



## Development and Quality Evaluation of Gluten Free Breakfast Cereal and Healthy Bar using Red Banana incorporated with Foxtail Millet and Pumpkin Seed

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### Abstract

**Background:** Celiac disease is an illness caused by an immune reaction to eating gluten, a protein found in wheat, rye and barely. Over time, the immune reaction to eating gluten creates inflammation that damages the small intestine's lining, leading to medical complications. It also leads to the malabsorption of certain nutrients. Furthermore, developing good-quality gluten free products could be challenging due to the unique properties of gluten. **Methodology:** The main aim of this study is develop gluten free, ready- to- eat food products such as breakfast cereal and healthy bar from the main ingredient red banana that is completely free from gluten and other ingredients such as foxtail millet and pumpkin seeds. The products were evaluated for their proximate compositions, physiochemical analysis and antioxidant activity. The product were formulated according to 3 variations. **Results:** The sensory evaluation showed high score of preference and acceptance in breakfast cereal and healthy bar containing 40% of red banana and were comparable to the control in all the parameters analyzed. This innovative approach could contribute to the development of healthier and more diverse gluten free food products catering to consumer demand for functional foods. **Conclusion:** The results indicates that the breakfast cereal and healthy bar from red banana not only provided gluten-free alternatives but, it was also found to enhance its nutritional quality.

**Keywords:** Red banana, Pumpkin seed, Foxtail millet, Celiac disease, Gluten-free

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## Introduction

Lifestyle changes and dietary habits of human all over the world may affect nutrient intake. Therefore, a healthy and balanced diet is important to meet the basic needs of human body. Nowadays, a special attention has been given to by-products, which can be utilized as raw materials to further avoid economic crisis and in the prevention of pollution. Nutrition or energy bars are getting popular among health aware consumers, school-goers, and weight-conscious public (**Rawat & Darappa, 2015**) due to its nutritive value, and its convenience to procure. Modern consumers prefer snacks not only to satisfy their hunger but also to provide themselves with essential nutrients. In this regard, food scientists today are aiming to develop formulations of cereal bars with various highly nutritious ingredients. Snacks satisfy hunger, replace a meal, and provide the body with essential nutrients including protein, carbohydrates, fats, and vitamins (**Anitha & Rajyalakshmi, 2014**). Ready-to-eat (RTE) breakfast cereals are widely used in daily life due to their desirable characteristics, e.g., convenience, texture, extended shelf life, diversified flavors and shapes, as well as their nutritional value. All these properties make such products attractive for health-conscious consumers. "As reported by **Spence (2017)**, breakfast cereals have constituted a standard fare since the end of the 19th century/early 20th century". Celiac disease is a chronic disease of the gastrointestinal system, in which characteristic damage of the small intestinal mucosa occurs in genetically susceptible people in response to the presence of gluten in food.

Red banana, foxtail millet, pumpkin seeds are gluten-free by-products, which makes them appealing for the production of alternative food products for celiac or gluten-intolerant consumers. A diet that excludes the gliadin and glutenin protein fractions in wheat, rye and barley is the only treatment available for individuals with celiac disease. There is, however, a growing enthusiasm for a gluten-free diet (GFD) or wheat avoidance in those without formally-diagnosed coeliac disease for its perceived benefit on health, weight loss, treating disease and/or minimizing future risk of disease. Banana (*Musa sp*) is a commonly consumed fruit and the fifth most important crop in the world export market. It contained dietary fiber, minerals and vitamins, pro-vitamin and phenolic compounds that are important in lowering the risk of chronic disease. Red banana (*Musa acuminata*), red dacca are a group of varieties of banana with reddish - purple skin. Banana is one of the oldest plant and all its parts have medicinal application (**Amarasingle et al., 2021**). Foxtail Millet is one such cereal, which can be substituted for wheat due to its availability and nutritional importance. Foxtail millet is a good source of crude fiber helps in the digestive process and helps to induce bowel movement, thus producing a laxative effect that is beneficial for a healthy digestive system. All these nutritional properties have made foxtail millet an important ingredient for preparing bakery products. In

addition to its nutritional properties, foxtail millet has also shown to possess several health benefits like prevention of cancer, hypoglycemic, and hypolipidemic effects (Saleh et al., 2013). Of particular importance for producing functional food ingredients are pumpkin seeds because of their high content of oil, proteins, fibers, minerals, and phenolic compounds (Hussain, et al 2022). The main products obtained by processing pumpkin seeds are oil and proteins. According to Vinayashreea and Vasu (2021), pumpkin seed protein isolates are rich in essential amino acids and have good functional properties, compared to those of soybean protein isolates.

## Methodology

To formulate the gluten free breakfast cereal and healthy bars using red banana, local variety of ripe Red banana (*Musa acuminata* & Red Dacca), pumpkin seeds (*Curcubita maxima*), foxtail millet (*setaria italica*) were selected. The ingredients were brought from a hypermarket in Coimbatore as raw ingredients that were processed for further preparation.

### Processing of Ingredients

Red bananas were processed using two different methods. Take required quantity (250g) of matured ripe red banana. After unpeeling, slice them in uniform thickness (1mm). Then put the uniformly sliced pieces in hot air oven at 60°C for 24 hours for complete removal of moisture content from the sliced red banana. After drying, displace them from hot air oven and let them cool in a desiccator. Later add these dried red banana in a mixer grinder and grind them into fine texture. Take the ground flour in a sieve and sift it. Spread the flour on a plate and keep it for some time till it gets completely dry. Then store the flour in an air-tight container kept at a cool place until used. Take 250 g of matured ripe red banana, peel and mash the pulp well into a paste without addition of water by using a mixer grinder or masher.

Scoop the mash into reusable plastic freezer safe bags and squeeze out extra air before sealing. Store them in a refrigerator. Foxtail millet (150g) were cleaned manually and drained off the water from grains and kept for drying. They were washed with clean double distilled water. The washed millet was dried in hot air oven for 60°C to remove the moisture content then the ingredient were ground into powder form. The pumpkin seeds was cleaned manually. After roasting, it was placed in a mixer to get fine powder. The powered form of pumpkin seeds was collected and stored in the airtight container protecting from moisture content and to maintain its nutritional quality.

### Formulation of Healthy Bars and Breakfast Cereals

To standardize the breakfast cereal and healthy bar, the selected ingredients were mixed in three different variations. The following table represents the different experimental variations of gluten free healthy bars and breakfast cereal from red banana.

**Table 1:** Formulation of breakfast cereal and healthy bar Ingredients

Ingredients	Variations			
	Control	Sample A	Sample B	Sample C
Foxtail millet flour	50 g	30g	30g	30g
pumpkin seed flour	25g	20g	20g	20g
Red banana flour	-	50g	-	-
Mashed red banana	-	-	40g	30g
Palm jaggery	10g	10g	10g	10g
Peanut butter	-	10g	10g	-
Cocoa powder	1g	1g	1g	1g
Vanilla essence	2 drops	2 drops	2 drops	2 drops

### Breakfast cereals and Healthy Bar Preparation

The ingredients were mixed to form a dough from the three compositional variations, to prepare breakfast cereals and healthy bars. Then the mixture were molded into round shape and rectangular bars for preparing breakfast cereal and healthy bars respectively and was baked at 125 °C for 30 minutes in an microwave oven, cooled down and stored in an air-tight containers.



**Figure 1:** Prepared breakfast cereals from red banana with different variations sample A, B, C, control respectively

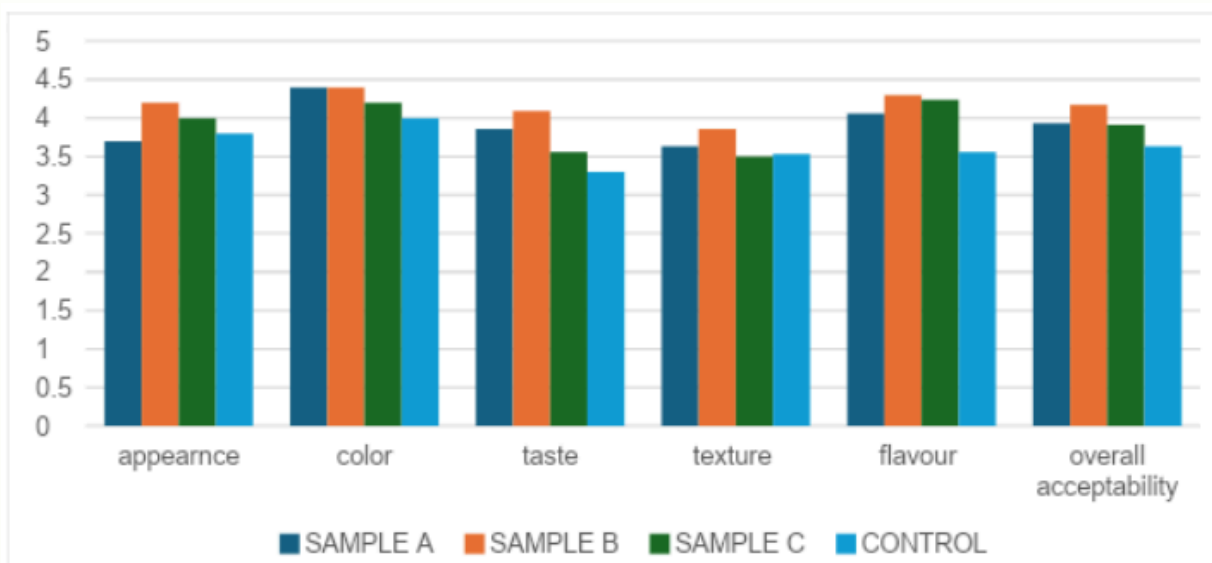


**Figure 2:** Healthy bars prepared from red banana incorporated foxtail tail millet and pumpkin seed.

## Results and Discussion

### Sensory Analysis

The organoleptic quality of the product was scored by a sensory panel comprising of ten PG food science students using a 5-point Hedonic rating scale. The aspects considered were appearance, flavor, color, taste and texture. The score of all the panelists were analyzed for each of the sensory attributes.



**Figure 3:** Graphical representation of sensory evaluation

Sensory analysis results show that the overall acceptability of variation sample B was more acceptable when compared to the other variations of Red banana incorporated breakfast cereal and healthy bar. Sample B was formulated with 50g ripe red banana with 30g foxtail millet and 15g pumpkin seeds along with the incorporation of palm jaggery and peanut butter for flavor and texture. As sample B was more acceptable it was finalized for further analysis.

### Proximate Analysis

The ash content of the selected Red banana incorporated breakfast cereal and healthy bar sample is 11.5%. The ash value is an indication of the mineral content, which is needed for bone development and teeth formation. Banana has high mineral content, the difference in ash content can also be due to the difference in the formulation of the samples. Ash content is the residue remaining after destroying combustible organic matter and it gives an overall estimate of the total mineral elements present in the food (Mbaeyi, 2005).

The moisture content of selected variation is 6%. High moisture content in food samples is of great disadvantage as it encourages microbial activities that lead to food spoilage (Anno et al., 2016). Previous researchers highlighted that, baked products with moisture content less than 13% are stable from moisture-dependent deterioration (AyoOmogie & Odekunle, 2015).

The readings were taken in a spectrophotometer at 660nm. The absorbance of selected Red banana incorporated breakfast cereal and healthy bar was 0.231 and the calculated value of concentration of protein was 26.91 ( $\mu\text{g/ml}$ ). Proteins are important food components, necessary for growth and repair of damaged tissues (Wardlaw, 2004).

The readings were taken in a spectrophotometer at 490nm. The absorbance of selected variation was 0.091. Standard graph was drawn and concentration of sample was calculated. The calculated value of concentration of carbohydrate was 39.16 ( $\mu\text{g/ml}$ ). This suggests that banana flours are rich sources of carbohydrate. The result has shown that the cake samples with banana flour are rich in carbohydrate, thus will serve as a source of energy to its consumers. Previously, researchers had reported similar results of an increase in carbohydrate content of cookies made with flour blends containing Cardaba banana as the major ingredient compared to cookies made from 100% wheat flour (**AyoOmogie & Adekunle, 2015**).

### Total Sugar Content

The total sugar percent of selected Red banana incorporated breakfast cereal and healthy bar sample was 30%. Total sugars include reducing sugars and non-reducing di- and oligo- saccharides like sucrose, which on mild acid hydrolysis are converted into reducing sugars. Starch is hydrolyzed by strong acids into glucose.

### Micronutrient Estimation

The phosphorous content of selected variation of red banana incorporated breakfast cereal and healthy bar was analyzed using a spectrophotometer. The absorbance of phosphorous was 0.201 and was recorded at 660nm. Concentration was calculated from standard graph. The concentration of phosphorous in sample is 0.698 ( $\mu\text{g/ml}$ ).

The iron concentration of selected red banana breakfast cereal and healthy bar was estimated from the standard graph. The absorption was 0.162 and reading was taken at 540nm. The concentration of iron in sample was 0.329 ( $\mu\text{g/ml}$ ).

### Antioxidant Activity

Anti-oxidant analysis was done for selected red banana breakfast cereal and healthy bar sample. The concentration variation of antioxidant activity is analyzed by making graph with absorbance against concentration. The antioxidant activity is calculated from the standard graph. The antioxidant activity is 73.85  $\mu\text{g/ml}$ .

The results indicates that the red banana breakfast cereal and healthy bar incorporated with foxtail millet and pumpkin seed contains phytochemicals such as alkaloids, phenolic compounds, flavonoids, tannins and carbohydrate.

### Water Absorption Capacity

Water absorption capacity of selected variation is 0.1g/ml.

## Phytochemical Analysis

**Table 2:** Phytochemical analysis of breakfast cereal and healthy bar

SL. No	TEST	RESULT
1	Alkaloids	Positive
2	Terpenoids	Negative
3	Phenols	Positive
4	Flavonoids	Positive
5	Tannins	Positive
6	Carbohydrate	Positive
7	Saponins	Negative
8	Glycosides	Negative

## Conclusion

The standardization, formulation and sensory evaluation of gluten free breakfast cereal and healthy bars using red banana, foxtail millet and pumpkin seed were done for three compositional variations, and sample B (50g ripe red banana with 30g foxtail millet and 15g pumpkin seeds along with the incorporation of palm jaggery and peanut butter) was found to be having a higher overall acceptability among the sensory panel. This composition was further used for proximate analysis and its antioxidant properties were estimated. All ingredients were free from gluten content. Gluten is a natural protein found in certain grains like wheat. Gluten helps foods maintain their shape, acting as a glue that holds food together. The peptide-amino acids that form the building blocks of protein- found in gluten are resistant to stomach acids, which can make it hard for people with celiac disease to digest it. These persons require strict gluten free diet, so the breakfast cereal and healthy bar from red banana, foxtail millet, pumpkin seeds make an ideal option for the celiac patients to include in their diet.

The study revealed that the red banana, foxtail millet with pumpkin seed combination provides complex carbohydrates, protein and other micronutrients such as phosphorous, iron and contain significant amount of antioxidants that makes a healthier option for gluten free diet because most of the gluten free diet lacks most of the nutrients due to limited discovery of gluten free foods which could



further lead to malnutrition. Therefore, this product can help by replenishing the nutrients and preventing ignite of unwarranted celiac disease symptoms among them.

### **Credit Authorship Contribution Statement**

All the authors contributed to Conceptualization, Methodology, Formal Analysis, Investigation, Writing and Visualization.

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### **Conflict of Interest**

The authors declare that there was no conflict of interest from preparation to publication of this manuscript.

### **Ethics Approval**

This study did not require Ethical Clearance.

### **Participant Consent**

This study obtained written consent for participation in the sensory evaluation of the formulated products.

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