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PHYSICO-CHEMICAL PROPERTIES OF BLENDS OF *MUCUNA COCHINCHINENSIS, UNRIPE CARICA PAPAYA AND MUSA PARADISIACA* FLOUR

Kelechi Selina Onumadu, Odom Theophilus & Alozie Queen

ABIA STATE POLYTECHNIC, ABA, NIGERIA

ABSTRACT

Mucuna cochinchinensis, unripe *Musa Paradisiaca* and unripe Carica papaya were processed into flour and blended into composites of MMCA, MMCB, MMCC, MMCD and MMCE respectively. The functional properties of the flour blends were evaluated. There were significant differences among the samples ($p<0.05$). The swelling index ranged from 2.93 to 3.44%. The result revealed higher value of swelling index in sample MMCB. The gelation temperature ranged from 68^0C to 72^0C. The water absorption capacity ranged from 2.10 to 3.90g/g. The bulk density ranged from 0.67 to 0.68g/cm^3. The oil absorption capacity ranged from 0.7 to 0.8g/g. Viscosity ranged from 0.74 to 0.84 Pa.s while the emulsion capacity ranged from 23.46 to 27.60% with sample MMCB having the highest value of 27.60%. The functional properties increases with high protein content as shown in increase quantity of *Mucuna cochichinensis* and decreases with increase in carbohydrate content as shown in increase in *Musa Paradisiaca* content. The samples have potential as functional agent in food formulation with sample MMCB having the highest functional properties. Sample MMCB can be used to modify the texture of food products and used in food such as stews, pudding, snacks and sauces. With the high protein content, it can be used to produce functional foods that will overcome the incidence of protein malnutrition.

Keywords: *Mucuna cochichinensis, Musa Paradisiaca,* Carica papaya, Functional properties, Flour

INTRODUCTION

The current high cost of animal protein in Nigeria has contributed to the problem of protein malnutrition (Udensi, 2001). Legumes are of considerable importance in Nigeria and in any African countries as a nutritious leguminous crop providing an alternative sources to animal protein. (Doulo etal., 1976) *Mucuna Cochinchinensis* is an underutilized legume which has a nutritional quality comparable to other conventional legumes as it contains similar proportions of protein, lipid, minerals, and other nutrient.

Plantain (*Musa Paradisiaca)* is a perennial plant. It is rich in potassium and it is commonly prescribed by doctors for people who have low level of potassium in their blood. The potassium in *Musa Paradisiaca* is very good for the heart, it helps to prevent hypertension and heart attack (Robinson, 1996). Cooked unripe *Musa Paradisiaca* is very good for treating diabetes as it contains complex carbohydrates that are slowly released over time (Ogbuji *et al.,* 2012).

Carica Papaya is a berry, developing from syncarpous superior ovary with parietal plantation (Kochner, 1986). It is favoured by the people of the tropics as breakfast and as ingredients in jellies, preserved or cooked in various ways. The juice makes a popular beverage. Fruit and seed extracts have pronounced bacteriocidal activity against *Staphyloccous aureus, Bacillus cereus, Escherichia, coli, pseudomonas aureginosa and Shigella flexneri, (Sagon, 2004).*

Some skeletal works have been reported on some nutritional and functional properties of *Mucuna* flour. However no work has been done exclusively on the functional properties of blend of *Mucuna* and Musa *Paradisiaca* and *Carica Papaya* flour as food or in food formulation.

The performance of the flour blend depends mostly on the physico-chemical properties required in the final products. (Mcwatters, 1990).
The properties of flour that enhance their utilization in food includes water and oil absorption, capacity, gelation capacity, foaming capacity, emulsion capacity, bulk density, swelling power, viscosity (Adeyeye, etal., 1994, Abbey and Ibeh, 1998). The objectives of this study is to utilize Musa paradisiaca, *Carica Papaya* and the lesser known legume *Mucuna Cochichinensis* in developing a potential flour with wider expansion of their uses as functional ingredients in food products.

MATERIALS AND METHOD

Mucuna cochichinensis, unripe *Carica Papaya* and *Musa paradisiaca* were purchased from Umungasi market in Aba. *Mucuna cochichinensis* were sorted, weighed, washed, boiled at 100^0c for 90 minutes, dehulled, dried at 65^0c to a constant weight, milled and sieved into flour. Unripe *Carica Papaya* were washed, weighed, peeled, sliced, blanched for 4 minutes, dried at 70^0c to a constant weight, milled and sieved into flour. Musa Paradisaca were washed, weighed, peeled, sliced, blanched for 4 minutes, dried at 70^0c to a constant weight, milled and sieved into flour. 5 different experimental samples were formulated with a total of 100g per sample based on crude protein requirement of baby foods (FAO, 1996).

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The respective *Mucuna, Cochichinensis, Musa Paradisiaca* and *Carica Papaya* flour were weighed into a beaker and poured into a blender and blended for 5 mins to produce the respective samples.

Table 1: ***Mucuna Cochichinensis, Musa Paradisiaca, Carica Papaya Blending ratio.***

40:40:20 (MMCA)	40	40	20
50:30:20 (MMCB)	50	30	20
30:50:20 (MMCC)	30	50	20
50:40:10 (MMCD)	50	40	10
40:50:10 (MMCE)	40	50	10

Functional properties/physico-chemical properties

Water absorption capacity: The method of Okaka and Potter (1979) was adopted 3g sample was weighed into a clean dry centrifuge tube. 10ml distilled water was added and mixed thoroughly. The mixture was allowed to stand at room temperature for 15mins. The mixture was centrifuged at 3500rpm for 15mins. The supernatant was discarded and the tube with its content re-weighed the amount of water bound by the sample was determined by difference.

Oil Absorption Capacity

The method of Okaka and Potter (1979) was adopted. Sample (3g) was weighed into a clean dry, centrifuge tube. Groundnut oil (10ml) was added and mixed thoroughly with the sample. The mixture was allowed to stand at room temperature for 15mins.

The mixture was centrifuged at 3500rpm for 15min. the supernatant was discarded and the tube with its content re-weighed. The amount of oil bound by the sample was determined by difference.

Gelation Temperature

The gelation temperature was determined by the method of Ikegwu et al., (2009). Sample (1g) was mixed in 10ml of distilled water in a beaker. A thermometer was clamped using retort stand with its bulb immersed in the suspension. The suspension was heated and the temperature (^{0}C) at which the gelatinization was noticed recorded.

Bulk Density

Bulk density was determined by the method of Salunkhe et al., (1985). A 10ml graduated cylinder was filled with the sample. The bottom of the cylinder was gently tapped on a laboratory bench for 10min. bulk density was calculated as weight of sample per unit volume of sample.

$$\text{Bulk density} = \frac{\text{mass(g)}}{\text{Vol. (cm}^3\text{)}}$$

Swelling Index

The method of Ikegwu et al., (2009) was adopted. Exactly 10g of the flour was weighed into 100ml measuring cylinder and the volume it occupied was recorded. Distilled water was very carefully added until the 10cm^3 was reached. The set up was left undisturbed for 1hr while record of the volume was taken every 15 minutes. The swelling index was given by the ratio.

Swelling index = V_2/V_1

Where, V_1 = initial volume

V_2 = Final volume

Viscosity Determination

Flour weighing 10g was added to 100ml distilled water and mechanically stirred for 2 hours at room temperature. The viscosity was measured using Digital display viscometer (NDT-95).

Emulsifying Capacity

The method of Okaka and Potter (1979) was adopted. Sample (2g) was mixed with 30ml distilled water and blended for 30 seconds. While still blending, 30ml refined vegetable oil at the rate of 10ml/min was added. The blending continued for an additional 30secs. The sample was transferred to a 50ml graduated centrifuge tube kept in hot water bath at 80^0C for 15 min and centrifuged at 3000rpm, for 40min. the volume of oil separated from the sample after centrifugation was read. The emulsion capacity was expressed as the amount of oil emulsified and held per gram of sample.

Results and Discussion

Physico-Chemical /Functional Properties of Flour Blends

Results of the functional properties that influence the utility of the flour blend are shown in Table 2.

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Table 2: Functional Properties of the Flour Blends Samples

Properties	MMCE 40:40:20	MMCA 50:3020	MMCB 30:50:20	MMCC 50:40:10	MMCD 40:50:10	LSD
Swelling index %	3.00[a]	3.44[a]	2.93[b]	3.40[a]	3.33[a]	0.08
Gelation Temperature ^{0}C	72.50a	68.40 [a]	68.50 [a]	70.40 [a]	71.45 [a]	0.29
Water absorption capacity g/g	3.83 [b]	3.96 [a]	2.10 [d]	3.90 [a]	3.73 [c]	0.44
Bulk Density g/cm ^{3}	0.67 [a]	0.69 [a]	0.67 [a]	0.68 [a]	0.69 [a]	0.05
Oil Absorption capacity g/g	0.81 [b]	0.89 [a]	0.70 [c]	0.82 [b]	0.80 [b]	0.04
Viscosity Pa.s	0.83 [a]	0.80 [a]	0.74 [b]	0.81 [a]	0.84 [a]	0.09
Emulsion capacity %	27.00 [a]	27.60 [a]	23.46 [b]	25.31 [c]	25.01 [c]	0.40

Values are means of three replicates. Means in the same row with the same superscripts are not significantly different (p>0.05)

Key Notes

M = Mucuna cochinchinensis

P = Musa paradisiacal

C = carica papaya

Swelling Index

The swelling index, which is the measure of the ability of flour to imbibe water and swell (Ikegwu et al., 2009) ranged from 2.93 to 3.44%. There were significant (P<0.05) differences in swelling index. The lower swelling power obtained from the flour 30:50:20 also may mainly be attributed to low presence of lipid and protein which are also important factors in controlling the swelling. The extent of swelling in the presence of water depends on the temperature, availability of water, species of starch, extent of starch damage due to thermal and mechanical processes and proteins and other carbohydrates such as pectins, hemicelluloses and celluloses (Ezema, 1989).

Gelation Temperature

The gelatinization temperature for the sample varied from 68 to 72^{0}C. The values were not significantly different (p>0.05). Values where lower than that reported by Udensi and Agwu (2008) which was 77-83^{0}C for *Mucuna – cassava* blends. The temperature provides an indication of the minimum temperature required to cook a given sample which could have implications for the stability of other components in a formulation and also the energy cost. This means that in the processing of these flour samples, low energy input will be required to gelatinize them. The ability of the flour blends to gel at different concentrations may suggest that unripe *Carica Papaya*, *Musa Paradisiaca* and *Mucuna Cochinchinensis* flour blends could be used as a gel forming system for pudding and snacks which require thickening and gelling.

Water Absorption Capacity

The water absorption capacity ranged from 2.10 to 3.96g/g. There were significant differences ($p<0.05$) in water absorption capacity of the samples with sample 50:30:20 having the highest value. Sample 50:30:20 absorbed water more than other blends. Water binding capacity is a useful indication of whether flour can be incorporated into aqueous food formulations like those involving dough handling (Giami, 1993). The ability of food materials to absorb water is sometimes attributed to the protein content (Kinsella, 1976). The presence of water in foodstuff and its concentration depends on water absorption capacity and stability and this determines to a high degree the palatability, physical structure and technical handling of the foodstuff (James et al., 2013).

Bulk Density

The bulk density of the flour blends ranged from 0.67 to 0.69g/cm^3. There were no significant differences ($p>0.05$) in the bulk density of the samples. Bulk density indicates the volume of the packaging material required (Udensi and Okoronkwo, 2006). High bulk density increases the rate of dispersion which is important in the reconstitution of flours into dough.

Oil Absorption Capacity

The oil absorption capacity values of the flour blends ranged from 0.7 to 0.89g/g. This range is higher than that reported by Prinyawatkul et al., (1997) for heat processed cowpea flour. The high oil absorption capacity of the flour samples could be due to the high protein and fat contents.

However, the hydrophobicity of protein also plays a major role in oil absorption (Voutsinas and Nakai, 1983).

Both water and oil absorption decreased with increasing content of *Musa paradisiaca* flours in the blend. Proteins in flours are mainly responsible for water uptake and to a lesser extent starch and cellulose at room temperature. The low oil absorption capacity values as compared to water absorption capacities suggest that the major proteins in the flours are predominantly hydrophilic (Deshpande et al., 1993).

Viscosity

The viscosity of the flour ranged from 0.74 to 0.84Pa.s. A higher viscosity corresponds to a higher thickening power of starch. Viscosity is an indication of the strength of paste which are formed from gelatinization during processing in food application. Viscosity is an important functional property that affects mouth feel, textural quality of fluid food such as beverage (McWatters and Brantly, 1982). Values were comparable to that reported by Nnam, (2000) for hungry rice flours.

Emulsion Capacity

The emulsion capacity of the flour ranged from 23.46 to 27.60% with sample 50:30:20 having the highest value. The result is higher than that obtained for *Mucuna* bean isolate which ranged from 12.50-17.40 (Udensi and Okoronkwo, 2006). The higher emulsion capacity of the flour blends especially 50:30:20 makes a potentially useful ingredient in preparing meat-like products and analogs (Udensi and Okoronkwo, 2006). The high emulsion could be as a result of higher protein 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, sugar and water contents (MC Watter and Brantly, 1982).

Conclusion

This sample MMCB which possesses the qualities that are required for the preparation of a weaning food (Odom, 2013) is found to have good functional properties and can be used for nutrition and various food formulation. They can be used in foods such as stews, pudding, snacks, sauces and can be used to modify the texture of food products. Flours which have low protein content can be enriched or fortified with sample MMCB. The utilization of *Mucuna Cochichinensis* as a lesser known legume will be increased. Since the protein content is high it can be used to produce functional foods that will overcome the incidence of malnutrition.

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