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Studies on the formulation and quality characteristics of gluten free muffins

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Abstract

This study was carried out to use blends of rice flour (RF), soy flour (SF), corn starch (CS) for production of gluten-free muffins suitable for patients with celiac disease. The gluten-free muffins were prepared from the RF/SF/CS blends and evaluated for the physico-chemical and sensory properties. The purpose of this study is to optimize the muffin's formulation using different proportions of gluten-free flours. Thus, were tested three different recipes (T1,T2,T3), all three containing the same amount of rice flour (RF), but different proportions of soybean flour (SF) and corn starch (CS) so: T1 – RF:SF:CS (80:20:0), T2 – RF:SF:CS (80:10:10), and T3 – RF:SF:CS (80:0:20) other ingredients were unchanged in all three cases.

The muffins prepared from the blends of 80% rice flour and 20% soybean [T1– RF:SF:CS (80:20:0)], contains the highest amounts of protein and obtained the highest global score, being the most preferred by consumers.

Keywords: gluten-free muffins, flour blends, sensory evaluation, chemical composition

1. Introduction

During recent years there has been a slow and steady increase in consumer interest for wheat (*Triticum aestivum*) free foods for minimizing the risk of relatively unfamiliar condition known as celiac disease (CD) [28,38].

Celiac disease is a life-long intolerance to the gliadin fraction of wheat and the prolamins of rye (secalins), barley (hordeins) and possibly oats (avidins) [30]. The reaction to gluten ingestion by sufferers of celiac disease is the inflammation of the small intestine leading to the malabsorption of several important nutrients including iron, folic acid, calcium and fatsoluble vitamins [12].

Presently persons with celiac disease are unable to consume some of the most commonly available products of the market including breads, baked goods, and other food products made with wheat flour [28]. During January 2007, the FDA proposed the rule for labelling gluten free products to satisfy the demand for high quality gluten free cookies/ breads having similar quality of wheat flour based cookies and breads [38]. The only effective treatment for celiac disease is a life-long gluten-free diet [33].

The most difficult product to be replaced for celiacs is bread, a basic food of everyday life, and that is the reason why many research groups are interested in this subject worldwide [37]. Gluten-free breads and cookies are principally based on flour from rice or maize with low content and poor-quality proteins [33].

As per rule the "Gluten free" is a voluntary term and defined as food containing less than 20 ppm of gluten [38]. Gluten is the main structure-forming protein in flour, and is responsible for the elastic characteristics

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of dough, and contributes to the appearance and crumb structure of many baked products. Gluten removal results in major problems for bakers, and currently, many gluten-free products available on the market are of low quality, exhibiting poor mouthfeel and flavour [4]. Since the diet of celiac patients must be completely free of any gluten, so all the products from wheat, rye, barley and oat must be replaced with corn, rice, soy, millet equivalents and various types of starch (corn, rice and potato) or appropriate mixtures [1].

Soybeans contain 40% high quality protein with excellent digestibility [21]. The use of soybean protein is increasing because of its functional properties and being an economic source of dietary protein. However, soybeans are rich in lysine but low in sulphur amino acids [21]. Studies carried out by different authors [1,3,5,7,11,22,29,32,35] found that enrichment of defatted soya flour up to 20% improves the nutritional quality of bakery products like biscuit, bread muffins without affecting its taste, textural and overall acceptability of product. High protein soya bakery product reduce incidence of malnutrition and encourage the farmers to grow more soyabean due to increasing demand in the market [22].

Rice is naturally gluten-free and contains proteins that are known to be nutritious and hypoallergenic [20,34]. Rice has properties such as absence of gluten forming ability, low levels of sodium and fat, but high level of protein. It also has high amount of easily digestible carbohydrate. Since ricepossess unique nutritional, hypoallergenic and bland taste, consumption by coeliac patients has been increasing.

Rice flour has been used to prepare gluten-free bakery products, such as breads and cakes, which are traditionally made with wheat flour [10,34]. Also it has the potential to be a wheat flour substitute in muffins.

However, little information is available on the use of rice flour for gluten-free products such as muffins. Rice flour is naturally gluten-free, rich in carbohydrates and low in fat.

In recent years, several researches have been conducted and most significant developments in gluten-free products have been obtained using starches, dairy products, gums and hydrocolloids, probiotics, and other combinations as alternative to gluten, in order to improve the structure and taste [14,31].

The aim of the present work was to test rice flour, soy flour and maize starch, in order to develop gluten-free muffins targeting a good sensory acceptance and good nutritional value. Also, evaluation of the quality parameters of the muffins was another target.

2. Materials and methods

2.1. Materials. The study was conducted in the laboratory of the Department of Food Products Engineering, Faculty of the Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine Cluj Napoca. The rice flour, soy flour, corn starch and other raw materials were procured from the local market of Cluj-Napoca. The plastic container, high density polyethylene bags and required chemicals were used from the laboratory stock and also procured from the local market.

2.2. Production of the gluten-free muffins. The egg whites and yolks were minted separately, each with half the amount of sugar provided in the recipe, for 10-15 minutes. During churning foam of yolks with sugar, the yogurt and grape seed oil are added gradually, little by little. Then, rice flour, soy flour, corn starch and baking powder were added and mixed for 2-3 minutes.

The dough was placed into the paper mini cups and dried cranberries were added on the top. The baking operation was done in an oven (type Zanolli, Italy) at 180°C/30 minutes. After this, the muffins were removed from the oven, cooled to room temperature, and put into plastic packs.

*2.3. Sensory analysis of gluten-free muffins.*Gluten-free muffins samples were analyzed for sensory characteristics. Sensory quality characteristics were evaluated by a panel of 10 untrained members using a 9-point Hedonic scale. The biscuits were evaluated for their color, texture, taste, flavor and overall acceptability.

2.4. Physicochemical analysis. Psysicochemical parameters (moisture, crude protein, lipids, total carbohydrates) of the muffins were determined using method SR 91:2007.

3. Results and Discussion

Sensory evaluation for gluten-free muffins. In figure 1-3, the three samples (T1-T3) of the gluten-free muffins are presented. Sensory analysis is carried out by using untrained panelists to measure sensory characteristics like senses of sight, smell, taste, touch and acceptability of food product. Mean score for sensory evaluation of muffins given in table 2, revealed that there are significant differences between treatments for sensory attributes like taste, colour, flavor, texture and overall acceptability.

Table 1. Design of dough preparation for the three muffin samples (T1-T3)

Raw materials and auxiliary	% in relation to starches and flour		
	RF:SF:CS T1(80:20:00)	RF:SF:CS T2(80:10:10)	RF:SF:CS T3(80:00:20)
Rice flour	80	80	80
Soy flor	20	10	-
Corn starch	-	10	20
Each	50	50	50
Yogurt	100	100	100
Sugar	60	60	60
Grape seed oil	40	40	40
Baking powder	1	1	1
Dried cranberries	8	8	8

Figure 1. Muffin sample (T1) RF:SF:CS (80:20:00)

Figure 2. Muffin sample (T2) RF:SF:CS (80:10:10)

Figure 3. Muffin sample (T3) RF:SF:CS (80:00:20)

Table 2. Sensory scores of prepared gluten-free muffins using different blends (RF:SF:CS)

Treatments	Colour	Texture	Taste	Flavor	Overall Acceptability
T_1	**6.9**	**7.9**	**7.7**	**8.3**	**7.8**
T_2	7.5	7.1	7.4	7.6	7.4
T_3	7.2	6.8	7.1	7.4	7.2

*Data represents means of three determinations

Sensory rating of gluten-free muffins for colour shows that treatment T2 (7.5) ranked one due to excellent appearance, followed by T3 (7.2) while minimum colour intensity was observed for T1 (6.9). The mean score of colour had been decline from 7.5 in the case of sample T2 to 6.9 for the sample T1 (Table 2).

With increasing level of flour soy the color of muffins turned from light brown to dark brown, leading to lower acceptance [35]. The darker colour may be due to the non enzymatic reaction (Maillard reaction) between reducing sugar molecules and lysine protein [35,39]. Soybean and rice flour are reported to be rich in lysine which produces darker shades of brown colour [36]. The darker colour of other fortified product (breads and biscuits) have been reported by several authors [6,15,29].

Mean score of taste and texture had been decreased from 7.7 (T1) to 7.1 (T3) in the case of the sample's taste, while the texture decreased from 7.9 (T1) to 6.8 in the case of sample T3 with a low level of soy flour and increased addition of starch.

Mean score for flavor of muffins had been decreased from 8.3 (T1) to 7.4 (T3). Mean for flavor shown in table 2 revealed that the judges ranked treatment T1 (8.3) at top position followed by treatment T2 (7.6), while T3 (7.4) was placed last.

Overall acceptability was determined on the basis of quality scores obtained from the evaluation of color, flavor, and texture of the gluten-free muffins. The mean regarding overall acceptability of gluten-free muffins are shown in table 2 revealing that the overall acceptability of T1 (80% rice flour + 20% soy flour + 0% corn starch) was highest, while the treatment T3 (80% rice flour + 0 % soy flour + 20% corn starch) had lowest acceptability. The decrease in overall acceptability was due to decrease in texture, flavor, and taste score. Treatment T1 (80% rice flour + 20% soy flour + 0% corn starch), had highest scores for the sensory attributes than other treatment.

Chemical analysis of gluten-free muffins. Physicochemical parameters for gluten-free muffins are presented in figures 4- 6.

During the present research no significant difference was found in the moisture content and total carbohydrates for the three gluten-free muffins (T1-T3). The moisture content of the gluten-free muffins ranged between 20.19% and 31.64% (Figure 4) The moisture content of the muffins increased with the increase of the soy flour, due to the fact that soy flour and rice flour absorb higher quantity of water. A high level of moisture content may be indicate short self life of composite muffins as they encourage microbial growth leads to spoilage. The total carbohydrates content ranged between 44% to 47.72% (Figure 4).

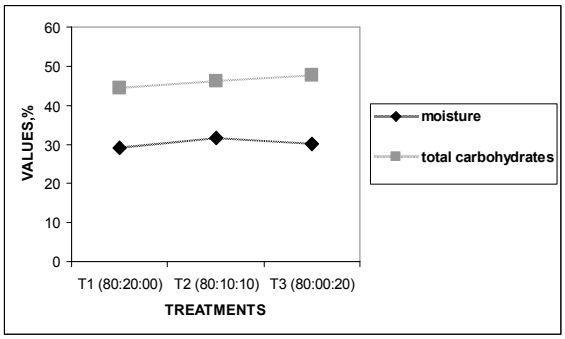

Figure 4. Effect of flours blending on moisture and total carbohydrates content of gluten-free muffin

The protein content and fat content of the gluten - free muffins increased with the increase in supplementation of the soy flour. The protein content ranged from 6.48% to 8.68%, while the fat content varied from 12.75% to 14.31% (Figure 5, 6).

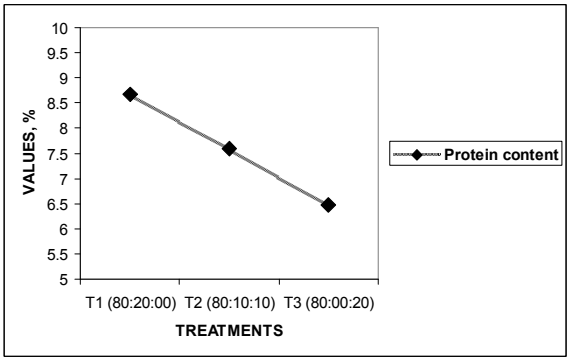

Figure 5. Effect of flours blending on protein content of gluten-free muffins

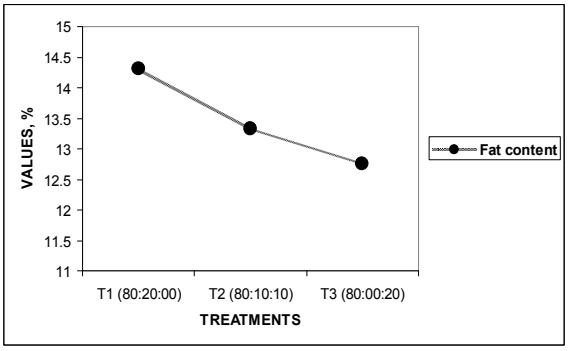

Figure 6. Effect of flours blending on fat content of gluten-free muffins

Significant changes in the muffins protein and fat values were recorded related to the increment of the soy flour content in the recipe. Soybean is an excellent source of protein and complement to lysine-limited cereal protein [29]. Addition of soy flour improve the quantity and quality of protein content of the food product, thereby has the great potential in combating with protein energy malnutrition [40].

The increase in fat content could be due to soy flour which is very rich in oil, (15-19.7%) [29]. Soybean have 20-22% high valued oil which is cholesterol free [31]. The oil of soybean contains 85% unsaturated fatty acid which includes 61% of polyunsatured fatty acid and 24 % of monounsatured fatty acid [41].

4.Conclusion

Gluten free flours combinations could be used to produce good quality muffins with acceptable physical and sensory qualities.

These muffins are advantageous for people suffering from gluten intolerance. All the blends of flours (rice, soy) and corn starch had improved both sensory and nutritional qualities of gluten-free muffins whereas the mixing of rice flour an soy flour [T1– RF:SF:CS (80:20:0)], had improved some of these parameters.

Compliance with Ethics Requirements: Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human and/or animal subjects (if exists) respect the specific regulations and standards.

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