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OPTIMIZATION OF WHEAT-SORGHUM COMPOSITE FLOUR FOR THE PRODUCTION AND ENHANCED STORABILITY OF LEAVENED FLAT BREAD NAAN

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ABSTRACT

The use of wheat composite flour for commercial production and consumption of leavened flat bread Naan are not yet popularized in Sri Lanka. The present study assessed the effect of optimization of composite flour on the quality of Naan by mixing wheat and sorghum flour at different ratios. Sorghum flours were used 0, 10, 20, 30, 40 and 50 % by weight to replace the wheat flour in the Naan. The formulated Naan were assessed for physico-chemical and organoleptic qualities. The moisture, protein, fiber, minerals, loaf weight and loaf volume of the developed Naan were evaluated. The highest moisture content (11.13 %) was recorded in the Naan made with 100 % wheat flour whereas 50 % incorporation resulted in decreased moisture content of 8.11 %. The fiber content increased from 4.78 to 6.04 % with the increment of sorghum flour substitution from 0 to 50 %. The highest mineral content of 2.91 % was recorded from 50 % sorghum flour contained Naan. The highest Naan bread volume of 233cm^3 obtained from 100 % wheat flour, while the mixture containing 50 % sorghum flour resulted in the lower volume of 187cm^3. As revealed by the sensory evaluation, Naan supplemented with 40 % sorghum flour was well acceptable in terms of colour, taste, texture, aroma and overall acceptability. The mixture of 40 % sorghum flour and 60 % wheat flour was found to be successful for the production of leavened bread Naan with improved physico-chemical and organoleptic qualities within the universally accepted standards. Based on the storage studies, the Naan packed in the low density polyethylene could be frozen stored at -10°C for 90 days without any significant changes in the quality characteristics.

Key words: Composite flour, Naan, Nutritional quality, Sorghum, Wheat

INTRODUCTION

Wheat (*Triticum aestivum*), a staple food of large proportion of the world population, has been the major ingredient of leavened bread for many years due to its functional gluten proteins. In Sri Lanka, the consumption of bread or "take away" products are increasing in both rural and urban areas as a consequence of changing lifestyle, convenience and high cost of cooking energy (Ekanayake *et al*., 2016). Wheat is also extensively used for the production of flat breads such as the naan, parotta and steam-leavened chapatti in India, Sri Lanka, China, Middle East and some parts of Africa (Parimala and Sudha, 2015). However, bread can be made from high gluten wheat which is difficult to grow in the tropical areas due to the prevailing climatic conditions (Carson and Sun, 2000). Developing countries have encouraged assessing the feasibility of alternative locally available flours as a substitute for wheat flour. Many researches (Olaoye *et al*., 2006; Turner, 2007), have been carried out to promote the use of composite flours, in which a portion of wheat flour is replaced by locally grown crops, to be used in bread, thereby decreasing the cost of imported wheat.

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The total production of sorghum (*Sorghum bicolor* Pers.) in Sri Lanka is 103.62 t in 2018 *maha* (Department of Census and Statistics, 2018) and is more likely to be that the grains are under-utilized. Processing of sorghum grains into flour would increase its utilization and a good source of nutrients such as carbohydrates, β-carotene and vitamin C, minerals such as calcium, phosphorus (Kent and Evers, 1994), iron, manganese (Mutegi *et al*., 2010) and zinc and can contribute to the dietary fiber, color and flavor in food preparations. Therefore, the use of sorghum flour for production of baked goods if feasible would help to lower the dependency of developing nations on imported wheat.

Numerous studies have shown the possibility of supplementing sorghum flour for wheat flour at various levels to produce bread when wheat is in short supply. Abdelghafor *et al*. (2011) investigated the rheological properties and baking potential of sorghum based composite flour containing variable amount of wheat gluten. In line with this situation, there is a possibility of incorporating sorghum flour into local foods in Sri Lanka, replacing wheat flour or rice flour. Considering all above factors, this research was designed to incorporate the sorghum flour with the wheat flour for the development of leavened flat bread Naan.

MATERIALS AND METHODS

Sorghum (cv. *Kafir*) grains were obtained from the Department of Agriculture, Batticaloa, Sri Lanka. The grains were cleaned to remove the foreign materials and then pearled in a hand operated chakki for removal of husk. The pearled grains were ground in a grinder (Alikeleyisi, flat wheel grinder) to make fine powder and passed through 250µm sieves to obtain uniform size flour. All-purpose wheat flour was purchased from Prima Company (Pvt.) Ltd., Trincomalee. Sugar (sucrose, white, granulated), salt (NaCl, commercial grade) shortening (partially hydrogenated vegetable oil) and instant dry yeast and water at 37 ºC were also used as ingredients.

Preparation of Composite Flour Blends

Sorghum flour was blended with 0, 10, 20, 30, 40 and 50 % wheat flour using a Cross-Flow blender (Patterson Kelly Co., USA) operated for 30 mins to produce homogenous 1 kg blends. The composite flours were stored in air tight containers in a freezer until needed.

Preparation of Leavened Flat Bread Naan

The standard formula used for leavened flat bread Naan was 300g sorghum-wheat composite flour, 4.5g yeast, 4.5g salt, 9g shortening, 9g sugar and water. All dry ingredients were weighed and placed in a mixer (Cuisinart Food Mixer, Model 4430) for 5 sec. Yeast was dissolved in luke warm water and stand for 10 mins, until frothy. Add the yeast water into the dry mixture was further run at high speed for 90 sec. The dough temperature was 30.1-31.2ºC after mixing. Dough was scaled into three portions, rounded into balls by hand and placed in lightly greased trays and placed in the fermentation cabinet (National Company, Lincoln, NE) at 30ºC and 90 % RH for 20 min.

Dough was rolled into thin sheets of 5mm, cut into 15cm diameter, placed in lightly greased pans and returned to the fermentation cabinet for a final proof for 45 mins. When the height of dough had risen to double the volume, the pans were placed in a pre-heated convection oven (Despatch oven Company, USA) and bake at 220°C for about 15 minutes until the bread is puffed and just browned.

Assessment of Nutritional, Physical and Sensory Attributes of Naan

Nutritional qualities of moisture, protein, fiber and minerals were assessed using the standard AOAC (2000) methods and the difference between means was compared using Duncan's Multiple Range Test. The loaf volume was measured by rapeseed displacement immediately after removal from the oven and weighing (Mettler 240A). Loaves were placed in a container of known volume into which rapeseeds were placed until the container was full. The volume of seeds displaced by the loaf was con-

sidered as the loaf volume.

Sensory parameters including colour, taste, texture, aroma and overall acceptability were evaluated using a trained 20-member sensory panel. Ranking test was used to evaluate the perceptive differences in intensity of each attribute among samples and the results were analyzed using Tukey's test using SAS software statistical package.

RESULTS AND DISCUSSION

Nutritional Qualities of Wheat and Sorghum Flours Used in this Study

The results of nutritional analysis of wheat and sorghum flour used in the wheat-sorghum composite flour added naan is presented in Table 1.

Table 1: Nutritional analysis of Wheat Flour and Sorghum Flour

Nutritional Composition	Wheat Flour	Sorghum Flour
Moisture (%)	11.13±0.08	10.06±0.07
Protein (%)	12.33±0.05	8.62 ±0.08
Fiber (%)	4.74±0.03	7.13 ±0.04
Fat (%)	1.87±0.01	2.01±0.02
Minerals (%)	2.09±0.02	3.74 ±0.02

Values are means of three replicates ± standard error.

Nutritional Qualities of Wheat-Sorghum Composite Flour Naan

The nutritive value of flat bread Naan depends entirely on the chemical composition of the flour and other ingredients used for its formulation. Elective constituents can be incorporated to increase processing or to produce specially and novelty breads which regularly have an improved nutritive value (Dhingra and Jood, 2001; Gocmen, *et al*., 2009). The effect of sorghum flour incorporation on the nutritional characteristics of flat bread Naan is presented in Table 2.

It can be observed that the moisture content was decreased when the increase in substitution of sorghum flour in the Naan bread. The highest moisture content of 11.13 % were recorded in the Naan made with 100 % wheat flour (T_6) whereas 50 % substitution of wheat flour by sorghum flour (T_5) reduced the moisture content of the Naan to 8.11 % which is significantly ($P<0.05$) different from other treatment combinations. This is in agreement with that reported by Abdelghafor *et al*., (2011), who found low moisture content associated with composite sorghum flour as opposed to 100 % wheat flour. This can be attributed to lower levels of gluten protein in the dough and consequently reduce the water holding capacity of the baked product. The lower moisture content in the product would

Table 2: Nutritional Analysis of Wheat-Sorghum Composite Flour Naan

Treatments	Moisture (%)	Protein (%)	Fiber (%)	Minerals (%)
T_1	10.9 ±0.07^{d}	12.3±0.07^{d}	4.95 ±0.01^{a}	2.42 ±0.05^{a}
T_2	9.80±0.09^{c}	11.89 ±0.08^{c}	5.28 ±0.01^{ab}	2.55 ±0.03^{ab}
T_3	9.13±0.12^{b}	11.03 ±0.02^{bc}	5.57 ±0.00^{b}	2.67 ±0.01^{b}
T_4	8.93±0.11^{b}	10.78 ±0.07^{b}	5.78 ±0.02^{b}	2.73 ±0.02^{bc}
T_5	8.11±0.12^{a}	10.09 ±0.00^{a}	6.04 ±0.01^{bc}	2.91 ±0.01^{c}
T_6 (Control)	11.13±0.08^{d}	12.47±0.12^{d}	4.78±0.01^{a}	2.38 ±0.03^{a}

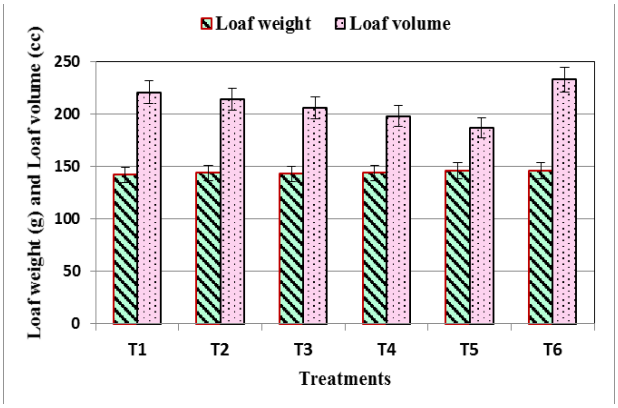
Values are means of three replicates ± standard error.
Means with the same letters are not significantly different from each other at 5% level based on DMRT.
(T_1 – 90g Wheat Flour+10g Sorghum Flour; T_2 – 80g Wheat Flour+20g Sorghum Flour; T_3 – 70g Wheat Flour+30g Sorghum Flour; T_4 – 60g Wheat Flour+40g Sorghum Flour; T_5 – 50g Wheat Flour+50g Sorghum Flour; T_6 – 100% Wheat Flour - Control)

help to increase the storability of the Naan and reduce the staling effect.

The protein content significantly decreased from 12.47 to 10.09 % while the fiber content increased from 4.78 to 6.04 % with the increment of sorghum flour substitution from 0 to 50 %. This is due to low protein and high fiber content in the sorghum flour compared to wheat flour. This is supported by Akingbala *et al*., (2005). Highest mineral content of 2.91 % was recorded for 50 % sorghum flour added Naan while the minimum value of 2.38 % was observed in 100 % wheat flour Naan. Mineral content of composite flours increased when the level of sorghum flour supplementation was increased. This implies that the inorganic nutrients in the composite flour are richer than the wheat flour.

Physical Characteristics of Wheat-Sorghum Composite Flour Naan

Naan bread volume decreased significantly ($P<0.05$) difference with increment of sorghum flour substitution level. The volumes of bread made from composite flours, were lower than that of made from pure wheat flour.



(T_1 – 90g Wheat Flour+10g Sorghum Flour; T_2 – 80g Wheat Flour+20g Sorghum Flour; T_3 – 70g Wheat Flour+30g Sorghum Flour; T_4 – 60g Wheat Flour+40g Sorghum Flour; T_5 – 50g Wheat Flour+50g Sorghum Flour; T_6 – 100% Wheat

Figure 1: Effect of Sorghum Flour addition on the Loaf weight and Loaf volume of Leavened Flat Bread Naan

The highest bread volume of 233cm^3 obtained with 100 % wheat flour (control), while bread containing 50 % sorghum resulted in the lowest volume of 187 cm^3. However, the volumes of the 10, 20, 30 and 40 % levels of substitution were not significantly different from each other. This finding is in accordance with that reported by Abdelghafor *et al*., (2011), who found lower bread volumes associated with composite flours compared to 100 % wheat flour. Similarly, Rose *et al*. (2013) found that, fry bread controls made from all-purpose wheat flour had larger volumes than fry bread containing sorghum and no differences in volume observed among sorghum flour containing treatments. This can be attributed to lower levels of gluten network in the dough and consequently less ability of the dough to rise, due to the low extensibility of sorghum protein. This is in agreement with the Hugo *et al.*, (2003) who concluded that the substitution of wheat flour with upto 40 % sorghum flour decreased the bread volume and Olaoye *et al.*, (2006) who reported that the addition of sorghum to wheat flour negatively influence the loaf volume. On the other hand, Schober *et al*., (2007) reported that adding of sorghum flour (5-20 %) to the standard bread formula decreased the loaf volume although acceptable breads were produced.

Sensory Attributes of Wheat-Sorghum Composite Flour Naan

Sensory characteristics are the crucial criterion for the acceptance of breads and subsequently the quality built during processing must last throughout the distribution chain and until the stage of consumption (Jensen *et al*., 2011). Naan should be soft to touch, spongy to handfeel, somewhat firm to tear, a little chewy to bite without sticking to teeth and possess a characteristic fermented flavor and a good overall acceptability (Parimala and Sudha, 2015). Sensory scores of tested organoleptic properties of wheat-sorghum composite flour Naan are shown below in the Table 3.

The results of the sensory qualities showed that the Naan supplemented with 40 % sorghum flour were well acceptable in terms of colour, taste, texture, aroma and overall acceptability however, decline was observed in all sensory properties except aroma. These findings were in line with the observations made by many investigators (Schober *et al*., 2007 and Abdelghafor *et al*., 2011). The colour and aroma of the developed Naan were not significantly different from each other at 5 % significant level in all the treatment combinations. In the case of taste, treatments were significantly differed from each other. High value was recorded for 100 % wheat flour Naan while lowest was observed 50 % sorghum flour supplemented Naan. For the wheat-sorghum composite flour naan bread, the sensory attributes of colour, taste, aroma and overall acceptability have deviated pattern of scores and score of texture have similar way of pattern compared with the results obtained by Akingbala *et al*., (2005).

Further, our findings on sensory attributes of Wheat-Sorghum flour added naan showed a comparable patterns of observations made by Dogra *et al*. (2001) who found that the scores for color, taste, and texture of naan decreased upon substitution of soy flour instead of wheat flour. Conversely, contradict results in sensory evaluation was observed by Wani *et al*. (2016) where flat bread Chapatti prepared from wheat–pulse (kidney bean and black gram) composite flours disclosed significant reduction in color, taste, aroma and overall acceptability score at 15 % or higher level of replacement. The mixture of 40 % sorghum flour and 60 % wheat flour had been successful for the formulation of leavened flat bread Naan with acceptable nutritional and organoleptic qualities compared to the Naan made with 100 % wheat flour.

CONCLUSION

Wheat flour could be substituted with sorghum flour in the manufacturing of nutritious leavened flat bread Naan. This study revealed that, up to 40 % sorghum flour could be used to substitute wheat flour to produce Naan that would be acceptable by the consumers. The bread produced from wheat and sorghum composite flour had increased nutrients of carbohydrate, fiber and minerals. The use of wheat-sorghum composite flour in the production Naan would promote value addition of sorghum and diversification of utilization of the crops in Sri Lanka and in other countries in the world as well. This would create wealth and enhance food security for the world population.

Table 3: Sensory Analysis of Wheat-Sorghum Composite Flour Naan

Treatments	Colour	Taste	Texture	Aroma	Overall acceptability
T_1	6.87± 0.11^{a}	6.60±0.12^{a}	6.43±0.13^{a}	6.85±0.10^{a}	6.85±0.07^{a}
T_2	6.64±0.05^{a}	6.35±0.15^{a}	6.31±0.11^{a}	6.83±0.07^{a}	6.70±0.09^{a}
T_3	6.52± 0.10^{a}	5.90±0.12^{b}	6.30±0.10^{ab}	6.80±0.10^{a}	6.55±0.10^{ab}
T_4	6.47±0.05^{a}	5.75±0.10^{b}	6.21±0.11^{ab}	6.82±0.07^{a}	6.40±0.09^{ab}
T_5	6.22±0.11^{a}	5.01±0.15^{c}	5.81±0.07^{b}	6.70±0.08^{a}	5.90±0.11^{b}
T_6	6.89±0.05^{a}	6.91±0.15^{a}	6.50±0.11^{a}	6.84±0.07^{a}	6.90±0.10^{a}

The values are means of 20 replicates ± standard error.
The means with the same letters are not significantly different from each other at 5% level based on Tukey's Studentized Range Test.

(T_1 – 90g Wheat Flour+10g Sorghum Flour; T_2 – 80g Wheat Flour+20g Sorghum Flour; T_3 – 70g Wheat Flour+30g Sorghum Flour; T_4 – 60g Wheat Flour+40g Sorghum Flour; T_5 – 50g Wheat Flour+50g Sorghum Flour; T_6 – 100% Wheat Flour - Control)

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