The effect of fermentation on functional properties of sweet potato and wheat flour

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ABSTRACT

In this study, the functional properties of flour produced from wheat flour and blended with unfermented and fermented sweet potato flour in the following ratios (WF:USPF:FSPF:100:0:0,0:100:0,-0:0:100,90:10:0,90:0:10) were evaluated. The result obtained showed that fermentation improved the foaming capacity, (2.00% to 8.00%), emulsion capacity (23.66% to 25.72%) and least gelation (6.00% to 10.00%).100% USPF with the highest bulk density of 2.50g/cm^3 and the highest oil absorption capacity of 220.00% while 90% WF:10% FSPF with the highest water absorption capacity of 200.00% had the highest swelling capacity of 0.80. The results show that blending wheat flour with fermented sweet potato flour improves the functional properties.

Keywords: Fermentation, Functional Properties, Sweet Potato Flour

INTRODUCTION

Sweet potato (Ipomoea batatas) is a dicotyledonous starchy, sweet tasting, tuberous roots are a root vegetable (John,1998).The young leaves and the shoots are sometimes eaten as green. Ipomoea batatas is native to the tropical regions in American (Woolfe, 1992) .

Sweet potato was also grown before western exploration in Polynesia. Sweet potato has been radio carbonated in the cook islands to 1000AD, and current thinking is that it was brought to the central poiynesia around 700AD (Ladefoged, et al, 2005). Sweet potato flour is produced from white sweet potato and dull white in colour , stiff in texture and has a somewhat sweet flavor .it is high in fibre and contain higher level of carbohydrates and a lower level of protein than common wheat flour.(Tewe, et al, 2003). Sweet potato flour can be used for baked goods such as bread, cookies, muffles, pancakes, doughnuts and has a thickner for sauces and gravies .Commonly used in gluten free cooking and baking,(Odebode, 2004). Sweet potato (Ipomoea batatas L), is among the worlds most important, versatile, and under exploited food crops, with more than 133million tones (FAOSTAT,1997) in annual productions.

Objective of the Study

The objective of this project is to evaluate the effect of fermentation on functional properties of sweet potato flour in order to increase its usefulness.

Literature review

Origin and history of sweet potato

Sweet Potato (Ipomoea batatas (L) was originally domesticated in tropical America (Roulier, et al 2013). The exact center of origin and domestication of the sweet potato has not been well defined, neither has the wild ancestor of this species been found (Denham, 2011) Sweet potato currently ranks as the most important food crop on a fresh weight basic in developing countries after rice, wheat, maize and cassava, Among the root and tubers crops, it is the only one that has a positive per capital annual rate of increase in production in sub-saharan Africa (Bashaasha and Mwanga,1996).

Nutritional composition

Although they are soft and creamy enough to be putin pies and called desert, sweet potatoes are also a surprising nutritious vegetable.(Low JP,1996).

Sweet potatoes are high in vitamin A, vitamin B5,B6, thiamin, niacin, riboflavin and due to their orange colour, are high in carotenoids said san Diego based nutritionist, they are fat free, relatively low in sodium and have fewer calories than white potatoes, although they have more sugar.(Tewe,2000).

Health benefit of consuming sweet potatoes

Not only are sweet potatoes readily available, inexpensive and delicious, sweet potatoes decreases the risk of obesity, diabetics, heart disease and overall mortality while promoting a health complexion increased energy and overall lower weight (Schoffro ,1998). They are many other benefits for your health.

METHODOLOGY

Sources of raw material

Wheat flour, fermented and unfermented sweet potato flour where purchased from a well known market called 'sasa market' in Akure South local government area of Ondo State.

Equipment such as blender, centrifuging machine, magnetic stirrer, graduated cylinder water bath, test tube, measuring cylinder were used when carrying out the analysis.

Preparation of raw materials

Preparation of unfermented orange fleshed sweet potato flour

The sweet potato flour was produced using the method described (Huang and sun, 2000).The orange fleshed sweet potato tuber were peeled and cut into thin pieces manually. The potato slices were then first immersed into (1%) Nacl solution into a solution containing potassium metabisulphate (1%) and citric acid (0.5%) and enhance the colour of the flour. Drying of sweet potato slices was done on perforated tray in a tray dryer (Tewe, 2005) at 55 degree Celsius till constant weight. The dried sweet potato chips were milled into four using the laboratory grinder (Roullier 2013) and passed through 250ÑM mech sieve, packed in air tight container and store in the refrigerator till further use.

Functional properties of sweet potato flour

Determination of bulk density

The bulk density (BD) was determined according to the method described by Okaka and Potter (1977). A 20g sample was put into a 100ml graduated cylinder. The cylinder was tapped on the palm for 40 t0 50 times and the bulk density was determined by reading the final volume.

Bulk density was calculated as.

$$BD = \frac{Mass\ of\ Materials}{Volume\ of\ Material\ after\ Tapping}$$

Determination of foaming capacity

The method of Coffman and Garcia (1977) was employed the determination of foaming capacity. 1g sample was whipped with 50ml distilled water for 5minutes in a Kenwood blender at speed set at maximum and poured into a 100ml graduated cylinder. Total volume at time interval at 0,5mins,10mins until 1hour was noted to study the foaming stability.

$$\%volume\ increase = \frac{Vol\ after\ whipping - volume\ before\ whipping}{Vol\ before\ whipping} \times 100$$

Determination of water and oil absorption capacity

Water absorption capacities (WAC) of the sample were determined by a combination Salunkhe and Sathe et al, (1982). Methods 1.0g sample was mixed with 10ml of water for 5minutes on a magnetic stirrer or using glass rod, the mixture was centrifuged at 3,500rpm for 30mins and the volume of the supernatant left after centrifuging was noted. Water bound was calculated from the difference in the initial volume of water used and the final volume after centrifuging.

The same procedure was used for oil absorption capacity (OAC), Just that oil was used in place of water.

$$WAC = \frac{Volume\ of\ water\ absorbed}{Weight\ of\ sample} \times \frac{100}{1}$$
$$OAC = \frac{Volume\ of\ Oil\ Absorbed}{Weight\ of\ sample.} \times \frac{100}{1}$$

Least gelation concentration (L G C)

The least Gelation concentration (L G C) of the flour blends will be determined using modified method of (Coffman and Garcia 1977) sample suspensions of 2%, 4%,6%,8%,10%,12%,14%,16%,18% and (M/V) will be prepared in 10ml distilled water in the test tube.

The tubes containing the suspension the suspensions will then be heated for 1hour in a gentle boiling water bath, after which the tubes will be cooled rapidly in water

Table 1. Nutritional composition of sweet potato flour and the amount per servings

Nutritional Facts	Amount Per Serving %DV*	Amount Per Serving %DV*
Serving size 1 medium	Total fact 0g 0%	Total carbohydrate 23g 8%
Calories from fat o	Potassium 4400mg 13%	Protein 2g

Sweet Potato Tuber

Sorting

Washing

Peeling

Slicing

Blanching

Drying

Draining/Cooling

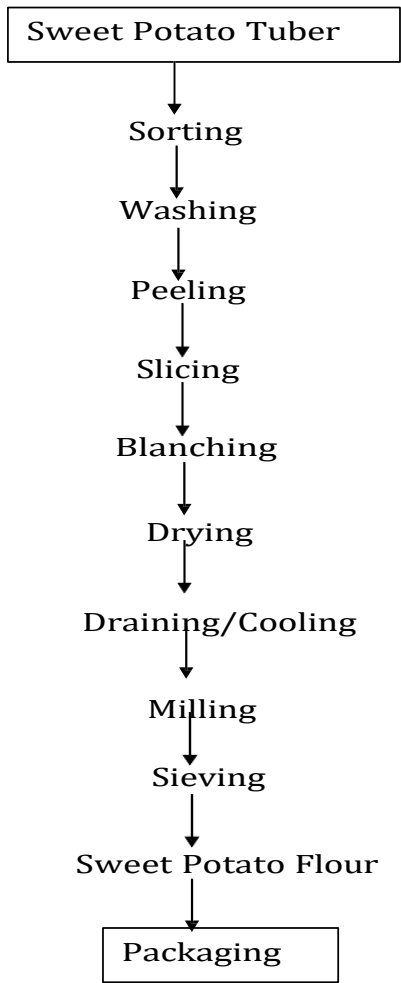Milling

Sieving

Sweet Potato Flour

Packaging

Figure 1.The flow chart for the production of unfermented sweet potato

at 40ºc for 2hours. Each tube will be then inveted one after the other. The L.G.C will be taken as the concentration that when the sample from the inverted test tube does not fall or sleep.

Determination of swelling index

The swelling index was determined using the method of Leach (1959). 75g of each sample was weighed into a 500ml of water added and allowed to stand for 4 hours

the level   of   swelling   was Observed   thereafter.
Swelling Index = volume after soaking – volume of the sample

Weight of the sample

Emulsion capacity determination

The emulsion capacity (EC) was determined by the method of Beuchat (1977). The emulsion 1g of sample, 10ml distilled water and 10ml of soya bean oil was

Table 2. Functional Properties of Fermented and Unfermented Sweet Potato and their Blend with Wheat Flour

Properties	100:0:0	0:100:0	0:0:100	90:10:0	90:0:10
Bulk Density(g/ml)	0.87	2.50	2.00	1.37	0.51
Foaming Capacity	12.00	2.00	8.00	4.00	10.00
Water Absorption Capacity(%)	190.00	110.00	140.00	160.00	200.00
Oil Absorption Capacity (%)	160.00	220.00	190.00	170.00	150.00
Swelling Index	0.79	0.74	0.75	0.77	0.88
Least Gelation (%)	18.00	6.00	10.00	12.00	16.00
Emulsion Capacity (%)	15.00	23.66	25.72	10.68	11.72

prepared in a calibrated centrifuge tube. The emulsion was centrifuged at 3,500rpm for 5minutes. The ratio of the height of the emulsion layer to the height of the emulsion layer to the height of the mixture was calculated as the emulsion activity expressed in percentage.

Formula for the emulsion capacity

EC = The ratio of height of emulsion layer
　　　　　　Height of the mixture

RESULT AND DISCUSSION

The result of the functional properties of flour produced from fermented and unfermented sweet potato and their blends with wheat flour are as shown in the table below.

DISCUSSION

Functional properties of wheat and sweet potato (fermented and unfermented) flour

The bulk density value for 100% wheat flour (WF) was 0.87g/cm^3 while 100% unfermented and 100% fermented sweet potato flour recorded 2.50g/cm^3 and 2.00g/cm^3 respectively. The result shows that fermentation decreases bulk density. Diets of lower bulk density is required for infants to allow them swallow it with ease without chocking or suffocation (Ikujenlola et al, 2013). It has been reported that increase in bulk density enhances oil absorption (Narayana and Narasinga 1982). Result from this study are in agreement with this report as 100% unfermented sweet potato flour with the highest bulk density (2.50g/cm^3) had the highest oil absorption capacity 220.00%. The oil absorption capacity decreased as more sweet potato flour was added and fermentation also had a reduction effect on the oil absorption capacity. Adeleke and odedeji (2010) reported a similar result on wheat and sweet potato flour blends.

The result of the water absorption capacity as shown in table 1 indicate that fermentation increased water absorption capacity. Beuchat (1976) postulated that breaking peptide bonds of proteins as a result of protcolytic activity during fermentation may cause an increase in polar groups which would increase hydrophilicity of the proteins. The higher water absorption capacity of the fermented flours (100% FSPF-140.00%

and 90% WF:10% FSPF_200.00%) In this study was probably caused by an increased number of hydrophilic group of the flour protein resulting from fermentation. The foaming capacity followed the same trend as fermentation increased it. Sample that contained fermented sweet potato flour had higher foaming capacities (100% FSPF _ 8.00% and 90% WF:10% FSPF _ 10.00%) as against the unfermented sweet potato flour with the value of 2.00%.

The results presented in table 1 shows that emulsion capacity of unfermented flour samples are lower than that of the fermented. The emulsion capacity was high in sweet potato flours while the wheat flour had a value of 15.00%. Adeleke and Odedeji (2010) reported a 14.68% emulsion capacity for wheat flour which is similar to the one obtained in this study. The least gelation of 100% WF was 18.00%, while the 100% unfermented and 100% fermented sweet potato flours had values of 6.00% and 10.00% respectively. The least gelation value recorded for sweet potato flour suggests that it may not be good gel for forming agent. This indicates that more flour will be needed to form gel with sweet potato flour because of its low gelation capacity (Adebowale, et al, 2005). However, fermentation improved the gelation capacity as shown in table 2

The swelling index of the flours followed a similar trend with the water absorption capacity. The higher the water absorption capacity, the higher the swelling index in the flours 90% WF:10% FSPF with the highest water absorption capacity (200.00%) had the highest swelling index of 0.88. These two parameter are used in determining the quantity of water that flours can absorb and the degree of swelling with a specified time (Adebowale et al, 2005)

CONCLUSION

The functional properties of fermented and unfermented sweet potato flour and their blends with wheat flour were investigated. The study showed that fermentation increased most of functional properties evaluated such as foaming capacity (8.00% for 100% FSPF and 10.00% for 90%WF : 10% FSPF),emulsion capacity (25.72% for 100% FSPF and 11.72% for 90%WF:10% FSPF) and least gelation (10.00% for 100% FSPF and 16.00% for

90%WF: 10% FSPF).However, fermentation decreased the bulk density from 2.50g/cm in 100% USPF to 2.00% in 100% FSPF. 90%WF:10% FSPF with the highest water absorption capacity of 200.00% has the highest swelling index of 0.88.

The result from this study showed that blending wheat flour with fermented sweet potato flour improves the function properties.

RECOMMENDATIONS

Further studies to evaluate the effect of fermentation on the proximate composition, antinutrient properties and mineral composition of flour blends of wheat and sweet potato should be carried out.

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Key ;

WF   = Wheat flour

USPF = Unfermented sweet potato flour

FSPF = Fermented sweet potato flour

100:0:0 = 100% WF

0:100:0 = 100% USPF

0:0:100 = 100% FSPF

90:10:0 = 90%WF:10% USPF

90:0:10 = 90% WF:10% FSPF

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