable development geared towards income generation for both farmers and consumers in Nigeria.

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