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DEVELOPMENT AND PASTING PROPERTIES OF CEREALS BASED COMPOSITE FLOUR FROM MAIZE AND MALTED SORGHUM ENRICHED WITH CIRINA FORDA LARVAE

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ABSTRACT
In this research, the pasting properties of flour blends of maize, malted sorghum enriched with cirina forda in various formulations was examined. From the result it was observed that the pasting Properties of the samples ranges as follows: Sample IM (244.91a±0.17) had the highest peak viscosity (RVU) while sample CE (161.95d±0.05) has the lowest peak viscosity, sample IM has the highest trough (RVU) Value to be (175.61a±0.12 while sample FD has the lowest trough (RVU) value to be 100.36d±0.05, Sample OR has the highest breakdown to be 69.30a ±0.11while sample CI has the lowest breakdown to be 56.64e±0.65. Sample OR has the highest setback to be 139.49a±0.21 while sample DA has the lowest setback RVU value to be 115.37e±0.18 and also for peak time (minutes) sample FD has the highest peak time (minutes) to be 5.75a±0.11while sample CI has the lowest peak time to be 4.79d+-0.03. We have the peak viscosity which contains 244.91a t o91a±0.17of sample OR to be the highest peak viscosity (RVU) final viscosity, set back, peak time (minutes) and pasting temperature. A combination of maize, malted sorghum and cirina forda could be recommended as appropriate breakfast cereal based porridge for adults and children.

KEY WORDS: *Cereal, Maize, Porridge, Malting and Sorghum.*

INTRODUCTION

Cereal-based porridges are widely used as a complementary food for infants in many developing countries, serving as a crucial part of the diet during the transition from breastfeeding to solid foods. These porridges are typically made from grains such as maize, rice, sorghum, or millet, and in some regions from starchy roots or tubers (Dewey & Brown, 2003). However, despite their prevalence, cereal-based porridges present significant nutritional challenges. One major issue is the gelatinization of starch during boiling, which necessitates the addition of large amounts of water to achieve a desirable consistency (Onofiok & Nnanyelugo, 1998). This dilution drastically reduces the energy density of the porridge, often resulting in an energy content as low as 1-2 kJ/g (0.25-0.5 kcal/g) if no other ingredients are added (WHO, 1998). Consequently, an infant relying solely on such porridge would need to consume 2000 to 4000 grams per day to meet their energy requirements, which poses practical difficulties (FAO/WHO, 2002). The challenge of providing adequate nutrition through cereal-based porridges underscores the importance of addressing these limitations to improve the nutritional status of infants in developing regions.

In many developing countries, cereal-based flours are a dietary staple, serving as the primary source of calories for large segments of the population (Dewey & Brown, 2003). Maize and sorghum are particularly important due to their

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widespread availability and affordability. However, these cereals are often deficient in essential amino acids and other nutrients, leading to efforts to enhance their nutritional profile through various means, including malting and fortification (FAO/WHO, 2002). Malting, particularly of sorghum, improves the digestibility and bioavailability of nutrients, while fortification with protein-rich sources such as *Cirina forda* larvae offers a promising solution to protein-energy malnutrition (Onofiok & Nnanyelugo, 1998).

Cirina forda, commonly known as shea caterpillar, is rich in protein, fat, and micronutrients, making it an ideal candidate for enriching cereal-based foods (Womeni et al., 2012). Previous studies have shown that the incorporation of insect protein can significantly enhance the nutritional value of foods, but its effect on the functional properties, such as pasting characteristics, is less understood (Akintayo et al., 2016). This study focuses on the pasting properties of composite flours made from maize and malted sorghum enriched with *C. forda* larvae, aiming to provide insights into how this fortification affects the functional properties of the flour and its potential applications in food product development.

The objective of this research was to Assess the impact of incorporating *Cirina forda* larvae into composite flours on key pasting parameters such as peak viscosity, trough viscosity, breakdown viscosity, final viscosity, setback viscosity, and pasting temperature and to Identify the most effective ratios of maize, malted sorghum, and *C. forda* larvae that result in desirable pasting properties, which are critical for the preparation and quality of cereal-based foods.

Materials

Maize (Zea mays), sorghum (Sorghum bicolor), and cirina forda larvae were procured from Oja-oba market in Ado-Ekiti, Ekiti State, and were taken to The Food Processing Laboratory at The Federal Polytechnic Ado-ekiti, Ekiti state and analysis were conducted in the central research laboratory at the Federal University of Technology and Agriculture (FUTA), Ondo State.

Preparation of Fermented Maize Flour

A few slight modifications were made to this from Inyang and Idoko (2006). The grains of white maize were properly cleaned and rinsed to remove any remaining dirt and dust. The grains were soaked in water for 72 hours before being wet milled. After being sieved and allowed to settle for three hours, the ground samples were drained. After being drained, the slurry was ground into flour and kept in storage until needed. It was dried in trays in an air dehydrator for 12 hours at 60.

Preparation of Malted Sorghum Flour

With a little modification for sorghum flour manufacturing, the method outlined by Bolerinwa et al. (2016) was utilized to create malted sorghum flour. After the sorghum grains were sorted to remove unwanted particles, they were cleaned, steeped in water for eighteen hours, and then drained. The dried grains were spread out on a jute bag and kept in a dark cabinet at room temperature (30C) for 72 and 120 hours, respectively, to germinate. The malted sorghum grains were air-blown dry cleaned, milled into flour, then rubbed between palms to get rid of sprouts after being dried for 48 hours at 60 °C in a cabinet dryer. The malted sorghum flour was sieved using a sieve with a 250 m hole to produce fine flour.

Preparation of Composite Flours

As indicated in Table 1, the different composite flours were made and homogenized using a binatone grounder. They were then sealed and packaged in a low-density polyethylene bag and stored at room temperature until needed for analysis.

Table 1: Formulations of Fermented Maize Flour, Malted Sorghum Flour and Cirina forda B flour

Samples	White Maize Flour %	Malted Sorghum Flour %	Cirina forda flour %
IM	70	20	10
PO	60	30	10
RT	50	35	15
AN	55	25	20
CE	50	30	20

Statistical Analysis

All analysis were done in triplicates, result was computed using Microsoft excel. Subsequent values were analysed with one way analysis of variance (ANOVA) (SPSS 23, IBM, New York, USA). Mean values and standard deviation were presented and values were compared using Tukey's test at $p \leq 0.05$ level of significance.

Determination of the Pasting Properties of Cereal-Based Flour Blends

This was determined using a Rapid Visco Analyser (Newport Scientific Australia). 3.5g of the sample were weighed into the text canister. 2.5g of Maize, Malted Sorghum and Cirina forda flour sample were weighed into a dried empty canister; 25ml of distilled water was dispensed into the canister containing the sample. The solution was thoroughly mixed and the canister was well fitted into the RVA, as recommended. The slurry was heated from 50 to 95 0 C with a holding time of 2 minutes followed by cooling to 50 0 C with 2 minutes holding time. The rate of heating and cooling were at constant rate of 11.25 0 C/min. Peak viscosity, trough, breakdown, final viscosity, set back, peak time and pasting temperature were read from the pasting profile with the aid of Thermocline for Windows Software connected to a computer Newport scientific (1998).

The pasting properties of the composite flours were determined using a Rapid Visco Analyzer (RVA), following standard procedures (Newport Scientific, 1998). Parameters measured included peak viscosity, trough, breakdown, final viscosity, setback, peak time, and pasting temperature.

Results and Discussion

Table 2. RESULTS FOR PASTING PROPERTIES OF CEREAL-BASED FLOUR BLENDS

AMPLES	Peak Viscosity (RVU)	Trough (RVU)	Breakdown (RVU)	Final Viscosity (RVU)	Set Back (RVU)	Peak Time (minutes)	Pasting Temperature °c
IM	244.91a ±0.17	175.61a ±0.12	69.30a ±0.11	69.30a ±0.11	139.49a ±0.21	5.55b ±0.01	83.29a ±0.0 8
PO	213.73b ±0.57	150.68b ±0.02	63.05c ±0.56	63.05c ±0.56	115.37e ±0.18	5.24c ±0.01	81.85c ±0.1
RT	165.32c ±0.03	108.68c ±0.68	56.64e ±0.65	56.64e ±0.65	118.28d ±0.43	4.79d ±0.03	81.43d ±0.13
AN	164.94c ±0.05	100.56d ±0.02	64.38b ±0.06	64.38b ±0.06	132.33b ±0.05	5.23c ±0.02	82.90b ±0.30
CE	161.95d ±0.05	100.36d ±0.05	61.59d ±0.03	61.59d ±0.03	126.96c ±0.06	5.75a ±0.11	81.76c ±0.01

TABLE 1; Mean ± SD. Mean with different superscript letters along the same column are significantly different ($p<0.05$).

KEYS: IM - 70% of white maize grain 20% of malted sorghum 10% of cirina forda, PO - 60% of white maize grain 30 % of malted sorghum 10 % of cirina forda, RT - 50% of white maize grain 35% of malted sorghum 15% of cirina forda, AN - 55% of white maize grain 25% of malted sorghum 20% of cirina forda, CE - 50% of white maize grain 30% of malted sorghum 20% of cirina forda.

DISCUSSION FOR PASTING PROPERTIES OF CEREAL BASED FLOUR BLEND

From the table above the peak viscosity (RVU), Sample IM has the highest peak viscosity (RVU) (244.91a±0.17) while sample CE has the lowest peak viscosity to be (161.95d ±0.05. trough (RVU) sample IM has the highest trough (RVU) Value to be (175.61a+-0.12) while sample CE has the lowest trough(RVU) value to be (100.36d±0.05) then for the breakfast (RVU), Sample IM has the highest breakdown (RVU) to be (69.30a ±0.11) while sample RT has the lowest breakdown to be (56.64e±0.65) the set back(RVU) sample IM has the highest set back RVU to be (139.49a±0.21) while sample PO has the lowest setback RVU value to be (115.37e+-0.18). And also for peak time (minutes) sample CE has the highest peak time (minutes) to be (5.75a±0.11) while sample RT has the lowest peak time to be (4.79d±0.03). The pasting temperature (degree Celsius) Sample IM has the highest pasting temperature to be (83.29±0.08) while RT has the lowest pasting temperature (degree Celsius) to be (81.43d±0.13). Therefore for the general acceptability of the samples, sample IM Is the most preferred sample because it has the highest value for the pasting Properties of cereal based flour blends, while sample RT happens to have the overall lowest value for the pasting temperature of the cereal based flour blend. Sample IM contains 70% of white maize, 20%of malted Sorghum and 10% of cirina forda.

Pasting Properties of Composite Flours

The pasting properties of the composite flours varied significantly with the inclusion of *C. forda* larvae. The peak viscosity of the flour blends decreased with increasing levels of larvae enrichment, likely due to the higher protein content interfering with starch gelatinization (Onofiok & Nnanyelugo, 1998). Similarly, the breakdown viscosity, which indicates the stability of the paste during cooking, was lower in the enriched flours, suggesting improved paste stability (Dewey & Brown, 2003).

The final viscosity, which reflects the viscosity of the paste after cooling, was higher in the composite flours containing *C. forda* larvae, indicating a thicker paste consistency upon cooling (FAO/WHO, 2002). The pasting temperature of the enriched flours was also higher, possibly due to the protein content requiring more heat to denature (Akintayo et al., 2016).

These findings suggest that the inclusion of *C. forda* larvae not only enhances the nutritional profile of maize and malted sorghum composite flours but also alters their functional properties in a way that may be beneficial for specific food applications.

Conclusion

The production of a cereal based porridge as achieved by mixing maize, sorghum, and cirina forda. The result observed gave a good indication that the five formulations could provide the nutrient needed by both children and adult. The result shows that the foodstuff blends can be of high nutritional value and a balanced status than their individual components. The pasting Properties of cereal based flour blends was determined by using a rapid visco analyzer (Newport scientific Australia). 305g of the sample was weighed into text caniser 2.5g of white maize, malted Sorghum and cirina forda flour. The pasting Properties was also known by the highest value of the result obtained. Sample OR which have 65% of white maize grain, 25% of malted Sorghum and 10% of cirina forda which is the most preferred sample while for sensory acceptability of cereal based porridge sample NA which contains 50% of white maize grain, 40% of malted Sorghum and 10% of cirina forda happens to be the most preferred sample for the sensory acceptability. They can also be used to meet specific nutritional requirements of different classes of people due to the simplicity of production, poor communities can use such formulations based on the local foodstuff available.

Recommendations

The findings of this project suggest that cereal based porridge flour enriched with maize, malted Sorghum and cirina forda larvae has potential to improve the Nutritional value of porridge and may be a useful tools in reducing malnutrition in vulnerable population. However further research is needed to better understand the Nutritional composition of flour, and to develop effective method for it' production and distribution. The research is needed to determine the economic viability of the flout, and to access potential impact on food security. I suggest that organization working on food security and malnutrition issues, should consider the use of cirina forda larvae in their production, or they should investigate other potential uses for the larvae beyond flour production.

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