

# Innovative Multidimensional Studies on the Production of Gluten Free Cakes and Cookies from Grains and Pulses-A Budget Friendly Process

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**Abstract**— In this manuscript, production of gluten free cakes and cookies from natural resources, focuses on the trial and error methods for mixing different ratios of pulses with grains like Ragi, Bazra and also rice flour for firm consistency and nutritional benefits. This chapter emphasizes principle and method of nutritional cookies production, its extended shelf life, physicochemical parameters and also rheological analyses. Sensory evaluation explains that gluten free treatments were acceptable from the consumer's point of view.

## OBJECTIVES

The study was carried out with following objectives:

To develop gluten free cookies for celiac patients.

To assess pulses as main bakery ingredients by substitution of wheat flour with rice flour.

To standardize the recipe for preparation of gluten free (GF) cakes and cookies and evaluation of nutritional, sensory and textural quality of the products.

**Index Terms:** Gluten, lentil, black gram, pulse, rice flour, cookies.

## INTRODUCTION

Cookies, among the bakery products, are most significant in the world [1]. Cookies differ from other baked products like bread and cakes because of their low moisture content which ensures that they are free from microbial spoilage and confer a long shelf life on the product [2]. Long shelf life of cookies makes large scale production and distribution possible. Fortification is done up to some level to meet following objectives; to maintain the nutritional quality of foods, keeping nutrients levels adequate to

correct or prevent specific nutritional deficiencies in the population or in groups at risk of certain deficiencies, to increase the added nutritional value of a product (commercial view) and to provide certain technological functions in food processing [3]. Substitution refers to completely replacing certain ingredients with some other suitable ingredient especially done in cases where a particular ingredient is allergen. In the present study wheat is being replaced by grains and pulses in preparation of gluten free cakes and cookies. The reason being wheat contains gluten (a special type of protein that is found in rye, wheat, and barley) which causes a disease called Celiac [4]. It is an immune-mediated disorder that affects primarily the gastrointestinal tract. It is characterized by chronic inflammation of the small intestinal mucosa that may result in atrophy of intestinal villi, mal absorption, and a variety of clinical manifestations, which may begin in either childhood or adult life. Intestinal symptoms can include diarrhea, abdominal cramping, pain, and distention, and untreated celiac disease may lead to vitamin and mineral deficiencies, osteoporosis, and other extra intestinal problems. Considerable scientific progress has been made in understanding celiac disease and in preventing or curing its manifestations by dietary interventions. According to NIDDK (2008), the only treatment for celiac disease is a gluten-free diet. Complete avoidance of gluten enables the intestine to heal, and the nutritional deficiencies and other symptoms to resolve. Children tend to heal more quickly than adults [5].

Rice is a popular, non-allergic, gluten free source of carbohydrate, vitamins, and minerals with little fat. Rice is a distinctive crop due to its colorless, soft taste, low sodium levels, easy edible carbohydrates and hypoallergenic properties [6]. Rice (*Oryza sativa*) is a cereal foodstuff which forms an indispensable part of diet, due to significant biological value and digestibility [7].

Lentil, black gram and Bengal gram are considered as among the world's most important pulses. These are good sources of vitamins C as well as dietary fiber, potassium, and iron, and they are low in fat and cholesterol. It serves as an important protein source for many world populations and is an important source of starch and other carbohydrates the human body needs [8]. The carbohydrate content of the storage roots varies from 25% to 30%, while the rest is composed of water (58%-72%). Sweet potato contains various micro-nutrients. Substantial quantities of vitamin C, moderate quantities of thiamin (vitamin B1), riboflavin (vitamin B2) and niacin, some quantities of pantothenic acid (vitamin B5), pyridoxine (vitamin B6), folic acid and satisfactory quantities of vitamin E are present. Sweet potato also contains some essential minerals and trace elements having especially high quantities of iron. Two other important minerals present are potassium and calcium [9]. Moderate quantities of zinc, sodium, magnesium and manganese also present.

The aim of the present work is to replace wheat flour in cookies with rice flour, pulses and grains for pasting in order to develop gluten-free cakes and cookies targeting a good sensory acceptance and quality parameters.

## METHODOLOGY

In order to prepare the cakes and cookies, the following materials have been purchased from local market Barrackpore, West Bengal, India: rice flour (RF), lentil, black gram and Bengal gram, butter, fresh whole eggs, refined oil, milk, vanilla essence, honey, baking powder, powdered sugar, sodium bicarbonate, salt and xanthan gum.

*1.1. Cake Preparation.* The ingredients used for the preparation and treatment of cookies are presented in Table 1. Cakes were prepared from blends containing 50% ragi flour and 50% four different types of pulses (Black gram flour, Dry

peas flour, lentil flour, Bengal gram flour). Cake batter was prepared in a kitchen aid professional mixer (KPM5), wherein, the flour, milk, baking powder, and oil were mixed together to get a fluffy cream; eggs and sugar were whipped together until semi-firm foam resulted. The sugar-egg foam was mixed with the creamed flour, after which the milk was added in small portions. Cake batter was poured into an aluminium cake mould and baked for 30 min in a cake oven. Cakes were cooled to room temperature [10-11]. For each treatment, three series replicates were produced.

*1.2. Cookie Preparation.* Cookies were also made by the same dough according a homemade cookie recipe. A resting period of 15 min at room temperature was given to the prepared dough. Then sheets are formed. It is then moulded and dropped on the baking tray. Then the tray is placed in cake oven for baking. After baking for 15 min, the tray was taken out, cooled and the cookies were ready [11]. For each treatment, three series replicates were produced. The samples were marked as T1, T2, T3, T4, T5. All of the samples were kept under ambient temperature.

*1.3. Physicochemical Analysis.* Moisture, ash and acid soluble ask content were measured in different cakes and cookies by AACC method, 2000 [13].

Table 1. Quantities of variable ingredients used in the formulation of cakes and cookies dough

Product	Samples	Ingredient Ratio
Cake	T1	Bajra:Black gram flour = 1:1
	T2	Bajra: Dry peas powder = 1:1
	T3	Bajra: Lentil flour = 1:1
Cookies	T4	Bajra: Dry peas powder = 1:1
	T5	Rice flour: Sweet potato = 1:2
	T6	Rice flour: Sweet potato = 2:1
	T7	Rice flour: Sweet Potato = 1:1

*2.4 Sensory Analysis.* The sensory parameters of different cakes and cookies were carried out by 50 panellists. The panellists were asked to evaluate the products based on taste, aroma, colour, texture, appearance and overall acceptability. The evaluation was based on 9-point hedonic scale ranging from 9 (extremely good) to 5 (extremely disgusted) for each

organoleptic characteristic. Bottled water at room temperature was provided to clean the palate between the treatments to have the correct result.

2.5 Statistical Analysis.

Statistical analyses were performed by using SPSS software (ver. 22) (IBM Corporation, Somers, NY). Data were presented as M ±SD and analyzed by the ANOVA. Duncan’s multiple range test was used to determine significance between means. Differences at p < 0.05 were considered to be significant.

3. RESULTS

3.1. Physicochemical Attributes. Moisture content influences mechanical strength (crumbliness) and crunchiness of cookies and cakes. Comparative studies shown in Table 2, the control has the lowest moisture content (35.5%) compared to other treatments (p < 0.05). Furthermore, T1 showed the highest moisture content (51%) among all treatments (p < 0.05). It can be attributed to the high protein and fiber content in Bazra and Ragi and the presence of hydroxyl groups that enhanced the capability of interaction with water molecules and thus increased moisture content. Sweet potato (SP) exhibited higher water holding capacity than other GF flours. Bakery product volume is a crucial factor influencing consumer acceptability. Similarly, the ash and acid soluble ash contents were found to be increased in bazra and ragi made cookies and cakes compared to the sweet potato ingredient.

Table 2. Physicochemical analysis of gluten free cakes and cookies

Cakes	Sample	Ingredient	Moisture (%)	Ash (%)	Acid insoluble ash (%)
	T1	Bajra: Black Gram = 1:1	19.18	2.20	1.26
	T2	Bajra: Dry Peas = 1:1	21.99	1.49	0.40
	T3	Ragi: Black Gram = 1:1	22.51	2.34	1.50
	T4	Ragi : Dry Peas = 1:1	17.16	2.21	0.45
	T5	Rice flour: Sweet potato = 1:1	33.5	0.46	--
Cookies	T1	Bajra: Dry Peas = 1:1	4.26	2.44	
	T2	Rice flour: Sweet potato = 2:1	5.41	2.43	1.05
	T3	Rice flour: Sweet potato = 1:1	12.68	2.43	1.34

The experiment was carried out in triplicate.

3.2 Sensory Properties. GF products exhibit different appearances, colors, texture, aroma, and taste compared to wheat flour products. Generally, GF bakery products exhibit lower sensory acceptability due to the undesirable appearance, darker color, more complex texture, and dry sandy feeling in the mouth [10]. Results illustrated in Table 3, that incorporating gluten replacers in cookie formulation had little influence (p < 0.05) on different treatments’ flavor and chewing ability. The lowest scores were recorded in control and T2 concerning firmness, while the highest values were those of T3 and T5. The control and T4 showed the lowest overall acceptability, while T6 received the highest score (p < 0.05). In the study [12], the addition of 7% concentrated chiku fiber powder to GF cookie resulted in the highest overall acceptability.

Table 3. Sensory attributes of gluten free cakes and cookies

PRODUCTS	SAMPLES	ATTRIBUTES					
		TASTE	AROMA	COLOUR	TEXTURE	APPEARANCE	OVERALL ACCEPTABILITY
CAKES	Control	7.05± 0.84 <sup>a</sup>	6.83 ± 1.16 <sup>a</sup>	7.16 ± 0.75 <sup>a</sup>	6.16 ± 0.75 <sup>a</sup>	6.36 ± 0.25 <sup>a</sup>	6.0 ± 0.63 <sup>a</sup>
	T1	7.55± 0.24 <sup>a</sup>	7.23 ± 0.16 <sup>b</sup>	7.56 ± 0.35 <sup>a</sup>	8.16 ± 0.73 <sup>b</sup>	6.86 ± 1.05 <sup>a</sup>	7.0 ± 1.23 <sup>b</sup>
	T2	7.05± 0.84 <sup>a</sup>	6.33 ± 1.06 <sup>a</sup>	7.16 ± 0.75 <sup>a</sup>	6.16 ± 0.75 <sup>a</sup>	6.96 ± 1.05 <sup>a</sup>	7.60 ± 1.03 <sup>a</sup>
	T3	7.15± 0.84 <sup>a</sup>	6.63 ± 1.36 <sup>a</sup>	7.56 ± 0.75 <sup>a</sup>	7.16 ± 0.75 <sup>a</sup>	7.36 ± 0.55 <sup>a</sup>	8.30 ± 0.73 <sup>a</sup>
	T4	7.25± 0.34 <sup>a</sup>	7.23 ± 0.16 <sup>b</sup>	7.36 ± 0.35 <sup>a</sup>	8.26 ± 0.73 <sup>b</sup>	6.36 ± 1.25 <sup>a</sup>	7.06 ± 1.23 <sup>b</sup>
	T5	7.15± 0.34 <sup>a</sup>	6.63 ± 1.06 <sup>a</sup>	7.66 ± 0.15 <sup>a</sup>	6.16 ± 0.75 <sup>a</sup>	6.56 ± 1.65 <sup>a</sup>	8.03 ± 1.33 <sup>a</sup>
COOKIES	Control	7.15± 0.84 <sup>a</sup>	6.23 ± 1.16 <sup>a</sup>	7.86 ± 0.71 <sup>a</sup>	6.16 ± 0.75 <sup>a</sup>	7.35 ± 0.65 <sup>a</sup>	8.30 ± 0.73 <sup>a</sup>
	T1	8.15± 0.24 <sup>a</sup>	6.38 ± 0.86 <sup>a</sup>	7.26 ± 1.35 <sup>a</sup>	8.16 ± 0.05 <sup>a</sup>	7.66 ± 1.35 <sup>a</sup>	8.30 ± 0.73 <sup>a</sup>
	T2	7.95± 1.14 <sup>a</sup>	7.63 ± 1.32 <sup>a</sup>	8.56 ± 0.25 <sup>a</sup>	7.66 ± 0.35 <sup>a</sup>	8.16 ± 0.95 <sup>a</sup>	8.30 ± 0.73 <sup>a</sup>
	T3	7.05± 0.84 <sup>a</sup>	0.63 ± 1.36 <sup>a</sup>	8.16 ± 0.75 <sup>a</sup>	7.26 ± 1.25 <sup>a</sup>	8.36 ± 0.25 <sup>a</sup>	8.30 ± 0.73 <sup>a</sup>
	T4	7.95± 0.04 <sup>a</sup>	6.63 ± 1.36 <sup>a</sup>	7.66 ± 0.35 <sup>a</sup>	7.56 ± 0.35 <sup>a</sup>	7.86 ± 0.95 <sup>a</sup>	7.30 ± 0.73 <sup>a</sup>

Means followed by different lowercase letters within a column are significantly different ( $p < 0.05$ ). A higher value indicates higher overall acceptability.

#### DISCUSSION AND CONCLUSION

During the present investigation no significant difference was found in the percent moisture content, and ash content was observed on increasing the incorporation of rice flour in the treatments (i.e., T1, T2, T3, T4 etc). In the present study the formulation was based on different ratios like 1:1, 1:2, 2:1, 3:2 of rice flour, grains and pulse grain blend. The moisture content of cookies increased linearly with increase in concentration of pulses. The ash content of cookies increased significantly due to externally added fat during preparation.

From sensory evaluation, it has been suggested that cakes fortified with rice flour and pulse in the ratio of 1:1 showed the better consistency and cookies fortified with pulse and grains in the ratio of 1:1 shows better acceptability. Overall, it can be concluded that, GF cakes and cookies were acceptable by the consumers.

#### ECONOMIC IMPORTANCE OF GLUTEN FREE (GF) CAKES AND COOKIES

People who are sensitive to gluten, they will be helpful for consuming such cakes and cookies naturally fortified with easy available ingredients which are economically accessible compared to the present market hike of the food products.

#### FUTURE ASPECT OF THE STUDY

In the pilot scale, we had developed the GF cookies and cakes that have consumer's acceptability, therefore, in the large scale production it might have industrial acceptability.

**CONFLICTS OF INTEREST:** The authors declare that there are no conflicts of interest.

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#### LIST OF ABBREVIATIONS IN THIS CHAPTER

GF – Gluten free