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Evaluation of Functional Properties of Melon/ Maize/OSU (*P. Tuber-Regium*) Mix for the Production of Melon Seed "Cake" Analogue

Ani C. O.
Chief Technologist, Department of Food Science and Technology,
Enugu State University of Science and Technology, Enugu, Nigeria
Okolie E. C.
Professor, Department of food science and Technology, Ebonyi State University, Abakaliki, Nigeria

Abstract:
Melon seed cake is traditional ceremonial diet served in some parts of Southern Nigeria. It is prepared by steaming 80:20 mixture of melon: Pleurotus tuberregium(Osu) flours. Pleurotus tuberregium(Osu) is relatively very expensive, and accounts for more than 60% of cost of production of the cake. In the effort to reduce the cost of production of melon cake, the feasibility of reducing quantity of the flour of Pleurotus tuberregium(Osu) used in the traditional melon cake production with maize flour was tested by examining the effect of inclusion of maize flour on the functional properties melon/osu flour mix. Functional properties of blends of melon seed, sclerotial of pleurotus tuberregium and maize flours were investigated. Melon seed flour were blended with the flours of Pelurotius tubergium and maize at the ratio of 80, 0, 20; 80,16,4%; and 80, 12, 8% respectively and flour blend containing 80% melon seed and 20% P. tuberregium was used as control. Bulk densities, water absorption, emulsion, swelling and oil absorption capacities as well as solubility, of the flour mixtures were evaluated using standard methods. Results showed that water absorption, oil absorption and swelling capacities of the blends, containing up to 8% maize in the melon/osu mixtures were found not to be significantly different from the control. However, the mixture containing up to 20% maize had significantly inferior water absorption, oil absorption, swelling capacities and solubility. Emulsion capacity of the control melon/osu (80/20) mix was significantly higher than all the mixtures (blends) containing maize. Inclusion of maize in the melon/osu mix resulted in significant increase in the bulk density of the mix. These results suggest that at high levels of maize inclusion beyond 8% in the melon cake analogue recipe, the quality of the final product may be impaired.

Keywords: *Melon Seed Cake, melon, maize, Pelurotius tubergium flour*

1. Introduction

Melon seeds popularly called "Egusi" in Nigeria go by various botanical names according to its variety. These include *citrulus edulus, citrulus vulgaris, citrillus lanatus* as reported by Odigboh (1979) and Okoro (1997). *Citrullus lanatus* (egusi) is indigenous to the West Africa region. Although, it is the progenitor of the water – melon, it was domesticated only for its seeds in West Africa (Blench 1977). Melon (Egusi) is an important component in the traditional cropping system; it is usually inter-planted with stable crops such as cassava, maize, sorghum, etc (Omidiji *et al;* 1985). Melon seed "cake" analogue is a traditional snack locally made from fermented *sclerotium of pleurotus tuberregium* "Osu" and melon seeds. It originated from 'Ikon' festival which is celebrated by Annang tribe of Akwa Ibom State, South Southern Nigeria. The cakes known as "Iho" were used during festivals to feed the gods and also as a celebrative cake. With the advent of Christianity, the cakes are now used during Christmas and New Year celebration in South Eastern Nigeria. The 'Osu' used in melon 'cake' analogue production is wild and not readily available; hence it is expensive when found. This underscores the need to find other domesticated crops such as maize which may be used to substitute completely or partially the Osu in melon cake production. Before partially substituting maize into melon seed cake, there is a need to investigate the effect of the maize substitution on the functional properties of the melon/Osu blend. This is because a significant change in functional properties of the blend could result in a product possessing characteristics different from what is accepted by consumers. This work therefore seeks to investigate the effect of Maize substitution/inclusion on the functional properties of the melon – Osu flour blends used in melon seed 'cake' analogue.

2. Materials and Methods

The melon seed (*citrullus lanatus*), sclerotia of (Pleurotus tuber – regium) also known as 'Osu' and yellow maize (Zea Mays) used for the study were purchased from Ogbete Main Market, Enugu, Enugu State, Nigeria.

2.1. Preparation of Samples

2.1.1. Melon Seed Flour

The melon seed flour was prepared according to the method of Bukola *et al* (2009). Five hundred grammes (500g) of melon seed (*citrullus lanatus*) were weighted and dehulled by manually breaking the seeds individually to remove the cotyledons. They were sorted to remove extraneous materials and washed with potable water to remove dust and other dirty particles. After that, the dehulled seeds were spread on trays and dried in a hot air oven (model ETA 224) at $60^{O}C$ for 6h. The dried seeds were milled into flour using an attrition mill. The melon seed flour produced was packaged in polyethylene bag and kept in a cool and dry airtight container until needed for analysis.

2.1.2. Osu Flour

Three hundred grammes (300g) of "Osu" was weighed, peeled manually with a kitchen knife and soaked with 2 litres of potable water at room temperature ($29 \pm 2^{O}C$ for 24h). The soaked 'Osu' was sliced into smaller sizes with a kitchen knife and the slices were dried in a hot air oven at $60^{O}C$ for 4h. The dried slices were milled into a fine powder using an attribution mill and sieved to pass through a 300-micron mesh sieve. The 'Osu' flour produced was packaged in sealed polyethylene bag and kept in a cool dry airtight container until needed for analysis.

2.1.3. Maize Flour

The maize flour was prepared according to the method of Enwere (1998). Four hundred grammes (400g) of yellow maize grains were weighed, sorted and cleaned with 1.5 litres of potable water to remove dirty particles and other contaminants. The washed grains were dried in a hot air oven at $60^{O}C$ for 8h. The dried seeds were milled into flour using an attrition mill and sieved to pass through a 300-micron mesh sieve. The maize flour obtained was packaged in sealed polyethylene bag and kept in a cool dry airtight container until needed for analysis.

2.1.4. Formulation of Melon/Osu/Maize Flour Blends

Melon seed flour was blended with Osu and Maize flour samples in the ratios shows in Table. 1.

2.1.5. Evaluation of Functional Properties

The water and oil absorption capacities, bulk density, gelling and emulsion capacities were determined by methods described by Onwika (2005).

Swelling capacity and solubility index were determined by the methods described by Leach *et al* (1959). Loose bulk density was determined by the method described by Akpapunam and Markakis (1981).

2.1.6. Statistical Analysis

The data obtained were analyzed statistically using analysis of variance (ANOVA) to detect significant differences among the sampled means at ($p \leq 0.06$). Significant means were separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

3. Results and Discussion

The functional properties of flour samples obtained from melon seed, Osu and Maize are presented in Table 2. The water absorption capacity of the flour samples ranged from 5.8ml/g to 9.6ml/g with melon seed flour having the highest value and maize seed flour having the least values. Water absorption characteristics represents the ability of a product to associate with water under conditions where water is limiting (Singh, 2001). According to Hodge and Osman (1976), flours with high water absorption have more hydrophilic constituents. This suggests that melon seed with a highest water absorption capacity has more hydrophilic constituents than the other samples while maize seed flour with the lowest water absorption capacity has the lower hydrophilic constituent than the other samples. Results show that all the values were significantly different ($p \leq 0.05$) from each other. The oil absorption capacity of the flour samples ranged from 3.06ml/g – 7.38ml/g with melon having the highest value and Osu flour having the least value. The oil absorption capacity (OAC) of flour is also important as it improves the mouth feel and retains the flavour (Kinsella, 1976). According to Kinsella (1976), more hydrophobic proteins show superior binding of lipids, implying that non-polar amino acid side chains bind the paraffin chains of fats. Based on this suggestion, it could be inferred that melon seed flour, which showed higher oil absorption capacity, had more available non-polar side chain in its protein molecules than Osu flours. Flours with excellent oil absorption capacity will be useful in the preparation of pastries. Results show that all the values were significantly different ($p \leq 0.05$) from each other. The swelling capacity of the flour samples ranged from 1.0% - 10.10% with melon having the highest value (10%) and maize (10%) and Osu (1%) flours having the least value. The results show that there were no significant differences ($p \leq 0.05$) from the results obtained. The bulk density of the flour samples ranged from 4.73g/ml. – 10.3g/ml with maize having the highest value and Osu flour having the least value. Bulk density is a measure of heaviness of a flour sample (Akubor and Badifu, 2004). High bulk density is disadvantageous for the formulation of weaning foods where low bulk density is required (Ubbor and Atuonwu, 2010). This suggests that flours with high bulk density such as maize flour will be disadvantageous in the formulation of weaning foods, while Osu flour with the least bulk density will be advantageous. Flours with good bulk density will also be useful in the preparation of bakery and confectionary products. Results show that all the values were significantly different ($p \leq 0.05$) from each other. The Loose Bulk Density (LBD) of the flour samples ranged from 7.67g/ml – 15.9g/ml with Maize having the highest value and Osu flour having the least value. The loose bulk density was observed to flow the same trends as the packed bulk density. Emulsion capacity of the sample ranged from 20% in maize to 27.20% in melon seed flour. Values obtained were all significantly different ($p \leq 0.05$) from each other. Results obtained suggest that melon seed flour has better emulsifying properties than the other flour samples.

3.1. Functional Properties of Cake Pre-Mix

The functional properties of cake pre-mix are shown in Table 3. The water absorption capacity of the cake pre-mix ranged from 8.81ml/g – 9.26ml/g with melon/Osu (ratio 80/20%) having the highest value while melon/maize (80/20%) having the least value. It was observed that all the cake pre-mixes containing Osu were not significantly different ($p \geq 0.05$) from each other but they were significantly higher than the pre-mix without Osu. According to Chen and Lin (2002), flours with higher value of water absorption capacity could retain some of the matrix of macromolecules that have the potential to entrap a large amount of water. This suggests that the combination of melon with Osu at different ratios has an increased ability to retain or entrap large amounts of water while maize has a reducing effect on the water absorption capacity. The result corroborates the findings in Table 2 where maize flour was seen to have the least water absorption capacity. According to Okoye and Igwe (2013) flours with high water absorption capacities are desirable for use in the preparation of sausages. This suggests that melon/Osu flour blends with high water absorption capacity will be desirable in the preparation of sausages. There is no difference in trends of water absorption capacity, oil absorption capacity, swelling capacity solubility between the control and mixture containing up to 8% maize. The oil absorption capacity of the cake pre-mix ranged from 6.51ml/g – 7.80ml/g with melon/maize ratio (80/20%) having the highest values while melon/Osu (80/20%) having the least value. It was observed that Osu had a lowering effect on the oil absorption capacity. This could be due to the low oil absorption capacity of Osu flour as seen in Table 2. Since oil absorption capacity of flours has been reported to improve mouth feel and retain flavour, this suggests that the melon/maize blend should have improved mouth feel and flavour. The swelling capacity of the cake pre-mix ranged from 9.40% - 10.2% with melon/ Osu/maize (80/16/4%) having the highest value while melon/Osu/Maize ratio (80/12/8%) having the least value. These results showed that all the values were not significantly different ($p \geq 0.05$) from each other. The solubility of the cake pre-mix ranged from 33.26% - 33.83% with melon/Osu/Maize ratio (80/12/8%) having the highest value while melon/Maize (80/20%) having the least value, but the solubility of the blends containing up to 8% maize did not significantly differ from the 8/20 melon/osu. Low protein solubility impairs foam formation in the cake system. Solubility for mixtures containing maize are the same, but different from the control melon/osu mix. The result shows that all the values are significantly ($p \leq 0.05$) different from each other.

The bulk density of the cake premix ranged from 5.40 – 6.43g/ml with melon/maize (80/20%) having the highest value while melon/Osu (80/20%) having he least value. The highest bulk density observed in the maize/melon blend could be due to the high bulk density of maize flour observed in Table 2. Increase in bulk density is desirable, in that it offers greater packaging advantage as greater quantity may be packed within constant volume (Molina *et al*, 1983). The loose bulk density of the cake premix ranged from 8.97 – 10.21g/ml with melon/maize (80/20%) having the highest value while melon/Osu (80/20%) having the least value. Results show that all the values are significantly different ($p \leq 0.05$) from each other. The emulsion capacity of the cake pre-mix range from 26.00 – 27.30% with melon/Osu (80/20%) having the highest value while melon/maize (80/20%) having the least value. Flours containing maize shows significantly lower emulsion capacity than did melon/osu blend. This could be due to the lower emulsion capacity of maize seen in Table 2.

4. Conclusion

This study has revealed that partial substitution of *p-tuber-regium* (Osu) with maize in melon seed cake analogue recipe at the level of 8% resulted in blends with functional properties close to those of melon/Osu blend in terms of swelling capacity, water absorption capacity, oil absorption capacity, but these blends have emission capacity, solubility, bulk density different from the control. This implies that the final product may not possess characteristics too different from what is acceptable by consumers.

S/N	Melon	Osu	Maize
1.	80	20	- (control)
2.	80	16	4
3.	80	12	8

Table 1: Ratios of Melon seed flour: Osu flour: Maize flour

	Melon	Osu	Maize
WAC ml/g	9.60^{a}	8.90^{b}	5.80^{c}
OAC ml/g	7.38^{a}	3.06^{c}	5.67^{b}
SC %	10.00^{a}	1.00^{a}	10.00^{a}
S %	38.00^{b}	12.40^{b}	15.20^{b}
BD g/ml	5.61^{b}	4.73^{c}	10.30^{a}
LBD g/ml	9.42^{b}	7.67^{c}	15.90^{a}
EC %	27.20^{a}	24.00^{b}	20.00^{c}

Table 2: Functional Properties of Raw Materials

Values are means of triplicate sample determination.

Values on the same column bearing different superscripts varied significantly ($p < 0.05$).

	Melon/osu 80/20%	**Melon/maize 80/20%**	**Melon/osu/maize 80/16/4%**	**Melon/osu/maize 80/12/8%**
WAC ml/g	9.26^{a}	8.81^{b}	9.24^{a}	9.21^{a}
OAC ml/g	6.51^{b}	7.80^{a}	6.62^{b}	6.70^{b}
SC %	9.56^{a}	9.60^{a}	10.2^{a}	9.40^{a}
S %	32.28^{b}	33.26^{a}	33.70^{a}	33.83^{a}
BD g/ml	5.40^{d}	6.43^{a}	5.67^{c}	5.87^{b}
LBD g/ml	8.97^{d}	10.21^{a}	9.36^{c}	9.76^{b}
EC %	27.30^{a}	26.00^{b}	26.30^{b}	26.30^{b}

Table 3: Functional Properties of Cake Pre-mix

Values are means of triplicate sample determination.
Values on the same column bearing different superscripts varied significantly ($p < 0.05$).

5. References

i. Adebayo-Tayo, B, Friday E.E., and Adebayo-Tayo B.C. (2009); Microbiological and Nutritional Qualities of Retail and Laboratory. “Ikpan” (Mushroom – Melon Cake), a local snack. The Internet Journal of Nutrition and Wellness. 2009, Vol. 8, No. 2.
ii. Akpapunam, M.A. and Markakia, P. (1981); Physicochemical and nutritional aspects of cowpea flour. Journal of food science, 46: 972 – 973.
iii. Akubor, P.I., Badifu Glo (2004); Chemical Composition Functional Properties and Baking Potential of African Breadfruit Kernel and Wheat Flour Blends. Int. J. Food Science and Technology, 39: 223 – 229.
iv. Blench R.M. (1997). The History of Agriculture in North Eastern Nigeria. Assessed on http://www.rogerblench.info/ethnoscience/nigeria-agriculture.pdf.
v. Chen, M.J. and Lin, C.W. (2002); Factors Affecting the Water Holding Capacity of Fibrinogen/Plasma Protein Gels Optimized by Response Surface Methodology. Journal of Food Science; 67(7): 2579 – 2582.
vi. Duncan, D.B. (1955); Multiple Range and Multiple F. Test: Biometrics 2, 164 – 186.
vii. Enwere, N.J. (1998); Foods of Plant Origin. Afro – Orbis Publication Ltd; Nsukka, Nigeria. pp106 – 109.
viii. Hodge, J.C. and Osman, E.M. (1976); Carbohydrates in R.O. Fennema (Ed), Principles of Food Science, Part 1. food Chemistry (pp. 97 – 200). New York: Marcel Dekker.
ix. Kinsella, J.E. (1976); Functional Properties of Protein in Foods: A Survey. Critical Reviews in Food Science and Nutrition, 7, 219 – 232.
x. Leach, H.W.; McCowen, L.D. and Scoch T.J. (1959), Structure of starch Granule 1. Swelling and Solubility Patterns of Various Starches Cereals Chemistry, 36: 534 – 544.
xi. Molina, M; Braham, J.E. and Bressani, R. (1983); Some Characteristics of whole corn: whole soybean (70:30) and rice: whole soybean (70:30) mixtures processed by simple extrusion cooking, Journal of Food Science (48): 434 – 437.
xii. Odigboh, E.U. (1977); A Spinning disc ‘melon’ seeds shelling machine: Development, Design and prototype construction. Accepted for publication in Transaction of ASAE, Ms No., p. 22.
xiii. Okoro, J.U. (1997); Modification and performance evaluation of an Egusi melon shelling machine. An unpublished Bachelor of Engineering Project. Department of Agriculture Engineering, Federal University of Technology Owerri, Nigeria.
xiv. Okoye, J. I. and Igwe, J.F. (2013) Effect of Sporting and Fermentation on the Chemical Composition and Functional Properties of African Yam bean. Journal of Science and Technology, Vol. 19, pp. 42 – 47.
xv. Omidiji, M.O., Oyedokun, J.B., Akinlsotu, T.A., Ogufowora, A.O. Oputa, C.O. (1985), Exploratory Survey on Cropping System and Related Activities at Ilugun Local Government Area, Ogun State. In Farming System Research in Nigeria: Diagnostic Surveys, Editing by Omidjiji. pp. 664 – 669.
xvi. Onwuka G.I. (2005); Food analysis and instrumentation. Theory and Practice Naphthali Prints, Lagos, Nigeria. 133 – 136.
xvii. Singh, U. (2001); Functional properties of grain legume flours. Journal of Food Science and Technology; 38(3), 191 – 199.
xviii. Ubbor Stella, C. and Atuonwu Adanma (2010); Functional Properties of water melon on seed flour. Book of Extended abstract of 34th Annual Conference and General meeting of NIFST. Garden City Port Harcourt, Oct. 18 – 20, 2010. 56.