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Development of Gluten Free Doughnuts with Buckwheat and Sorghum

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Abstract

The development of gluten free doughnuts were formulated by Buckwheat and Sorghum. Grinded flours of Sorghum and Buckwheat were used. Nutrient profile of each ingredient was observed and various ratios such as 30:70, 40:60, 50:50, and 60:40 were studied. Among which 60:40 had better texture and taste that led to a positive result, which shows that the increase in Buckwheat content led to better quality of doughnuts. Buckwheat was taken as a replacement for wheat to meet the physical properties of wheat. Sorghum is taken along with Buckwheat to improve its nutritional properties. Doughnuts were developed by oil frying the fermented, proofed and shape formed dough at a temperature of 170^{0}C. Chemical analysis was conducted and recorded. Based on sensory evaluation, doughnuts made of 60:40 ratio was liked very much on 9 point hedonic scale having more acceptance.

Keywords: Ash, Buckwheat, Cinnamon, Crude Fat, Doughnuts, Gluten Free, Gluten Intolerance, Kjeldahl, Moisture, Oil Frying, Proofing, Protein, Sorghum, Soxhlet

1. Introduction

Doughnuts were fried confections which are ring shaped, that are popular as sweet snack. These are usually deep fried from a sweetened fermented dough. Doughnuts are consumed by people irrespective of their ages. These are usually prepared by cereal flours which may also include water, leavening agent, sugar, oil, shortening and flavours.

As doughnuts were mostly made from wheat flours, it is not encouraged for people with gluten intolerance or Celiac disease. It is an immune mediated systemic disease that results in an upset stomach. The major solution is to have a gluten free diet through their entire life. Gluten intolerance is the inability to breakdown gluten protein in their intestine which results to adverse effect in damaging the intestinal villi[1].

As buckwheat has viscoelastic properties, water holding capacity and retains gas during the process of fermentation, it is used as good substitute for wheat in doughnut. The major gluten containing food material is Wheat and thus Buckwheat was taken as its replacement for its similar physical properties in spite of its beneficial nutritional components.

According to Li and Zhang[2] Buckwheat (*Fagopyrum esculentum*), known as a pseudo cereal have similar use and chemical composition of cereals mainly wheat along with many nutraceutical compounds. As reported by Baljeet[3], "It is having similar physical properties of Wheat and hence mostly used to maintain it. Buckwheat flour has high foaming capacity compared to Wheat flour". Studies[4] shows that "bakery products are processed with ingredients having a good foaming capacity". Reports of

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Sayoko and Yoshiko reveal that, "Buckwheat is rich in B vitamins and is also considered superior to wheat flour for its rich mineral content". As per CODEX standards, Buckwheat can be consumed regardless of age and weight which can lower blood pressure on a regular consumption of 30g of Buckwheat. Thus, Buckwheat flour can thus be justified as it is gluten free and rich in composition.

Research reports of Laura *et al.*,[5] reveal that "Sorghum (*Sorghum bicolor*) is a major cereal which is also gluten free that can be used significantly for people with immunological response to gluten intolerances. Its composition is mainly of 12% protein, 82% starch and 5% of B-complex vitamins. It is an important cereal in the world of which 35% is grown for human consumption". Thomas and Kuruvilla[6] states that, "Cinnamon (*Cinnamomum verum*) has been used in small quantities for its naturally obtained flavour. The component cinnamaldehyde is responsible for sweet and woody flavour". Reviews of Gruenwad *et al.*,[7] shows that, "buckwheat also has many health benefits responsible for treating diabetic conditions".

According to Uday *et al.*,[8] "During the frying process, water is replaced by the oil. The temperature of the product being fried exists in a temperature range from room temperature up to 100^{0}C, at which water is lost as steam". Shih *et al.*,[9] suggests that, "The relatively high oil uptake is more in wheat-based products due to the presence of gluten. Studies showed that fried gluten free food have significantly low oil uptake which plays a role in determining the oil intake".

2. Materials and Methods

2.1 Materials

Buckwheat (*Fagopyrum esculentum*), Sorghum (*Sorghum bicolor*), along with other ingredients were bought from local market. Buckwheat seeds and Sorghum are dried and ground separately. Other materials like sugar, cinnamon and yeast were procured from local stores. Sugar is powdered and yeast has been activated at 40^{0}C. Refined Sunflower oil was used for frying doughnuts.

2.2 Methods

2.2.1 Product Development

Doughnuts were prepared by incorporation of Buckwheat flour and Sorghum flour along with other ingredients in the ratio as given in (Table 1) and the product obtained is depicted in (Figures 2, 3, 4 and 5). Sugar, fat and cinnamon powder are kept constant as 60 g, 35 g, and 2 g respectively on 100 g flour basis. For the same 5 g of dry yeast has been added in 15 ml of water for activation.

Dough was prepared by uniform mixing of gluten free flours, sugar, fat, cinnamon powder and activated yeast. This mixture was kneaded into smooth dough. Dough was later formed into ring shaped structures and placed on a butter paper. These formed dough rings were allowed for proofing about 2 hr. Proofed dough rings were later fried on both sides in a deep fryer at a temperature of 170^{0}C using refined sunflower oil. These oil fried doughnuts were cooled at room temperature (Figure 1). These doughnuts were later allowed for chemical analysis and sensory evaluation.

Table 1. Formulation of gluten free doughnuts

Trail	Buckwheat (g)	Sorghum (g)	Sugar (g)	Fat (g)	Cinnamon powder (g)	Yeast (g)
1. 30:70	30	70	60	35	2	5
2. 40:60	40	60	60	35	2	5
3. 50:50	50	50	60	35	2	5
4. 60:40	60	40	60	35	2	5

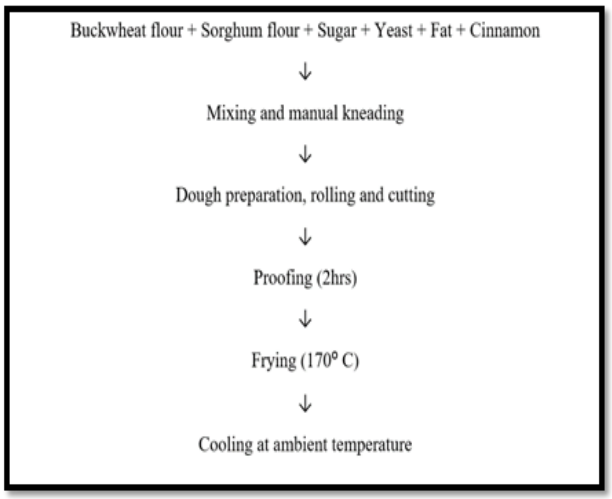

Figure 1. Process flow chart for gluten free doughnuts.

2.2.2 Chemical Analysis

Moisture content is estimated by drying 2 grams of ground gluten free doughnuts sample each at 105°C in hot air oven that later cooled and estimated for moisture content by hot air oven method, protein content by Kjeldahl method, estimation of crude fat by Soxhlet method and the sample was ashed using muffle furnace.

2.3 Sensory Evaluation

Hedonic sensory evaluation was conducted with few members. Different formulation were prepared and sensory evaluation is carried out. The panel members were selected from the faculty staff and students of department of food processing technology of JNTU, Kakinada. The prepared doughnuts were given to the panellist and were asked to rate the samples based on texture, taste, flavour, colour, appearance using a 4 point scale for measuring the acceptability of doughnuts.

3. Results and Discussion

3.1 Gluten Free Doughnuts

Deep fat fried gluten free doughnuts were prepared at different ratios which appeared to be unique from each other in their colour and texture.

3.2 Chemical Analysis

Chemical analysis was conducted on doughnuts made of gluten free flours with different proportions (Table 2). Moisture content, protein, fat and ash content were analysed by their respective methods and depicted in (Figure 6 and Table 2).

Figure 2. Doughnuts made from 30:70 ratio of Buckwheat flour and Sorghum flour.

Figure 3. Doughnuts made from 40:60 ratio of Buckwheat flour and Sorghum flour.

Figure 4. Doughnuts made from 50:50 ratios of Buckwheat flour and Sorghum flour.

Figure 5. Doughnuts made from 60:40 ratios of Buckwheat flour and Sorghum flour.

Table 2. Chemical composition of gluten free doughnuts

Buckwheat: Sorghum	Moisture content (%)	Protein (%)	Fat (%)	Ash content (%)
30:70	7.328	15.203	0.05±0.2	0.999±0.01
40:60	7.112.1	13.605±0.1	2.432±0.2	0.996±0.01
50:50	6.841	12.007±0.4	4.923±0.3	0.994±0.01
60:40	6.5712	10.409±0.1	7.41±0.42	0.991±0.01

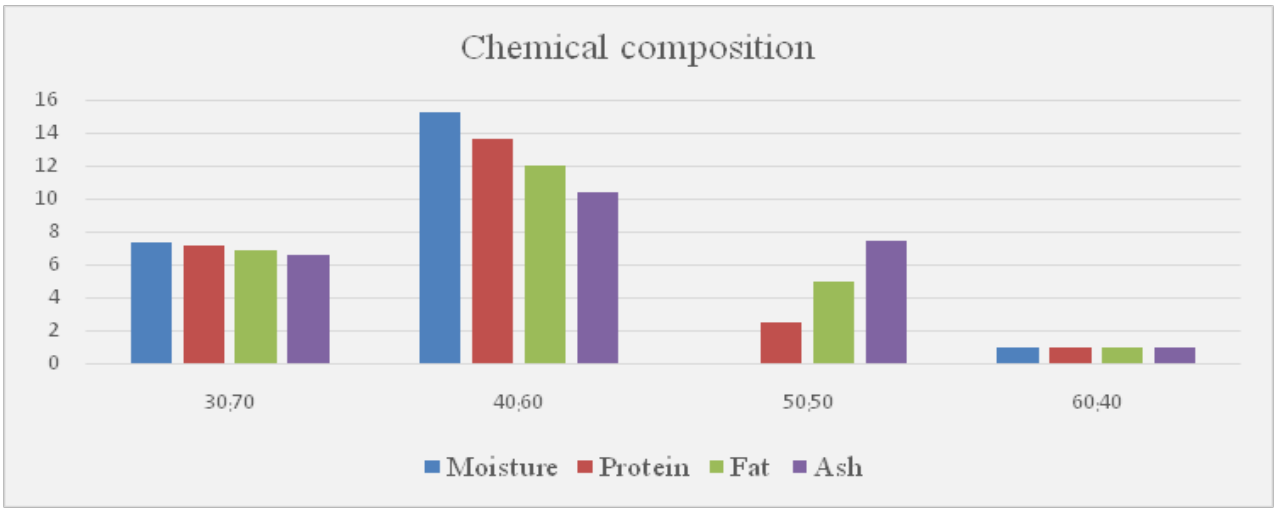

Figure 6. Graph representing chemical composition of Gluten free doughnuts.

3.3 Sensory Evaluation

Based on four-point scale method gluten free doughnuts made from 30% of buckwheat flour was of poor quality and the doughnuts made from 60% of buckwheat flour

Table 3. Sensory sheet

Buckwheat: Sorghum	Texture	Colour	Flavour	Taste	Overall acceptability
30:70	2	5	4	3	3.5
40:60	6	6	7	6	6.25
50:50	8	8	7	7	7.5
60:40	9	8	8	9	8.5

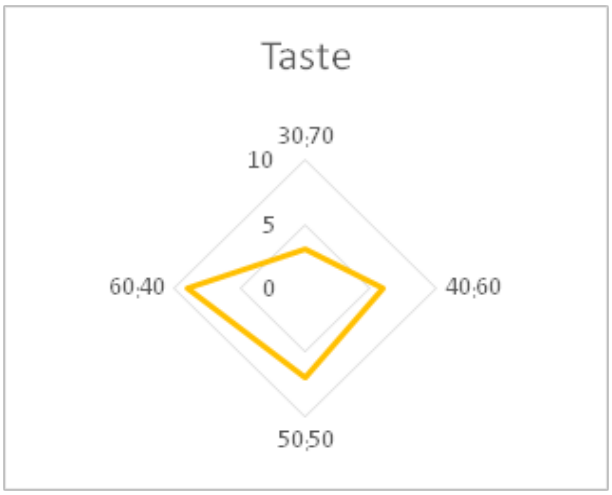

Figure 7. Radar chart for taste.

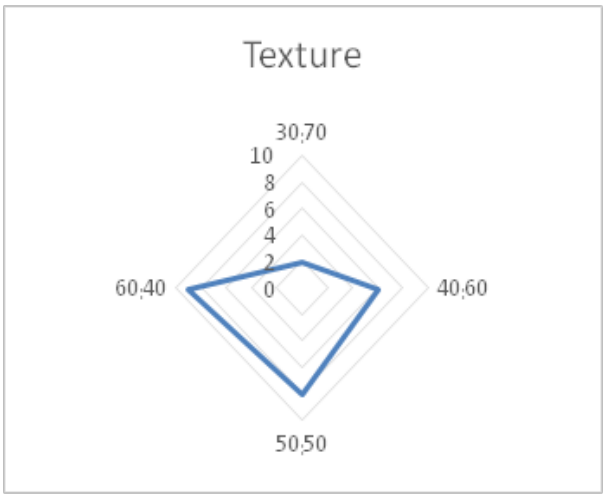

Figure 9. Radar chart for texture.

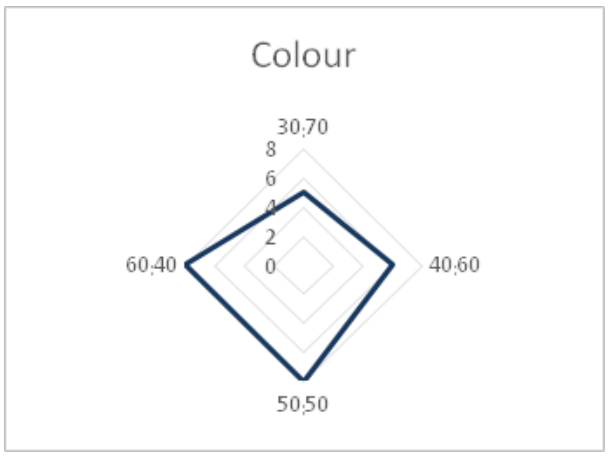

Figure 8. Radar chart for colour.

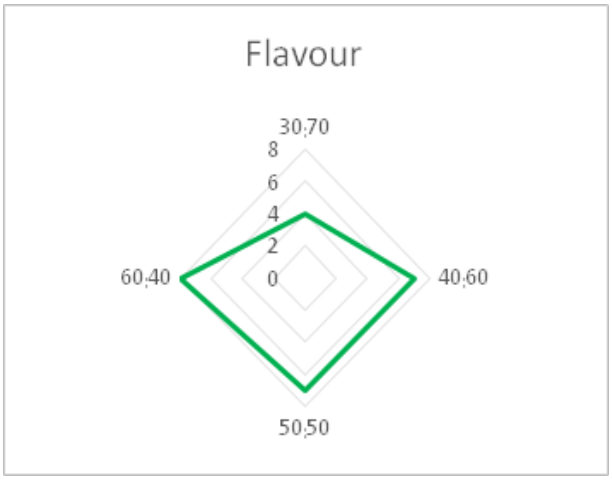

Figure 10. Radar chart for flavour.

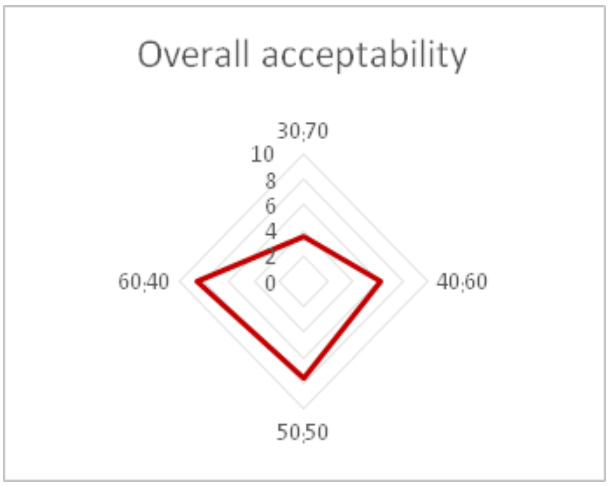

Figure 11. Radar chart for overall acceptability.

are better in their every characteristic compared to others (Table 3). These were liked very much with an overall acceptability of 8.5. (Figure 7 to 11).

4. Conclusion

Gluten free doughnuts were prepared of different ratios of Buckwheat and Sorghum flours. These gluten free doughnuts were chemically and sensory evaluated. Based on chemical evaluation, gluten free doughnuts made of 30:70 ratios of Buckwheat and Sorghum flours were having high moisture, high protein and high ash content profile and have least fat. When the Buckwheat flour percent has increased it resulted in low moisture content, moderate protein content and low ash content with high amounts of fat. This shows that oil absorption capacity of GF doughnuts made of 60:40 ratio of Buckwheat and Sorghum is more and thus most of the moisture has been removed which is a positive sign of shelf life improvement.

When these gluten free doughnuts were sensory analysed, gluten free doughnuts made of 30: 70 ratios of Buckwheat and Sorghum flours were of very poor quality and are disliked moderately and gluten free doughnuts made of 60:40 ratios of Buckwheat and Sorghum flours were liked very much.

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