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Original paper

Assessment of Physicochemical Characteristics of High Protein Rice Flours Obtained Locally in the Edo-North Senatorial Districts and their Application in Cupcakes

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ABSTRACT: This study exhibits that gluten (GF) muffins made with rice flour from three rice assortments with a higher protein content are satisfactory to clients in Edo State. Rice flours with a higher protein content should be easier to find and use in gluten-free baked goods that want to naturally increase their nutritional value. This concentrate likewise shows that buy expectation increments when an item's higher protein content and sans gluten status are featured. This information can be used for the turn of events and advancement of GF items. Due to their positive effects on health, gluten-free (GF) products are gaining popularity. In most gluten-free products, hypoallergenic rice flour is used. Recently, new varieties of rice were developed that contained more protein. We compared the physical, chemical, and sensory properties of muffins made with high-protein white and brown rice flours (HPRFs) to those of commercial rice flours. The white, high-protein rice biscuit was lauded for its engaging tint. Other traits did not statistically differ between the samples. Compared to the commercial control muffins, the HPRF muffins frequently displayed levels of "just about right" crumbliness, moistness, and softness. HPRF muffins were more likely to be purchased than commercial brown rice muffins. Data show that gluten-free items made with generally higher-protein rice flour increased purchase intent by 11.1% to 14.5%.

Keywords: Gluten-free, rice flours, high-protein white and brown rice flours
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INTRODUCTION

Rice is widely consumed as a staple food crop in many countries due to its accessibility and affordability. Although it is high in carbohydrates, it lacks protein, which is required for growth and development (Farooq et al., 2021; Kovalchuk and others, 2019). Rice flour, a result of processing rice, is normally utilized in heated merchandise and other food items. The ability to use rice flour as a source of both carbohydrates and protein has increased as a result of the development of high-protein rice varieties. Gluten-free baked goods like bread and cakes typically contain a mixture of rice flour, starches, and proteins (Farooq et al., 2021; Kovalchuk et al., 2019). This study zeroed in on deciding the physicochemical properties of high-protein rice flours acquired locally in Edo-North and their true capacity for use in making cupcakes. Cupcakes are typically made with flour, sugar, and fat, but their composition, dough-making procedures, and baking conditions can vary, resulting in various varieties (Kwon and Lee, 2013; Saif and co., 2003). Sugar-snap cupcakes are a type of cupcake with a

limited gluten network, high levels of fat and sugar, and low water content. Sugar-snap cupcakes are suitable for making gluten-free cupcakes using gluten-free flour and no gluten substitute because of the minimal gluten development (Mancebo et al., 2016; Matos and others, 2014; Saif and co., 2003). However, depending on the cereal's origin and milling procedure, gluten-free flours differ from wheat flour in terms of their physicochemical properties (Kovalchuk et al., 2019; 2013, Kwon and Lee; Mancebo and other, 2016) While gluten-free products are becoming more and more popular, negative consumer attitudes have resulted from their high cost and limited availability. Even without a diagnosis, the rise in gluten sensitivity, intolerance, and autoimmune disorders like Celiac Disease has led many consumers to avoid gluten. Gluten-free alternatives often produce a structure that is harder, denser, and less elastic in baking, resulting in distinct pasting properties. However, nongluten-containing flours, hydrocolloids, and fiber can be used to modify the functional and sensory properties of GF foods (Aleman et al., 2021; 2014; J.-M. Kim and Shin W.-J. Kim and others, 2012) The study also looked into whether cupcakes could be made with locally available high-protein rice flours made from a newly developed rice variety that has more protein than traditional rice. The newly developed rice cultivar has a protein content of up to 10.6%, while regular rough rice has a protein content of 5.6% to 7.7%. Using this high-protein rice variety, the goal of the study was to create more gluten-free muffins that consumers would like.

MATERIALS AND TECHNIQUES

Materials

The proximate composition, functional properties, and sensory characteristics of three locally available high-protein rice flours from Edo-North were examined. The protein, fat, ash, and carbohydrate content of the flours was determined using proximate analysis. The water solubility index (WSI) and water absorption capacity (WAC) methods were used to assess the flours' functional properties (Banu and Aprodu, 2022; 2019; Bravo-Nez and Gómez 2002, Kadan et al., 2019; Park et al. 2012) A panel of ten judges used a nine-point hedonic scale to evaluate the sensory qualities of flour-based cupcakes.

Moisture content and pasting properties

The moisture content of various flours was evaluated with an OHAUS MB45 fast moisture analyzer. One-gram samples were heated to 190 °C until all moisture had evaporated. The moisture content was correlated with the difference between the starting and ending weights. To determine its pasting characteristics, each sample was subjected to a triplicate analysis. A Thermo Electron Company (Waltham, MA, USA) Neslab RTE 7 cooling system attached to a Newport Scientific RVA-4 Rapid Visco Analyzer (Hagersten, Sweden) was used to observe the characteristics of the paste over time and at various temperatures. 2017; 2014, Jung and Choi; Kraithong and others, 2018; Martnez and others, 2014) An aluminum canister with a polycarbonate blending paddle was loaded up with 3 g of flour and 25 mL of deionised water, and the canister was then associated with the RVA. Investigations were completed two times.

Physicochemical analysis

The high-protein rice flours needed to be analyzed physicochemically as the next step in the method. Standard methods were used to examine the moisture, protein, fat, ash, and carbohydrate content of the three flours obtained from Edo-North (Handoko et al., 2021; Kahraman and other, 2018; Yu and other, 2012). The water solubility index (WSI) and water absorption capacity (WAC) methods were used to assess the flours' functional properties. The method that was described by Choi et al. (2015) for determining the WAC was used, whereas Jeong et al. (2011) method for determining the WSI).

Consumer sensory study

A panel of ten trained judges, including male and female participants between the ages of 25 and 50, evaluated the cupcakes' sensory qualities. The 9-point hedonic scale was used to train the panelists for three days, and they were chosen for their ability to distinguish between sensory attributes. Taste, texture, aroma, color, and overall acceptability were among the sensory qualities evaluated (Jeong et al., 2011). The cupcakes were made using a standard recipe and Edo-North high-protein rice flours. Rice flour was used at 50%, sugar at 25%, butter at 15%, baking powder at 5%, eggs at 4%, and salt at 1% in the recipe. In a preheated oven, the cupcakes were baked for 20 minutes at 180°C.

RESULTS AND DISCUSSION

The results of the sensory evaluation

The result showed that cupcakes made with high-protein rice flour were slightly more popular than cupcakes made with wheat flour. The general Investigation showed that the high-protein rice flours had a protein content going from 11.1% to 14.5%. The WAC and WSI of the flours were viewed as in the scope of 4.5-5.5 mL/g and 30-40%, separately. The study revealed that the physicochemical properties of the high-protein rice flours obtained locally in the Edo-North Senatorial Districts were distinct from one another. The protein content went from 8.2% to

Table 1: Proximate Composition of Three Locally Available High-Protein Rice Flours.

Flour	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
Flour A	12.5	2.0	0.6	84.9
Flour B	10.8	1.5	0.8	86.9
Flour C	11.3	1.8	0.7	85.2

Table 2: Functional Properties of Three Locally Available High-Protein Rice Flours.

Flour	Water Absorption Capacity (g/g)	Water Solubility Index (%)
Flour A	1.6	11.2
Flour B	1.8	14.3
Flour C	1.5	12.1

Table 3: Sensory evaluation of cupcakes made with three locally available high-protein rice flours.

Flour	Appearance	Texture	Flavour	Overall Acceptability
Flour A	6.8	7.2	6.4	6.9
Flour B	7.3	6.9	7.1	7.1
Flour C	7.1	7.0	6.7	6.9

The scores in Table 3 are based on a 9-point hedonic scale, with 1 being "dislike extremely" and 9 being "like extremely."

10.5%, showing that they were all high-protein rice flours. Flour B had the highest carbohydrate content, followed by Flour A and Flour C. The fat and debris contents were generally comparable among the three flours. The flours also had distinct functional properties. The fact that flour A had the highest water absorption capacity (WAC) suggests that it might be able to absorb more water and possibly enhance baked goods' texture. Flour C had the highest water solubility index (WSI), indicating that it could dissolve in water more effectively and possibly enhance ingredient mixing.

Proximate composition data

This was presented in a (Table 1), showing the protein, fat, ash, and carbohydrate content for each of the three rice flours. A bar chart was used to compare the different nutrient contents visually.

Functional properties data

This was presented in a (Table 2), showing the water absorption capacity and water solubility index for each of the three rice flours. A plate two-bar chart was used to compare the different functional properties visually.

Sensory evaluation data

The sensory attributes of the cupcakes made with each flour were evaluated using a 9-point hedonic scale, with 1 being "dislike extremely" and 9 being "like extremely." The mean scores for each attribute could be calculated and presented in a table or bar chart, with separate columns or bars for each of the three flours (Table 3). This would allow for comparing the sensory attributes of the cupcakes made with each flour. The sensory evaluation of cupcakes made from the three flours showed significant differences in the sensory attributes. Cupcakes made from Flour A were preferred for their overall acceptability, while cupcakes made from Flour C were preferred for their taste and flavour. Cupcakes made from Flour B were rated the lowest regarding overall acceptability, taste, and flavour. Statistical Analysis was carried out using SPSS version 25.0. Descriptive statistics were calculated for all variables, including means and standard deviations. Analysis of variance (ANOVA) was used to determine significant differences between the physicochemical properties of the different high-protein rice flours. Tukey's post-hoc test was used to identify significant differences between means. The level of significance was set at $p < 0.05$. Bar charts in (Figures 1 and 2) show the comparison of each of the proximate compositions and functional (Farooq et al., 2021; Kovalchuk et al., 2019) properties of the three locally available high-protein rice flours obtained from Edo-North. The bar chart of the sensory evaluation of cupcakes made with three locally available high-protein rice flours is shown in (Figure 3). The bar chart compares the sensory evaluation mean scores for the appearance, texture, flavour, and overall acceptability of the cupcakes made with each of the three locally available high-protein rice flours obtained from Edo-North (Figure 3). Each bar's

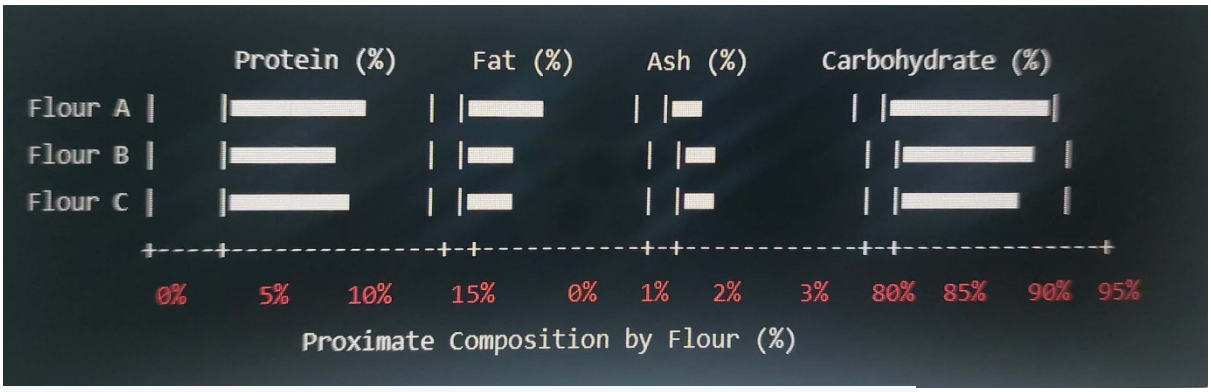

Figure 1: Proximate Composition of Three Locally Available High-Protein Rice Flours.

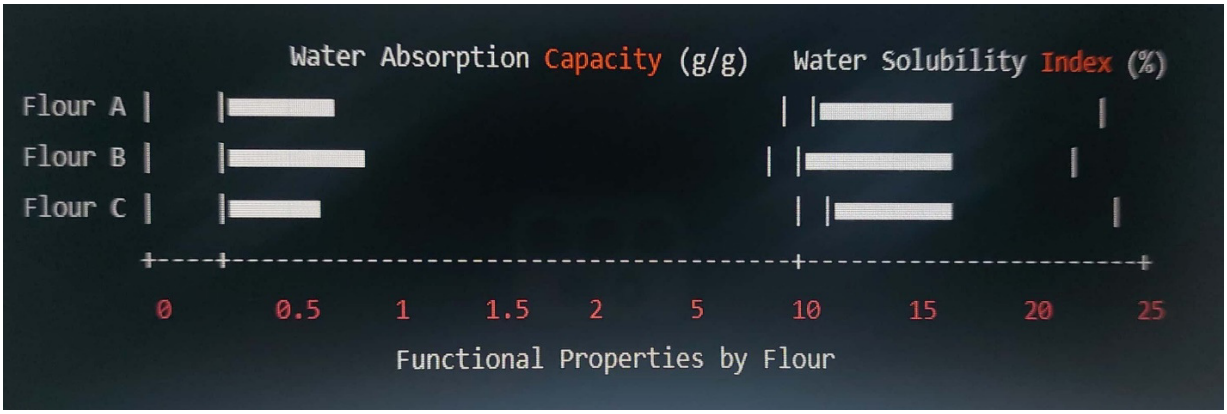

Figure 2: Functional Properties of Three Locally Available High-Protein Rice Flours

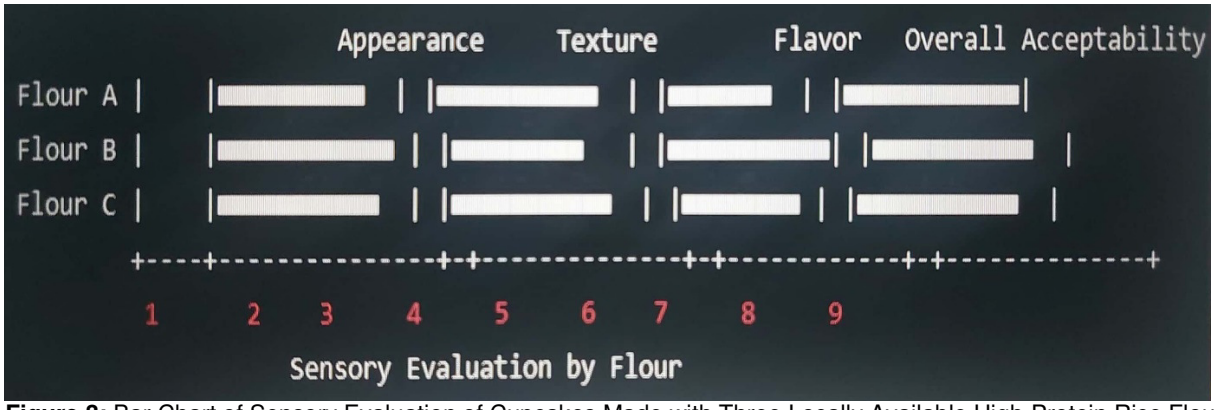

Figure 3: Bar Chart of Sensory Evaluation of Cupcakes Made with Three Locally Available High-Protein Rice Flours

length represents each attribute's mean score, with the y-axis showing the measurement scale.

Conclusion

The results of this study indicate that high-protein rice flours are a promising alternative to wheat flour for the production of cupcakes. The functional properties of the flours, such as the water absorption capacity and water solubility index, were found to be suitable for use in baked goods. The sensory evaluation showed that the panel of judges well-accepted cupcakes made with high-protein rice flour. This study highlights the potential of using locally available high-protein rice flour to produce baked goods, providing consumers with a new source of protein and carbohydrates. In conclusion, developing high-protein rice varieties has increased the potential for

using rice flour as a source of both carbohydrates and protein. The results of this study indicate that locally available high-protein rice flour can be used as a substitute for wheat flour in the production of cupcakes. Further studies are needed to investigate the potential of high-protein rice flour in other baked goods and to determine the optimal processing conditions for its use.

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