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Functional Properties of Composite Flour made from Wheat and Breadfruit

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ABSTRACT

Breadfruit is one of the underutilized crops in Africa. It is a valuable food resource but the usage is limited due to poor storage properties of the fresh fruit. Breadfruit was processed hygienically into dried chips using NSPRI multipurpose drier powered by kerosene stove. The chips were milled into flour and mixed with wheat flour in the following ratio (wheat flour : breadfruit flour; 100:0, 90:10, 80:20, 70:30, 60:40, 0:100) packed in 0.04mm thick gauge transparent polyethylene nylon and evaluated for its functional properties. Water absorption capacity of the blend ranged from 161– 402 % while oil absorption capacity ranged between 106 – 160 %. The loose bulk density, packed bulk density, emulsion capacity, emulsion stability, foaming capacity, foaming stability and least gelation concentration of the breadfruit- wheat composite flour were in the range of 0.38 – 0.47g/ml, 0.62 – 0.66g/ml, 14.2 – 18.8%, 6.6 – 11.9%, 7.5 – 11.3%, 3.7 – 7.0% and 16.7 -27.8% respectively. The results from the flour blends showed that the flour may be useful for confectionery products, aerated foods and high nutrient density weaning foods.

Keywords: breadfruit; confectionery products; functional properties; multipurpose dryer; storage

INTRODUCTION

Breadfruit (*Artocarpus communis*) is a tree and fruit native to Malaysia and countries of the South Pacific and the Caribbean. Breadfruit has been an important staple crop and component of traditional agro-forestry systems in the Pacific for more than 3,000 years. It is an important food in these areas (Taylor and Tuia, 2007). The tree has a great productive ability with an average sized tree producing 400 to 600 fruits per year (Adepeju *et al*.,2011). It produces fruit twice a year, from March to June and from July to September with some fruiting throughout the year. Present level of breadfruit production in the South-Western Nigeria has been estimated to about 10million tonnes dry weight per year with potentials for exceeding 100million tonnes every year (Adewusi *et al*., 1995; Ajayi, 1997).
Breadfruit is a versatile crop and the fruit can be cooked and eaten at all stages of maturity. It is an excellent dietary staple and compares favorably with other starchy staple crops commonly eaten in the tropics, such as taro, plantain, cassava, sweet potato and white rice. Breadfruits contain a sizeable quantity of carbohydrates with low levels of protein and fat and a moderate glycemic index. These carbohydrates, utilized as simple sugars (such as fructose and glucose) by the body are readily used to enhance the energy generation process in the body.

Breadfruits contain essential vitamins and antioxidants, such as xanthin, which work to protect the body from the debilitating attacks of bacterial and viral agents. 100 grams of breadfruit contains an impressive inventory of vitamins which includes vitamin B1 (0.2 mg), vitamin B6 (0.1 mg), vitamin C (29.1 mg), vitamin E (0.1 mg), niacin (0.9 mg) and chloine (9.81 mg).
It is a good source of dietary fiber, potassium, calcium, and magnesium with small amounts of thiamin, riboflavin, niacin and iron. Some varieties contain small amounts of folic acid. Yellow-fleshed varieties can be a good source of provitamin A carotenoids (NTBG, 2013). It is typically consumed when mature, but still firm and is a delicious substitute for any starchy root crop, vegetable, pasta, potato or rice. Sliced breadfruit can be fried to make chips or French fries and pounding like pounded yam (Morton, 1987). The breadfruit pulps are made into various dishes; it can be pounded, fried, boiled, or mashed to make porridge; it can also be processed into flour and used in bread and biscuit making (Amusa *et al*., 2002).

Breadfruit is highly nutritious, cheap and readily available in overwhelming abundance during its season, it has found limited applications in the food industries (Omobuwajo,2003). Although, a lot of work has been done on breadfruit but the objective of this work is to assess the functional properties of composite flour from breadfruit and wheat flour.

MATERIALS AND METHODS

Material Collection

Matured green ripe and wholesome fruits of breadfruit (*Artocarpus communis*) were obtained from Ajifowobaje – Ilode market in Ile-Ife, Osun State. Commercial wheat flour (Eagles flour Mill, Ltd, Ibadan, Nigeria) was purchased from Bodija market in Ibadan, Nigeria.

Production process of breadfruit flour

Breadfruits were processed into flour as shown in Figure 1. Wholesome breadfruit samples were washed, peeled and sliced manually into 1cm thick slices using stainless steel knife. The washed sliced breadfruit pieces were immersed in a 70ppm solution of sodium metabisulphite. The sulphited slices were steam blanched at 70°C for 10mins in a water bath (Clifton model) and then dried at 55°C for 16hrs using a cabined dryer. The dried chips were sieved (Model BS 410) (Giami *et al*.2004). The flour was packaged in thick gauge (0.04mm) transparent polyethylene nylon for further use.

Functional properties determination of flour

Water absorption capacity

The WAC was determined at room temperature and at temperatures ranging between 60 to 90°C using a combination of the AACC (1995) method and those of Sosulski (1962) and Rutkowski and Kozlowska (1981). A 2 g sample was dispersed in 20 ml of distilled water. The contents were mixed for 30s every 10 min using a glass rod and after mixing five times, centrifuged at 4000 g for 20 min. The supernatant was carefully decanted and then the contents of the tube were allowed to drain at a 45° angle for 10 min and then weighed. The water absorption capacity was expressed as percentage increase of the sample weight.

Oil Absorption Capacity

Oil absorption capacity of the flour samples was determined by the centrifugal method elicited by Beuchat (1977) with slight modifications. One gram of sample was mixed with 10 ml of pure canola oil for 60 s, the mixture was allowed to stand for 10 min at room temperature, centrifuged at 4000 g for 30 min and the oil that separated was carefully decanted and the tubes were allowed to drain at a 45° angle for 10 min and then weighed. Oil absorption was expressed as percentage increase of the sample weight.

Matured Breadfruit
↓
Washing
↓
Peeling
↓
Slicing
↓
Washing
↓
Sulphiting
↓
Steam Blanching (10mins)
↓
Draining
↓
Drying (55°C for 16hr)
↓
Milling
↓
Sieving
↓
Packaging
↓
Breadfruit flour

Figure 1: Flow chart for the processing of Breadfruit flour

Emulsion Capacity

This was determined using Beuchat (1977) method. 16g of the sample was suspended in 100ml of distilled water in a jar and blended for 30 seconds using an osterizer blender. Peanut oil from a burette was added to the blending sample at a rate of 0.5ml per second until the emulsion breakpoint was reached. Results were expressed as the percentage of oil emulsified per gram of flour used.

Foaming capacity and stability

The procedure of Lawhom *et al* (1971) was used. Two grams of flour sample and 50ml distilled water were mixed in a Braun blender at room temperature. The suspension was mixed and shaken for 5 minutes at 1600rpm. The content along with the foam was poured into a 100ml graduated measuring cylinder. The total volume was recorded after 30seconds. Then the content was allowed to stand at room temperature for 30 minutes and the volume of foam only was recorded.

Foaming Capacity (FC) =

$$\frac{\text{Vol. of foam AW} - \text{Vol. of foam BW}}{\text{Vol. of foam AW}} \text{ x } 100$$

Where:
AW = After Whipping
BW = Before Whipping
FS: The volume of foam only (Total volume – liquid volume) after the 30 min standing is taken as foam stability.

Gelation Capacity

The least gelation concentration was determined by a modification of the method of Coffman and Garcia (1977). The flour dispersions of 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20% (w/v) were prepared in 5ml distilled water in test tubes, which were heated at 90^{o}C for 1 hour in water bath (Gallenkamp). The heated dispersions were cooled rapidly under running tap water and then at 4oC for 2 hours. The least gelation concentration was determined as that concentration when the sample from the inverted tube did not slip or fall.

Bulk Density

The bulk density was determined according to the method described by Wang and Kinsella (1976). A 20g sample was put into 50ml measuring cylinder. The cylinder was gently tapped on the bench top 10 times from a height of 5cm. The bulk density was calculated as weight per unit volume of sample.
Calculation:
Bulk Density (BD) g/ml

$$= \frac{Weight\ of\ Sample}{Volume\ of\ sample\ after\ tapping}$$

RESULTS AND DISCUSSION

Data on selected functional properties of the composite flours are given in Table 1. Water absorption capacity ranged from 161 – 402%. High water absorption capacity may be attributed to the breakdown of starch during blanching and ease of absorption of water by partly gelatinized starches (Ogbugu *et al*., 2005). At 100%, breadfruit flour had the highest water absorption capacity (402%). This implied that blanching enhanced the water absorption capacity. Water absorption characteristics represent the ability of a product to associate with water under conditions where water is limiting such as dough and paste (Nwoji, 2004).

Table 1: Functional properties of wheat and breadfruit flour sample missed in different proportions.

Properties	Wheat and Breadfruit flour samples					
	A	B	C	D	E	F
Water Absorption Capacity	161±1.0	202.5±1.5	253±1.0	247.5±1.5	367±2.0	402±1.0
Oil Absorption Capacity	106.5±1.5	109±1.0	118±1.0	113.5±0.5	128.5±1.0	160±2.0
Foaming Capacity	11.3±0.10	9.45±0.15	8.75+0.15	8.40±0.10	7.55±0.15	8.20±0.10
Foaming Solubility	7.0±0.1	6.2±0.1	5.2±0.1	4.5±0.1	4.0±0.1	3.7±0.1
Emulsion Capacity	14.24±0.02	17.93±0.01	14.41±0.03	10.05±0.03	18.86±0.02	14.70±0.04
Emulsion solubility	6.60±0.02	7.88±0.00	9.40±0.04	9.27±0.03	11.80±0.04	11.96±0.01
Least Gelation Capacity	27.84±0.00	25.49±0.00	22.56±0.00	19.34±0.00	17.66±0.00	16.74±0.00
Loosed Bulk Density (g/ml)	0.44±0.00	0.38±0.00	0.48±0.00	0.40±0.00	0.44±0.00	0.48±0.00
Packed Bulk Density (g/ml)	0.63±0.00	0.67±0.00	0.67±0.00	0.63±0.00	0.63±0.00	0.63±0.00

All the parameters are in percentages with the exception of both bulk densities. A=Wheat flour (100%), B=Wheat flour (90%) and breadfruit flour (10%), C=Wheat flour (80%) and breadfruit flour (20%), D=Wheat flour (70%) and breadfruit flour (30%), E=Wheat flour (60%) and breadfruit (40%) and F=Breadfruit (100%).

Oil absorption capacity increases with increase in level of substitution (106 – 160%).The oil absorption capacities of the flour blends suggests that they may be useful in food preparation that involve mixing like bakery products where oil is an important ingredient (Banigo and Mepba, 2005). The oil absorption capacities of the composite flours tended to increase with increase in protein content since the protein in foods influences fat absorption.

Foam capacity ranged from 7.55-11.30%. The higher foaming capacity in the flour blends shows that breadfruit flour is a good foaming agent and is useful in aerated foods. Also, the foam stability decreases with increase in level of substitution (7.0 – 3.7%). It was noticed that as the level of substitution increases, the values for foam stability kept decreasing. Hence, it is not a native proteins crops; it's expected to have lower stability. At 100% wheat flour had the highest stability than other flour blends. This suggests that wheat flour is more stable. Protein foams are important in many processes in the beverage and food industries and this has stimulated interest in their formulation and stability. Foams are used to improve texture, consistency and appearance of foods.

The least gelation concentration varies from 27.84% to 16.74%. That is, as the proportion of breadfruit flour in the mixture increased, the least gelation concentration decreased in value. The variation in gelation of samples suggests that interactions between such components may have significant role in functional properties. It was observed that 100% breadfruit flour had the lowest least gelation concentration. Also, the values suggesting that the flour blends may not be a good binder in breakfast foods (Osundahunsi, 2006).

Emulsion capacity ranged from 14.2 – 18.85%. This is suggesting that the flour blends may be a good emulsifying agent. Increase in protein content with increase in substitution level aid in formulation and stabilization of emulsion (Abbey et. al., 1998). Emulsion stability increased with increase in level of substitution. This ranged between 6.60 – 11.96%. At 100%, breadfruit flour had the highest emulsion stability while 100% wheat flour had the lowest. The flour blends had stable emulsions because the protein content of the blends was not denatured by heat.

For all the flour blends, it was observed that both the loose and packed bulk densities increased considerably with increase in level of substitution. This is because the breadfruit flour is high in carbohydrate content. Loose and packed densities ranged between 0.38 – 0.47g/ml and 0.62 – 0.66g/ml respectively. The relative high bulk density of the flour blends indicates that packaging would be economical as observed by Osundahunsi and Aworh (2002). Breadfruit flour may be more useful in preparing high nutrient density weaning foods.

CONCLUSION

Breadfruit has immense potential; not only does it provide food security but the fruit is nutritious and versatile. There is need for commercial awareness, more support with production and processing techniques in order to put this time-honoured staple crop back on the menu. Also, with the recent policy of 10% cassava flour supplement for wheat flour in Nigeria, incorporating breadfruit flour into some of our products as a result of its functionality is therefore recommended.

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