Physical and Sensory Properties of Bread and Roti Made from Rice-Wheat Composite Flour

Narita Chandrawattie Singh, Dharamdeo Singh, Roland Daynauth, Nequesha Dalrymple, Rajendra Persaud, and Bissessar Persaud

ABSTRACT

Guyana is targeting a reduction in its food import bill by substituting wheat, a major food commodity imported, with locally grown crops. In this study, the physical and sensory characteristics of value-added products (bread and roti) made from various ratios of rice-wheat composite flour were examined to ascertain whether bread and roti could be successfully used to partially replace wheat flour. Bread and roti were produced from rice-wheat composite flours at rice:wheat ratios of 100:0, 20:80, 40:60, 60:40, and 80:20. Physical evaluation showed significant differences in the width, height, weight, and volume of bread produced from the composite rice-wheat flour and the control (p<0.05). Significant differences were also observed for the thickness and weight of the roti (p=0.005 and p=0.024 respectively). There were no significant differences in the length among treatments for both bread and roti (p=0.05 and p=0.10, respectively). The length, height, weight and volume of bread and the length, thickness and weight of roti produced from 20% rice flour+80% wheat flour was statistically similar with the control (100% wheat) treatments (p>0.05). For the sensory evaluation, there were significant differences for all attributes evaluated including aroma, colour, texture, taste, and overall acceptance (p=0.001). Sensory attributes for bread treatments made from 20% rice flour+80% wheat flour and roti treatments made from 20% rice flour+80% wheat flour and 40% rice flour+60% wheat flour were similar to the control (p>0.05). The study revealed that substituting 20% of wheat flour with rice flour in products such as bread and roti is possible without compromising the quality and sensory characteristics of the products.

Keywords: Composite Flour, Physical Properties, Sensory Properties.

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I. INTRODUCTION

Guyana’s food import bill has been increasing over the years. In 2022, the value of food import for cereals, flours, and starches was USD $48,651,200 [1]. In 2014, Guyana imported US$24 millions of wheat [2]; this amount is estimated to be higher today with the current increase in global wheat prices. Wheat is strictly imported in Guyana; and only recently has field trials on wheat varieties commenced [3].

Wheat flour is the major ingredient in two of Guyana’s primary staple foods, bread, and roti. The use of wheat flour has increased significantly with the introduction of numerous lines including high fibre, whole wheat, multigrain, and instant mixes (e.g., parsad and halwa mix, pholourie mix, roti mix) made from wheat flour [4]. In 2021 after the Covid-19 pandemic, Guyana saw an 11.6% increase in some food prices. In 2022, the prices of these food commodities declined; however, wheat prices continued to increase [5]. As a result, the cost for bread and other related products increased [6]. In non-wheat-producing countries, like Guyana, the importation of wheat will only continue to grow unless a substitute for wheat is incorporated in the preparation of popular staple foods such as bread and roti.

Composite flour involves mixing or replacing various types of flours with or without wheat flour. Wheat flour can be substituted/replaced with tubers, root crops, cereals, berries, legumes, and nuts [7]. Non-wheat flours are usually good sources of dietary fibers, minerals, and phenolic compounds and when used to partially replace wheat flour they usually improve the nutritional quality of the products [8]. The concept of composite flour can be traced back to 1964, where the Food and Agricultural Organization (FAO) promoted the use of indigenous crops as a partial substitution for wheat flour. The project yielded bakery products (made from composite flours) that had characteristics similar to those made from wheat flour [9].

Bread is considered one of the most ancient foods;
however, its consumption has been rapidly increasing especially in developing countries [10], and Guyana is no exception. Roti is a flatbread made from wheat flour, baking powder, oil/fat and water which is then cooked on flat roti pan called the “tawah”. It is usually eaten with curries or stews and is consumed at breakfast, lunch and dinner by persons of all cultural backgrounds in Guyana. In Guyana, there have been several attempts to substitute wheat flour in bakery products. In 2016, the National Agricultural Research and Extension Institute (NAREI) in collaboration with a local bakery launched a line of bread made from 20 to 30% cassava flour and wheat flour with plans of expanding the blend to other products, such as pastries [11]. The plans for expansion did not materialize and the project was unfortunately halted. One possible explanation for the failure of the project was the unstable supply of large amounts of cassava to produce the flour. The University of Guyana, however, is also working on composite flour using sweet potatoes and cassava and has seen successful results in numerous trials. The University has since indicated that for the commercial supply of baked products, there needs to be an increase in the production of sweet potatoes and cassava in Guyana [12].

Rice is a crop that is better suited to produce composite flour since it has no supply-side constraints. It accounts for the largest agricultural sector in Guyana with respect to the area cultivated, its production, and yearly increase in yield [13]. Annually, over 90% of the rice produced is exported [13] and the remaining is consumed locally as boiled rice. Compared to other major rice-producing countries, rice is under-utilized; and value-added rice products are usually imported.

Rice flour is produced from rice that is finely milled and can be a good substitute for wheat flour especially in products consumed by individuals suffering from Celiac Disease [14]. However, non-wheat flours such as rice have technological properties that differ from wheat flour including rheological changes which prevent the production of a viscoelastic dough [8]. This phenomenon is due to the absence of gluten proteins in rice flour. Gluten proteins create a strong viscoelastic network; are important for gas retention during fermentation; and play a critical role in water absorption, extensibility, resistance to deformation, tolerance to kneading and dough strengthening properties [9], [15]. Products made from 100% non-wheat flours using conventional methods do not have good textural properties and are therefore usually blended with wheat flour in small quantities to prevent significant alterations in the physical and sensory characteristics of the end product. Since the quantity of gluten is lowered in composite flour, gas retention during fermentation is also lowered and this results in lower volume and porosity and affects the ratio between the height and width of the loaf and hence its overall quality. When producing bakery products from composite flour, it is important that the quality of the products is as similar to those made from wheat flour. This study aims to determine a suitable blend of rice-wheat flour for the production of bread and roti that would not compromise the physical and sensory properties and hence overall quality of the products.

II. METHODOLOGY

A. Source of Raw Materials

Namilco all-purpose Thunderbolt wheat flour was procured along with other baking ingredients (yeast, oil, baking powder, sugar, and salt) from a local supermarket. The rice flour was obtained by milling GRDB 10, Guyana’s most dominant rice variety.

B. Rice Flour Preparation

GRDB 10 paddy was shelled and then polished according to the acceptable standard. The polished/white rice was milled by a Burr mill to produce the rice flour, which was then passed through a sieve to achieve a particle size of less than 350 µm.

C. Preparation of the Composite Flour

The rice flour was blended with the wheat flour in different combinations using a mixer. Table I shows the various combinations. 100% wheat flour was used as a control treatment. The various treatments of composite flour were stored in a sealed container.

D. Preparation of Bread

The straight dough method was used to prepare the bread [16]. For this method, all the ingredients: flour (100 g), salt (1 g), water (64 ml), sugar (20 g), yeast (3 g) and shortening (3.5 g); were added at the mixing stage and kneaded to obtain a dough. The dough samples were placed in labelled baking pans, smeared with vegetable oil and covered for one hour to allow for fermentation and gluten development. The bread samples were baked in an oven for 15 minutes at 176.67 ºC. After baking, the loaves were carefully removed from the pans, allowed to cool (at room temperature) and packaged in polyethylene bags for analysis.

E. Preparation of Roti

All ingredients: flour (100 g), baking powder (0.2 g) and water (70 ml); were mixed and formed into soft a round dough. The dough samples were smeared with oil and covered with a damp paper towel for 1 hour. The dough was then flattened evenly to 20 mm thickness and brushed with oil. The flattened dough was rolled to form a ball, and after one hour, it was flattened again to 5 mm thickness. The flattened dough was placed on the heated pan (150 ºC) for 10 seconds then flipped and brushed with oil on both sides. Each side of the roti was heated for 15 seconds. After cooking, the roti was placed in a towel and clapped 5 times to release air pockets.

F. Physical Evaluation of Bread Loaves

Loaf Length, Width and Thickness: The bread samples were placed on a flat surface. The length, width and thickness (height) were determined by measuring the longest, widest, and highest points of the bread using a
vernier caliper. Length, width, and thickness were expressed in millimeters.

Loaf Weight: After cooling, each bread sample was placed on an electronic balance. The weight of the bread loaves was expressed in grams.

Loaf Volume: The loaf volume of the bread was measured using the rapeseed displacement method [17]. A container was filled with barley (used instead of rapeseed) and the amount of barley in the container was weighed ($V_1$). Each bread sample was placed into the same container and barley was added into the container until it was full. The volume of barley in the bread container was measured ($V_2$). The analysis was done using triplicate samples. The loaf volume was calculated as follows:

$$\text{Loaf Volume} = V_1 - V_2 \, \text{(g)}$$

G. Physical Evaluation of Roti

Roti Thickness and Length: After cooling, the thickness and length of the roti samples were measured using a vernier caliper. The length was determined by measuring the diameter of the roti. Thickness and length were expressed in millimeters (mm).

Roti Weight: After cooling, each roti sample was placed on an electronic balance. The weight of the roti samples was expressed in grams.

H. Sensory Evaluation

Sensory evaluation was done on the same day the bread and roti were prepared. The bread and roti samples were coded and presented to twenty-seven (27) semi-trained panelists who were familiar with the sensory attributes of the two products. After evaluating each sample, to clear their palates, panelists were instructed to drink water or rinse their mouths. The panelists scored the aroma, colour, texture (mouthfeel), taste and overall acceptance of the bread and roti using a nine-point hedonic scale (1- dislike extremely, 2-dislike very much, 3-dislike moderately, 4-dislike slightly, 5-neither like nor dislike, 6-like slightly, 7-like moderately, 8-like very much, 9-like extremely).

Sensory Panel: Approval for the sensory evaluation was given by the Research Sub-Committee of the Guyana Rice Development Board. Each participant of the sensory evaluation was verbally informed of research and a description of the treatments was provided. All panelists had to sign consent forms prior to the evaluation.

I. Data Analysis

The analysis of variance (ANOVA) was done to examine the significance level of all parameters measured. The Least Significant Difference (LSD) test was used for the comparison of means with a 0.05 level of significance. Data were reported as the means ± standard deviations.

III. RESULTS AND DISCUSSION

A. Physical Properties of Bread and Roti

Only four bread treatments (T1, T2, T3 and T4) were evaluated for physical characteristics; T5 (80% rice flour) was not included. According to [18], rice flour has low levels of prolamins (about 2.5 to 3.5%), and as a result, the viscoelastic dough was not formed when the rice flour was kneaded with water for T5 bread samples. In addition, gases produced during proofing and baking were not retained and the resulting product did not resemble the control (wheat bread). The physical properties of all five treatments (T1 to T5) were evaluated for roti.

B. Physical Properties of Bread

Length, width, and height of bread: Fig. 1 shows the length, width and height (thickness) of the bread loaves for the four treatments after baking and cooling. The length of all treatments was similar (p=0.74) while significant differences were observed among treatments for the width
and height (p=0.001). Bread loaves consisting of 100% wheat flour were significantly wider (99.09±1.16 mm) than all other treatments and progressively decreased as the level of rice flour increased in each treatment (p=0.001). Bread height/thickness translates to the ability of the dough to trap carbon dioxide and be stretched. The height of the bread loaves for the control (56.23±5.62 mm) and T2 (59.16±7.41 mm) were similar (p>0.05) and significantly higher (p<0.05) than the height of T3 (40.81±2.00 mm) and T4 (31.86±1.11 mm) bread loaves. Studies using soy, sprouted mung bean and mango kernel-wheat composite flour and barley-wheat composite flour also revealed that increasing the proportions of the non-wheat flours affected the shape and height of the bread resulting in more flat products [19], [20].

Weight and loaf volume: There were significant differences in the weight and loaf volume among the various treatments (p=0.13 and p=0.001 respectively) (Table II). According to [21], loaf weight is determined by the amount of dough baked and the amount of moisture and carbon dioxide released from the loaf during baking. Since rice flour is non-glutenous, it aids in moisture and carbon dioxide loss in the loaf which reduces both weight and volume of the bread [21]. T1 (control) bread samples had the highest weight (162.87±3.67 g); however, it was statistically similar (p>0.05) to the weight of T2 (158.10±1.47 g) and T3 (159.70±2.82 g) bread samples and lower (p<0.05) than T4 (157.18±2.53 g) samples. For studies that used other commodities such as sweet potato, sesame, maize and oil bean for composite flour, the loaf weight of the control (100% wheat) was significantly lower than the treatments with composite flours and increased progressively with the increase in the composite flours [16], [22], [23]. However, [24], [21] and [20] found that loaf weight decreased with the progressive increase in the amount of maize, rice and barley flour respectively. Loaf volume can be defined as the space occupied by the bread loaf. One of the major contributing factors to loaf volume is gas retention which is determined by the amount of gluten present in the dough [17]. T2 (20% rice) had the greatest average loaf volume (437.33±67.29 ml) which was similar (p>0.05) to the control (384.40±54.58 ml) and significantly higher (p<0.05) than T3 (28.23±13.42 ml) bread samples. [24] and [21] also found that as the level of rice flour incorporation increased there was a decrease in loaf volume. The loaf volume of bread produced from other types of composite flours such as sesame-wheat, maize-sweet-potato-wheat, and oil bean-wheat were significantly lower than the control treatments (100% wheat), and loaf volume significantly decreased as the level of sesame, maize-sweet potato, and oil bean flour increased [22], [16], [23], [20] observed that bread produced from 10% barley and 90% wheat had similar loaf volume to the control (100% wheat). [19] stated that the reduction in loaf volume may be due to the reduction in the wheat structure forming proteins and a lower ability of the dough to enclose air during proofing.

### C. Physical Properties of Roti

Length and thickness of roti: Like the bread treatments, the length of the roti did not differ significantly among treatments (p=0.10) (Table III). In contrast, a study using white and brown jackfruit flour and gram flour in combination with wheat flour to produce chapati (a product similar to roti) showed that the control (100% wheat) had the smallest length which increased as the amount of wheat flour in the treatments decreased [25]. Significant differences were however observed in the thickness of the various roti treatments (p=0.005). Roti samples made from 100% wheat (control) had the greatest mean thickness (3.27±0.29 mm). The thickness of the control samples was similar to roti produced from 20% rice (T2) and significantly higher (p≤0.05) than those made from 40%, 60% and 80% rice flour (T3, T4, and T5 respectively). In the composite jackfruit seed and gram flour study, the thickness of the chapati treatments varied, with the treatment consisting of 80% wheat + 5% white jackfruit seed flour + 10% brown seed flour + 5% Bengal gram flour being the thickest, and the treatment with the lowest amount of wheat flour (45% wheat) being the thinnest [25].

### TABLE III: THE LENGTH AND THICKNESS OF COMPOSITE RICE-WHEAT FLOUR ROTI TREATMENTS

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Length (mm)</th>
<th>Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>24.50±0.70a</td>
<td>3.27±0.29a</td>
</tr>
<tr>
<td>T2</td>
<td>23.67±0.72a</td>
<td>2.80±0.44a</td>
</tr>
<tr>
<td>T3</td>
<td>24.87±0.60a</td>
<td>2.10±0.10a</td>
</tr>
<tr>
<td>T4</td>
<td>25.00±0.40a</td>
<td>1.57±0.15a</td>
</tr>
<tr>
<td>T5</td>
<td>24.93±0.49a</td>
<td>1.93±0.81b</td>
</tr>
<tr>
<td>Total</td>
<td>24.59±0.72</td>
<td>2.33±0.74</td>
</tr>
<tr>
<td>P - Value</td>
<td>0.10</td>
<td>0.005</td>
</tr>
<tr>
<td>F - Value</td>
<td>2.58</td>
<td>7.39</td>
</tr>
</tbody>
</table>

T1 = 100% wheat/control; T2 = 20% Rice + 80% Wheat; T3 = 40% Rice + 60% Wheat; T4 = T4 60% Rice + 40% Wheat; T5 = 80% Rice + 20% Wheat.

Roti weight: Fig. 2, shows the weight of the various roti treatments. There were significant differences among the treatments (p=0.024). Roti produced from 100% wheat had the highest weight (157.20±3.70 g) which was statistically similar (p>0.05) to that of roti made from 20% rice flour (154.43±0.45 g) and significantly higher (p<0.05) than roti made from 40%, 60% and 80% rice flour (T3, T4, and T5 respectively). In contrast, [25] found that the weight of chapati roti did not differ depending on the amount of wheat flour substituted with jackfruit seed flour and gram flour.

### D. Sensory Evaluation of Bread and Roti

Demographics: Sensory evaluation was done on three treatments of bread and five treatments of roti by 27 semi-trained panelists ranging from the ages of 15 to 60 years. The results of the age distribution of participants showed that the majority of participants (46.3%) were between 26–30 years of age.

Sensory characteristics of bread: There were significant differences among bread treatments for all sensory attributes (p<0.001) (Table IV). T2 (20% rice) bread samples had statistically similar scores (p>0.05) in aroma, colour, texture, taste and overall acceptance when compared to the
composite flour bread. A study using barley-wheat composite flour revealed that 20% barley flour+80% wheat flour bread had statistically similar scores (p>0.05) in crust colour, crumb texture, taste/odour, and overall acceptability to those of the control (100% wheat) [20].

Sensory characteristics of roti: Composite blends for roti ranged from 0 to 80% rice flour. There were significant differences among treatments in the scores of all sensory characteristics evaluated (p=0.001) (Table V). All sensory characteristics for T2 (20% rice) and T3 (40% rice) roti samples were statistically similar to the control (100% wheat) (p>0.05); while sensory scores for T4 (60% rice) and T5 (80% rice) samples remained significantly lower (p<0.05). Studies using composite rice-wheat flour in roti were lacking; however, in some countries, other commodities such as chickpea, jackfruit, quinoa, sorghum and soybeans were used. [26] found that the textural quality of roti (chapatti) using blends higher than 20% chickpea flour was affected and the overall acceptability and textural quality decreased upon increasing chickpea flour at levels of 25 and 30%. The same study revealed that soy flour at the level of 5% and 10% did not change the sensory quality of the roti and were similar to the control (100% wheat) [26]. Another study which used gram flour and white and brown jackfruit seed flour found that 80% wheat flour and 20% of the other flours (5% white jackfruit seed flour, 10% brown seed flour, 5% bengal gram flour) had similar colour, flavour, texture and overall acceptability to chapatis made from 100% wheat flour [25]. [27] also found that composite flour consisting of sorghum and quinoa had less acceptability than chapatis made with 100% wheat and there was a significant decrease in appearance, taste, tearing strength, and aroma with increased sorghum and quinoa flour levels.

**IV. CONCLUSION**

The study was done to identify suitable bread and roti formulations using rice-wheat composite flour. The physical and sensory properties of the bread and roti produced from the composite rice-wheat composite flour were determined and compared to those of the standard products made from 100% wheat. Physical characteristics of bread such as loaf width, height, weight and volume made from the varying ratios of composite rice-wheat flour were all much lower than bread made from 100% wheat except for those made from 20% rice flour and 80% wheat flour. Loaf weight of composite bread had an inverse relationship with amount of rice flour incorporated into the bread. Roti made from 20% rice flour and 80% wheat flour also had similar physical properties (length, thickness and weight) to those made from 100% wheat.

Sensory evaluation of both bread and roti made from composite rice-wheat flour showed that the amount of rice flour in the products influenced the scores of all sensory attributes evaluated inclusive of aroma, colour, texture, taste, and overall acceptability. However, all sensory characteristics for bread made with 20% rice flour and roti made with 20% and 40% rice flour were similar to bread and roti made from 100% wheat flour, respectively.

**TABLE IV: SENSORY SCORES OF BREADS PRODUCED FROM RICE-WHEAT FLOUR BLENDS**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Aroma</th>
<th>Colour</th>
<th>Texture</th>
<th>Taste</th>
<th>Overall Acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>7.38±1.14a</td>
<td>7.80±0.97a</td>
<td>7.47±1.21a</td>
<td>7.70±1.38a</td>
<td>7.63±1.20a</td>
</tr>
<tr>
<td>T2</td>
<td>7.09±1.26a</td>
<td>7.47±1.18a</td>
<td>7.05±1.30a</td>
<td>7.15±1.32a</td>
<td>7.16±1.18a</td>
</tr>
<tr>
<td>T3</td>
<td>6.60±1.49b</td>
<td>6.81±1.35b</td>
<td>6.10±1.62b</td>
<td>6.25±1.86b</td>
<td>5.91±1.95b</td>
</tr>
<tr>
<td>Total</td>
<td>7.02±1.34</td>
<td>7.36±1.22</td>
<td>6.87±1.50</td>
<td>7.03±1.58</td>
<td>6.92±1.65</td>
</tr>
<tr>
<td>F-Value</td>
<td>7.36</td>
<td>15.37</td>
<td>20.63</td>
<td>20.02</td>
<td>20.17</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
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</table>

**TABLE V: SENSORY SCORES OF ROTI PRODUCED FROM RICE-WHEAT FLOUR BLENDS**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Aroma</th>
<th>Colour</th>
<th>Texture</th>
<th>Taste</th>
<th>Overall Acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>6.60±1.63a</td>
<td>6.71±1.83a</td>
<td>6.50±1.89a</td>
<td>6.53±1.73a</td>
<td>6.53±1.30a</td>
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<tr>
<td>T2</td>
<td>6.78±1.47a</td>
<td>6.90±1.53a</td>
<td>6.43±1.61a</td>
<td>6.42±1.81a</td>
<td>6.22±1.30a</td>
</tr>
<tr>
<td>T3</td>
<td>6.64±1.49a</td>
<td>6.47±1.41a</td>
<td>6.01±1.59a</td>
<td>6.24±1.66a</td>
<td>6.13±1.52a</td>
</tr>
<tr>
<td>T4</td>
<td>5.41±1.79b</td>
<td>5.49±1.73b</td>
<td>4.85±1.88b</td>
<td>4.93±2.07b</td>
<td>4.86±1.96b</td>
</tr>
<tr>
<td>T5</td>
<td>5.18±1.89b</td>
<td>4.92±2.17c</td>
<td>4.06±2.00c</td>
<td>4.18±2.06c</td>
<td>4.24±2.04c</td>
</tr>
<tr>
<td>Total</td>
<td>6.12±1.78</td>
<td>6.10±1.91</td>
<td>5.57±2.03</td>
<td>5.66±2.08</td>
<td>5.60±2.03</td>
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<tr>
<td>F-Value</td>
<td>14.99</td>
<td>16.95</td>
<td>25.36</td>
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<td>20.76</td>
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<tr>
<td>P-Value</td>
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**TABLE VI: SENSORY SCORES OF ROTI PRODUCED FROM RICE-WHEAT FLOUR BLENDS**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Aroma</th>
<th>Colour</th>
<th>Texture</th>
<th>Taste</th>
<th>Overall Acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>6.60±1.63a</td>
<td>6.71±1.83a</td>
<td>6.50±1.89a</td>
<td>6.53±1.73a</td>
<td>6.53±1.30a</td>
</tr>
<tr>
<td>T2</td>
<td>6.78±1.47a</td>
<td>6.90±1.53a</td>
<td>6.43±1.61a</td>
<td>6.42±1.81a</td>
<td>6.22±1.30a</td>
</tr>
<tr>
<td>T3</td>
<td>6.64±1.49a</td>
<td>6.47±1.41a</td>
<td>6.01±1.59a</td>
<td>6.24±1.66a</td>
<td>6.13±1.52a</td>
</tr>
<tr>
<td>T4</td>
<td>5.41±1.79b</td>
<td>5.49±1.73b</td>
<td>4.85±1.88b</td>
<td>4.93±2.07b</td>
<td>4.86±1.96b</td>
</tr>
<tr>
<td>T5</td>
<td>5.18±1.89b</td>
<td>4.92±2.17c</td>
<td>4.06±2.00c</td>
<td>4.18±2.06c</td>
<td>4.24±2.04c</td>
</tr>
<tr>
<td>Total</td>
<td>6.12±1.78</td>
<td>6.10±1.91</td>
<td>5.57±2.03</td>
<td>5.66±2.08</td>
<td>5.60±2.03</td>
</tr>
<tr>
<td>F-Value</td>
<td>14.99</td>
<td>16.95</td>
<td>25.36</td>
<td>22.18</td>
<td>20.76</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.001</td>
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<td>0.001</td>
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</tr>
</tbody>
</table>
The study revealed that substituting 20% of wheat flour with rice flour in products such as bread and roti is possible without compromising the quality of the products. This creates an opportunity for Guyana to increase its rice utilization, reduce its wheat flour importation and brings the country one step closer in achieving the Caricom Regional target to cut food imports by 25% by 2025.

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CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

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