SENSORY EVALUATION, PROXIMATE ANALYSIS AND AVAILABLE CARBOHYDRATE CONTENT OF SOY FLOUR INCORPORATED CEREAL BASED TRADITIONAL SRI LANKAN BREAKFAST FOODS

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ABSTRACT

Soy incorporated foods have low glycaemic index and consumption of soya increase insulin sensitivity and improve glycaemic control. Therefore this initial study was conducted to evaluate the feasibility of incorporating soy flour into traditional selected breakfast foods such as rotti, pittu, wandu, thosai, hoppers and string hoppers which could be used as a protein, fiber and polyunsaturated fat enriched low glycaemic foods which will be used for future glycaemic index studies. Rice flour (Bg-352), Wheat flour (Prima) and Soy bean (Pb-1) were used to prepare rotti, pittu, thosai, hoppers, string hoppers and wandu with either 25% soy flour and 75% rice flour mixture (SFRF) or 100% rice flour (RF) or 100% wheat flour (WF) following traditional food preparation methods. Sensory evaluation was conducted to taste, evaluate and comment on sensory characteristics by a trained taste panel. Food items selected by sensory evaluation were analyzed for proximate composition following AOAC methods and available carbohydrate by megazyme assay kit. Student ‘t’ test was performed to compare mean values obtained from proximate composition and available carbohydrate analysis. Except string hoppers all the other preparations with soy flour and rice flour did not change sensory attributes, thus could be used as alternate foods. The amount of fat in the flour made from BG-352 was 1.26 g/ 100g dry weight and protein was 7.3 g/ 100g dry weight. The amount of fat and protein in soy flour made with PB-1 variety was 21.0 g/ 100g and 38.4 g/ 100g dry weight respectively. Protein content of foods prepared with SFRF ranged from 19.05% to 24.3%, WF from 11.3% to 18.5% and RF from 9.1% to 15.0%. Foods prepared with SFRF had higher fat content ranging from 9.2% to 12.1% than WF (5.28 to 6.64%) and RF (5.0 to 6.3%). All foods made with SFRF had higher ash content (1.9%) than RF (1.1% - 1.4%) and WF (0.6% - 1.8%). Hence, rotti, pittu, thosai, hopper and wandu made with 25% soy bean flour and 75% rice flour, had higher protein and fat contents and lower carbohydrate content than rice and wheat flour preparations. This difference could be attributed to high nutrient content of soy. No significant differences were observed in crude fiber content among rotti, pittu, hopper, wandu and thosai prepared with SFRF, RF and WF. Hoppers had the highest available carbohydrate content (28.99±1.0) and wandu had the lowest (23.02±1.2) when made with SFRF. The mean total carbohydrate content calculated by ‘difference’ method and enzymatic method was significantly different in rotti (36.9 ± 2.7 vs 28.47±1.4 %) and wandu (32.2±1.7 vs 23.02±1.2 %) made with soy and rice flour mixture. But in general foods made with 25% soy flour in combination with 75% rice flour had lower available carbohydrate content analyzed by enzymatic method than obtained by ‘difference’ method.

Key words: breakfast foods, rice flour, wheat flour, soy flour, proximate analysis, available carbohydrate
1. INTRODUCTION

Diabetes mellitus is becoming a national burden in Sri Lanka. The predicted estimate of pre-diabetes, diabetes and overall dysglycemia for the year 2030 would be 13.11%, 13.9% and 26.2%, respectively (Katulanda et al., 2008). Long-term consumption of foods with high Glycaemic Index invokes increased insulin demand and results in insulin resistance, leading to Type II Diabetes and thus eventually to cardiovascular diseases (Brand-Miller et al., 2002). It has been proven that management of diabetes at the initial stage and prevention of future onset of diabetes and also diabetes related complications could be easily and effectively achieved by dietary management (Sahabdazian et al., 2006; Committee CDACPGE (2008).

Soybeans (**Glycine max**) are native to Asia, but today this plant is cultivated and consumed worldwide. Soybean flour has many important nutritious components, such as protein (29.8 g %), including all essential amino acids, fats (19.5 g %), carbohydrates (36.1 g %), fibers (3.8 g %), water soluble vitamins particularly B₁ (0.45 g %), B₂ (0.21 g %) and minerals particularly calcium (189 mg %), phosphorus (540 mg %) and iron (7.5 mg %) (Food Composition Tables for South East Asia, 1972). Glycaemic index of soy products are low and are valuable foods to be included in a diabetic diet. This has been attributed to many factors (Lee et al, 2006). The isoflavones are considered to be essential for the healthy functioning of bowels, heart, kidney, liver, and stomach (Perkins, 1997). The superiority of soy protein regarding the capability to reduce blood cholesterol compared to animal derived proteins has also been documented (Desroches et al, 2004). Soy protein exerts several anti-atherogenic effects and it decreases LDL cholesterol significantly. Soy has also been shown to increase insulin sensitivity and to prevent the development of diabetes (Yang et al, 2004). Dietary fiber, protein, and its constituent isoflavones support its role in the improvement of glycaemic control.

Rice (**Oryza sativa**) is the staple food amongst all the ethnic groups in Sri Lanka and is a basic ingredient for many breakfast foods. Rice is approximately 75% carbohydrates, 10% protein, 1 to 2% fat, 10% moisture and 1 to 2% ash. Whole grains are good source of iron, thiamine and niacin and fair source of riboflavin (Food Composition Tables for South East Asia, 1972). Rice protein does not contain all the essential amino acids in correct proportion for good health, and should be combined with other source of protein. Rice is specially deficient in essential amino acid lysine and high in tryptophan and methionine. Rice flour does not contain gluten so is suitable for people requiring gluten free diet. Rice is a good source of cellulose, which increases bulkiness in the gastrointestinal tract (Charley, 1990).

Literature indicated that the glycaemic index of soy incorporated foods are low and hence have favorable effects on plasma lipid profile and glycaemic control among Type II Diabetes mellitus. Although glycaemic index values for soy and soy milk are included in international table (Atkinson et al., 2008) the glycaemic index values of typical soy incorporated traditional Sri Lankan breakfast foods are not incorporated. Studies on the importance and effect of regular consumption of soy incorporated cereal based breakfast foods in dietary management among healthy and diabetic Sri Lankan individuals under local conditions and lifestyle have not been carried out up to now. The knowledge of the glycaemic index of Sri Lankan soy incorporated cereal based breakfast food preparations will be vital with the increasing incidence of diabetes and cardiovascular diseases, for manipulation of the diets of individuals who are on diet control. Therefore this initial study was conducted to evaluate the feasibility of incorporating soy flour into traditional selected breakfast foods such as rotti, pittu, wendu, thosai, hoppers and string hoppers which could be used as a protein, fiber and polyunsaturated fat enriched low glycaemic foods for diabetics since diabetes affects a significant proportion of Sri Lankan population.

2. MATERIALS AND METHODS

2.1. Raw Materials

Raw rice (Bg-352) was obtained from Rice Research and Development Institute, Bathalagoda. Wheat flour (Prima, Ceylon Agro-Industries Limited, Seeduwa, Sri Lanka) was purchased from the local market. Soy bean (Pb-1) variety was purchased from Pelwehera farm, Department of Agriculture, Dambulla, Sri Lanka.
2.2. Preparation of Raw Materials

Soy bean flour and rice flour were prepared at the Food Research Unit, HORDI, Department of Agriculture, Gannoruwa.

2.3. Soy Bean Flour

Soybean seeds were processed into flour using the method of Wolf and Cowan (1981) to ensure effective removal of most anti-nutritional factors (Joseph, 1974). Soy bean seeds were sorted washed and dehulled using a Hull Remover (Reeves Reliance Electrical Company, Illinois, USA). They were soaked overnight in cold water and blanched at 100°C for 30 minutes, drained by placing on a nylon sieve for 1 hour. Subsequently they are dried in a Vertical Dryer at 50°C for 5 hours (Phoenix TM -10, Japan) and milled using a Ferrell-Ross Roller Mill (Ferrell-Ross Corporation, Oklahoma, Okla, USA) and stored in a 350 gauge polypropylene bag (Wolf and Cowan, 1981) at room temperature.

2.4. Rice Flour

Paddy BG-352 was milled to 7% polishing rate. Raw rice grains were sorted, washed, soaked for 2 hours, drained, dried in a Vertical Dryer at 50°C for 5½ hours (Phoenix TM -10, Japan), followed by milling in a Micro Pulverizer ( Reeves Reliance Electrical Company, Illinois, USA) and stored at room temperature in a 350 gauge polypropylene bag.

2.5. Food Preparation

Six starch based traditional breakfast foods such as rotti, pittu, wandu, hoppers, string hoppers and thosai were prepared at Food Research Unit, Gannoruwa using either 25% soy flour and 75% rice flour (SFRF) or 100% rice flour (RF) or 100% wheat flour (WF) following traditional food preparation methods and it was standardized, so that the composition of the foods prepared on different days did not vary. The ratio of soy flour and red rice flour in SFRF amounts of scraped coconut, coconut water, salt for each food preparation and amount of black gram flour for thosai preparation were selected by considering the palatability accepted by a taste panel.

2.6. Preparation of Rotti

A mixture of flour, required amounts of salt, boiled cooled water and grated coconut were mixed thoroughly to a suitable consistency that did not stick to the bowl. Then the dough was divided into small balls, flattened to get a round shaped rotti. Rotti were placed on a circular rotti pan and heated on a mild blue-flame for 10 min, turning the rotti upside down on the pan at 2 min intervals until the outer surface was brown in colour.

2.7. Preparation of Pittu

Flour was steamed. Then required amounts of grated coconut, salt and boiled cooled water added and made it into putty. This mixture was then broken into small pieces of approximately 2 mm to 5 mm diameter in size. This granular flour mix was loosely packed and steamed in a pittu mould (Pittu-Bambuwa) for about 10-12 minutes.

2.8. Preparation of Wandu

A mixture of flour, required amounts of salt, coconut water, boiled cooled water and yeast were mixed into a paste and kept for 4 hours for fermentation. After 4 hours coconut milk and caramel were added and the paste made to a smooth batter. Then the batter was covered and kept for about 30 minutes. A small amount (25 - 30 ml) of batter was placed in the plate of the Wandu maker and steamed for about 18 - 20 minutes.

2.9. Preparation of Hoppers

A mixture of flour, required amounts of salt, coconut water, boiled cooled water and yeast were mixed into a paste and allowed to ferment for 6 hours. Then coconut milk was added and the paste made to a smooth batter and kept for about 15 to 30 minutes. Then small amount of batter (25 - 30 ml) was placed in a non stick hopper pan and cooked for about 2-3 minutes.

2.10. Preparation of Thosai

A mixture of flour, black gram flour (10%), salt, coconut water and yeast was kept for overnight fermentation. Then required amount of coconut milk was added to make a smooth batter. A small amount of the batter (25 to 35 ml) was spread
into a thin circle on a frying pan and heated on a mild blue-flame for 10 min, turning the thosai upside down on the pan at 2 min intervals until the outer surface became golden brown in colour.

2.11. Preparation of String Hoppers

A mixture of flour, required amounts of salt, boiled cooled water were mixed well to form a ball and kept aside. Then the string hopper mould was filled with the dough and squeezed onto cane trays and was steamed for nearly 8-10 minutes.

2.12. Sensory Evaluation

Sensory evaluation was conducted by 20 trained taste panelists from the Food Research Unit, Gannoruwa. Each panelist received three samples of six freshly prepared rotti, pittu, wudu, hoppers, string hoppers and thosai to taste, evaluate and comment on sensory characteristics. They were asked to evaluate the flavor, texture, color and overall acceptability based on 5 point hedonic scale; like very much = 5, like moderately = 4, neither like nor dislike = 3, dislike moderately = 2 and dislike very much = 1.

2.13. Determination of Proximate Composition and Available Carbohydrate Content

Food items were analyzed for proximate composition by AOAC methods (1995) and available carbohydrate by Megazyme assay kit (Megazyme International Ireland, Ireland). The available carbohydrate are those digested and absorbed by the small intestine such as D-glucose, D-fructose, sucrose, maltodextrins, D-glucose component of lactose, and measured as D-glucose plus D-fructose following enzymatic hydrolysis.

2.14. Statistical Analysis

Non Parametric one - way ANOVA (Analysis of variance) Kruscal Wallis test was performed to calculate Mean Ranks and Significance Levels of color, flavor, texture and overall acceptability of cereal based traditional breakfast foods prepared with SFRF, RF and WF to estimate consumer preference. Student ‘t’ test was performed to compare the mean values of nutrients obtained from proximate analysis. SPSS statistical software version 14 (SPSS inc., Chicago II., USA) was used to analyze data and significances were determined at p< 0.05.

3. RESULTS AND DISCUSSION

3.1. Proximate Composition of Dehulled Soy Flour (PB-1) and Rice Flour (BG-352)

Moisture, fat, protein, ash and crude fiber content of dehulled Soy flour (PB-1) and Rice flour (BG-352) were determined by standard procedures (AOAC, 1995) and carbohydrate content was calculated following by ‘difference’ method. The proximate composition is given in Table 3.1.

In the present study, the amount of fat in rice flour made from BG-352 was 1.26 g/ 100g dry weight and protein 7.3 g/ 100g dry weight. Palipana et al. (1988) determined the proximate composition of rice flour of 12 BG rice varieties grown in Sri Lanka and reported the fat content to vary from 0.07 g/ 100g dry weight (BG-379) to 2.11 g/ 100g dry weight (BG-94-1). They also observed a minimum protein content of 6.29 g/ 100g dry weight in BG-276-5 and maximum amount of 8.98 g/ 100g dry weight in BG-90-2. The fat and protein values obtained for BG-352 variety were within the range reported by Palipana et al. (1988).

The calculated total carbohydrate content of rice flour (BG-352) was 77.81 g/ 100g dry weight. Sompong et al. (2011) analyzed three unknown Sri Lankan rice varieties and found the total carbohydrate content to be between 75.45 to 79.27 g/100g dry weight. Hence, BG-352 variety had carbohydrate content similar to that reported by Sompong et al. (2011) but was slightly lower than the value of 80.1 g/ 100g dry weight given in Food Composition Table for rice flour (Food Composition Table for use in East Asia, 1972). The mean available carbohydrate content of 53.65 g/ 100g dry weight in BG-352 was lower than the calculated total carbohydrate content.
The amount of fat in soy flour in variety (PB-1) in our study was 21.0 g/100g dry weight, which was similar to the value of 21.68 g/100g dry weight reported by Srirwardhana et al. (2002) for the same soy flour variety. Further the protein content in soy flour in variety (PB-1) was 38.4 g/100g dry weight which was slightly lower than the value (41.34 g/100g dry weight) obtained by Srirwardhana et al. (2002).

Carbohydrate composition of soy beans varies according to the geographical locations where the soybean is grown, harvesting conditions and post-harvest processing. The total carbohydrate content of soy flour in the present study was 32.35 g/100g dry weight, which was higher than the value of 28.42 g/100g dry weight reported by Srirwardhana et al. (2002). Dehulled soy beans contain 35% carbohydrates with sucrose ranging between 3-8%, raffinose between 0.1 - 1.5% and stachyose between 1 to 6% and non starch polysaccharides between 20 - 30%, the latter consisting of 8% cellulose and the remaining as peptic polysaccharides (Choc, 2010). Stachyose and other raffinose family oligosaccharides are not digested by humans, chickens, pigs, and other non-ruminant animals (Obendorf et al., 2011). Myoung et al. (2010) reported 4.6% of sucrose in dried powdered soybean seeds when estimated by HPLC method. The available carbohydrate content found in this study was 2.16 g/100g dry weight.

3.2. Sensory Evaluation

The result of sensory evaluation of rotti, pittu, thosai, hoppers, string hoppers and wandu prepared with SFRF, RF and WF by trained taste panel at Food Research Unit, Gannoruwu are presented in table 3.2.

Sensory characteristics such as color, flavor and texture of rotti prepared with SFRF, RF, WF were at the same intensity, therefore no significant differences were identified by the panelists (p >0.05). SFRF (25% soy flour and 75% red rice flour) mixture scored the highest value for overall acceptability (16.90) for Rotti.

Flavor, color and texture of pittu prepared with RF had the highest mean rank. However the mean rank of pittu prepared with SFRF, RF, WF were at the same intensity, therefore no significant differences among them (p>0.05). At the same time pittu prepared with 100% red rice flour (RF) was identified as significantly superior (p = 0.007) in their overall acceptability compared with SFRF and WF.

Among the three thosai preparations, color, flavor, texture of SFRF preparation was identified as significantly superior (p<0.05) with an overall acceptability of 19.30 (p=0.012).

Hopper made with SFRF had the highest mean rank for flavor (17.55). Color and texture of hopper made with RF was superior (18.10, 17.00 respectively). Hoppers made with SFRF and RF were accepted as best food preparation (16.60) but no significant difference was observed (p=0.551) between them.

Among the 3 string hopper preparations color, flavor, texture of WF preparation was identified as significantly superior (p>0.05) than others. String hoppers made using 25% soy flour
Table 3.2. Mean Ranks of Color, Flavor, Texture and Overall Acceptability of all Cereal Based Foods prepared

<table>
<thead>
<tr>
<th>Name of the food prepared</th>
<th>Flavor</th>
<th>Color</th>
<th>Texture</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotti</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFRF</td>
<td>17.15</td>
<td>14.55</td>
<td>16.10</td>
<td>16.90</td>
</tr>
<tr>
<td>RF</td>
<td>17.15</td>
<td>18.30</td>
<td>16.95</td>
<td>16.50</td>
</tr>
<tr>
<td>WF</td>
<td>12.20</td>
<td>13.65</td>
<td>13.45</td>
<td>13.10</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>0.253</td>
<td>0.299</td>
<td>0.516</td>
<td>0.393</td>
</tr>
<tr>
<td>Pittu</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFRF</td>
<td>12.50</td>
<td>12.15</td>
<td>11.20</td>
<td>9.45</td>
</tr>
<tr>
<td>RF</td>
<td>17.10</td>
<td>19.40</td>
<td>18.25</td>
<td>20.90</td>
</tr>
<tr>
<td>WF</td>
<td>16.90</td>
<td>14.95</td>
<td>17.05</td>
<td>16.15</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>0.365</td>
<td>0.132</td>
<td>0.126</td>
<td>0.007</td>
</tr>
<tr>
<td>Wandu</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SFRF</td>
<td>16.10</td>
<td>16.25</td>
<td>16.40</td>
<td>15.05</td>
</tr>
<tr>
<td>RF</td>
<td>16.10</td>
<td>15.25</td>
<td>17.55</td>
<td>17.40</td>
</tr>
<tr>
<td>WF</td>
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<td>15.00</td>
<td>12.55</td>
<td>14.05</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>0.846</td>
<td>0.933</td>
<td>0.278</td>
<td>0.613</td>
</tr>
<tr>
<td>Hoppers</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>SFRF</td>
<td>17.55</td>
<td>15.15</td>
<td>15.30</td>
<td>16.60</td>
</tr>
<tr>
<td>RF</td>
<td>16.15</td>
<td>18.10</td>
<td>17.00</td>
<td>16.60</td>
</tr>
<tr>
<td>WF</td>
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<td>14.20</td>
<td>13.30</td>
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<tr>
<td><strong>P</strong></td>
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<td>0.389</td>
<td>0.742</td>
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<tr>
<td>String Hoppers</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>10.05</td>
<td>9.50</td>
<td>10.80</td>
<td>8.80</td>
</tr>
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</tr>
<tr>
<td><strong>P</strong></td>
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<td>0.012</td>
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<td>0.033</td>
</tr>
<tr>
<td>Thosai</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFRF</td>
<td>18.25</td>
<td>20.70</td>
<td>19.65</td>
<td>19.30</td>
</tr>
<tr>
<td>RF</td>
<td>10.25</td>
<td>8.70</td>
<td>16.60</td>
<td>9.60</td>
</tr>
<tr>
<td>WF</td>
<td>18.00</td>
<td>17.10</td>
<td>16.25</td>
<td>17.60</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>0.003</td>
<td>0.041</td>
<td>0.041</td>
<td>0.012</td>
</tr>
</tbody>
</table>

and 75% red rice flour was identified as significantly inferior (overall acceptability of 8.80, P = 0.003) by the taste panel.

Flavor characteristic of wandu made with SFRF and RF was at the same level (16.10). SFRF preparation was identified as superior (16.25) in its color and RF was identified as superior (17.55) in its texture. RF preparations were identified as the best food among the three preparations (overall acceptability of 17.40). No significant differences were identified in their sensory characteristics as well as overall acceptability among the three wandu preparations.

3.2. Proximate Composition of Rotti, Pittu, Thosai, Hoppers and Wandu

Proximate composition of rotti, pittu, thosai, hoppers and wandu prepared with SFRF, RF and WF are given in Table 3.3. Total carbohydrate content was calculated by ‘difference’ method.
3.4. Moisture

Moisture content of foods prepared with SFRF ranged from 31.7% – 37.5%, RF ranged from 31.4% – 37.6% and WF 32.5% -37.9%. Rotti had lowest moisture (31.7%) content while pittu had the highest (37.5%). Significant difference was observed between pittu and rotti (37.5%, 31.7%, p=0.012), pittu and thosai (37.5%, 33.5%, p=0.037) and pittu and hoppers (37.5%, 33.6%, p=0.022). Thosai made with RF (31.4%) had the lowest moisture content and it was highest in wandu (37.55%). Significant difference was observed between foods made with RF such as rotti and pittu (32.5%, 37.4%, p=0.019), rotti and wandu (32.5%, 37.6%, p=0.012), pittu and thosai (37.4%, 31.4%, p=0.009), wandu and thosai (31.4%, 37.6%, p=0.005) and wandu and hoppers (34.3%, 37.6%, p=0.008). Thosai made with WF (32.59%) had lowest moisture content and wandu had the highest (37.7%). No significant difference was observed among foods made with WF except between thosai and wandu (32.5%, 37.9%, p=0.0429).

3.5. Protein

Protein content of foods prepared with SFRF ranged from 19.05% - 24.3%, WF 11.3% - 18.5% and RF ranged from 9.1% - 15.0%. Soy flour is rich in protein (Table 3) therefore foods made with SFRF had the highest protein content compared with foods made with WF and RF. Cereals are deficient in essential amino acid lysine and high in tryptophan and methionine but soya is deficient in methionine and rich in lysine (Charley, 1990). Therefore foods made with SFRF will provide better protein quality to the consumers. Foods made with WF had higher protein content
compared to RF since wheat flour contain more protein (8.6%) (Food Composition table for use in South Asia, 1972) than BG-352 rice flour (7.3%, Table 3.1). Rotti had lowest protein (19.05%) content and thosai had the highest (24.3%). Significant difference was observed between thosai and rotti (24.3%, 19.6%, p=0.006), thosai and hoppers (24.3%, 21.0%, p=0.002) and thosai and wandu (24.3%, 19.5%, p=0.004). Pittu made with RF had lowest protein content (9.1%) and thosai had the highest (15.0%). Significant difference was observed between thosai and rotti (15.0%, 10.3%, p=0.02), thosai and pittu (15.08%, 9.18%, p=0.008), thosai and hoppers (15.08%, 9.3%, p=0.005) and thosai and wandu (15.08%, 9.6%, p=0.014). Similarly thosai made with WF had the highest protein (18.5%) and wandu has the lowest (11.3%). Significant difference was observed between rotti and hoppers (16.75%, 12.05%, p=0.003), rotti and wando (16.75%, 11.24%, p=0.007), pittu and thosai (18.5%, 15.08%, p=0.045), pittu and hoppers (15.68%, 12.05%, p=0.047), pittu and wandu (15.085, 11.24%, p=0.041), thosai and hoppers (18.5%, 12.05%, p=0.005) and thosai and wandu (18.5%, 11.24%, p=0.012). Protein content of thosai was the highest among foods prepared with either SFRF or WF or RF because of the added black gram (26.8%) which is rich in protein (Hettiarachchi et al., 1981).

3.6. Fat

Foods prepared with SFRF had higher fat content ranging from 12.1% - 9.2% than WF (6.64% - 5.28%) and RF (6.3% - 5.0%). Significant difference was observed between thosai and pittu (12.1%, 9.2%, p=0.022) and thosai and hopper (12.1%, 10.2%, p=0.034) with SFRF. Highest fat content observed in thosai (6.3%) and lowest observed in pittu (5.0%) made with RF. No significant difference observed in foods made with RF. Thosai made with WF had highest fat content (6.64%) and the lowest was hoppers (5.28%) and the difference was significant. Partial replacement of WF and RF used to prepare breakfast food with soy flour thus increases the fat content appreciably. Since soy contains 54% linolenic acid and 7% linoleic acid, which are essential fatty acids (Earl et al., 2005), the replacement with soy flour may prove beneficial.

3.7. Ash

All foods made with SFRF had higher ash content (1.9%) than RF (1.1% - 1.4%) and WF (0.6% - 1.8%). Foods made with RF and SFRF did not differ in their ash content. Rotti and Pittu made with WF had equal amount of ash (1.8%) and it was higher than wandu (1.2%). Thosai and hoppers made with WF had the lowest ash content (0.6%). Significant difference was observed between rotti and thosai (1.8%, 0.6%, p=0.001), rotti and hoppers (1.8%, 0.6%, p=0.001), rotti and wandu (1.8%, 1.2%, p=0.005), pittu and thosai (1.8%, 0.6%, p=0.001), pittu and hoppers (1.8%, 0.6%, p=0.001) and pittu and wandu (1.8%, 1.2%, p=0.005).

3.8. Fiber

No significant difference was observed in crude fiber content among rotti, pittu, hopper, wandu and thosai prepared with SFRF, RF and WF.

3.9. Total Carbohydrate

Total carbohydrate content was calculated by ‘difference’ method and it was low in rotti, pittu and thosai made with SFRF (36.9%, 29.3%, 27.7% respectively) compared to RF (49.9%, 46.8%, 45.5% respectively) and WF (38.9%, 42.4%, 41.3% respectively) because soy flour contain 32.35 % of carbohydrate, rice flour has 77.81% (Table 3.1) and white wheat flour contains 77% (Food Composition Tables for South East Asia, 1972).

3.10 Available Carbohydrate Content of Rotti, Pittu, Thosai, Hoppers and Wandu made from SFRF

The available carbohydrate content of rotti, pittu, thosai, hoppers and wandu made with SFRF are given in table 3.4. The mean total carbohydrate content calculated by ‘difference’ method and enzymatic method was significantly (p < 0.05) different in rotti (36.9 ± 2.7 vs 28.47±1.4 %) and wandu (32.2±1.7 vs 23.0±1.2 %) made with soy and rice flour mixture.
Table 3.4. Comparison between total carbohydrate content and available carbohydrate content of rotti, pittu, thosai, hoppers and wandu made from SFRF

<table>
<thead>
<tr>
<th>Name of the Food</th>
<th>Total CHO by ‘Difference, (g/100g) (X%)’</th>
<th>ACH (g/100g) (Y%)</th>
<th>Difference in mean carbohydrate content (X – Y%)</th>
<th>P value by ‘t’ test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotti</td>
<td>36.9 ± 2.7</td>
<td>28.47±1.4</td>
<td>8.43</td>
<td>0.028</td>
</tr>
<tr>
<td>Pittu</td>
<td>29.3±2.0</td>
<td>27.98±1.6</td>
<td>1.32</td>
<td>0.309</td>
</tr>
<tr>
<td>Thosai</td>
<td>27.8±2.5</td>
<td>25.48±0.9</td>
<td>2.20</td>
<td>0.224</td>
</tr>
<tr>
<td>Hoppers</td>
<td>33.6±2.5</td>
<td>28.99±1.0</td>
<td>3.17</td>
<td>0.085</td>
</tr>
<tr>
<td>Wandu</td>
<td>32.2±1.7</td>
<td>23.02±1.2</td>
<td>9.18</td>
<td>0.004</td>
</tr>
</tbody>
</table>

1= Mean of 3 replicates; 2= Mean of 6 replicates

4. CONCLUSION

Except string hoppers all the other preparations with soy flour and rice flour did not change sensory attributes, thus could be used as alternate foods. It was observed that 25% of soy bean flour in combination with 75% rice flour was significantly high in protein and fat but low in carbohydrate in rotti, pittu, thosai, hopper and wandu compared to rice and wheat flour preparations because of the high fat and protein content of soy flour. Foods made with 25% soy flour in combination with 75% rice flour had lower available carbohydrate content analyzed by enzymatic method than obtained by ‘difference’ method.

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6. REFERENCES


