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COMPARATIVE ANALYSES FOR GLUTEN-FREE BISCUITS FROM MIXTURE OAT AND CORN

– Short communication –

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Abstract: Gluten-free products are necessary for the people suffering from celiac disease or having a sensibility for products containing gluten. The aim of this study was to prepare and evaluate gluten free biscuits made from a mixture of flours (50% corn flour and 50% oat flour) with various fats (palm fat, coconut oil) and sweeteners (sugar, stevioside with erythritol). Sample biscuits were made and then analyzed to find out the moisture, water activity, braking point, specific volume and sensory evaluation. All samples had the moisture close to 5-6%. Water activity ranged from 0.49 to 0.71. The breaking point was higher for sample prepared with palm fat and sugar (0.43). This sample was accepted by panellist better than others samples of biscuits.

Keywords: biscuits, gluten-free, acceptability, oat, corn

INTRODUCTION

In recent years increased the incidence of disorder of gastrointestinal tract, the disorder is named celiac disease in which the glutenic proteins after ingestion determined the damage of small intestinal mucosa by an immune mediated mechanism. The disorder appears at individuals with genetic susceptibility towards gluten (Tye-Din et al., 2008). Celiac disease impose the total withdraw of gluten from consumption. Food industry must develop different types of new products without gluten or to replace the raw ingredients which contain gluten. The replacement of wheat flour in regular food products is a challenge because the absence of viscoelastic network created by gluten proteins (Tye-Din et al., 2018). Gluten free products can be included in the diet of patients suffering from celiac disease as only treatment available.

In the group of cereal plant, among the main representative wheat, corn and rice, it is a minor grain crop, oat (*Avena sativa*. This is considered a rich source of essential nutrients such as proteins, lipids, vitamins, mineral and fibre (Erkinbaev et al., 2017). Oat has high protein content and amino acid profile is well balanced. In general consumption of oats is safe for celiac patients (Bascuñán et al., 2017). Oat is used in many gluten free products (GFP) (breakfast cereals, granola bars, biscuits, breads, etc.) even if along time it was doubt because of the cross-contamination during processing (mills and factories), handling and transportation. If crops are grown under especial conditions of farming and precaution are taken during harvesting and distribution oat can be safely consumed by celiac patients (Bascuñán et al., 2017). 20 ppm or less is considered the maximum limit for gluten in flour to be considered gluten-free (Erkinbaev et al., 2017). Oat is considered functional ingredient, can contribute to reduce the level of cholesterol and glucose in blood due to the content of soluble dietary fibre β-glucan (Duta and Culetu, 2015) and also decrease the risk of cardiovascular disease.

Corn flour is used for processing and development of a wide variety of foods and products (Xue et al., 2017). Corn flour contains the protein fractions of maize, zein (prolamin), which is the most abundant fraction (Ozturka et al., 2018). Zein contains high amounts of hydrophobic amino acid residues like leucine, phenylalanine, proline, alanine (Fevzioglu M., 2012). Lysine, tryptophan and methionine are tipically at low levels in maize (Scott and Emery, 2016). At room temperature corn flour does not form a viscoelastic dough but the will be

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stretchable, extensible and cohesive (Ozturka et al., 2018).
Shortening or solid fat are used in biscuits manufacturing because they have some important properties. They are plastic at room temperature (consistency, high melting temperature) and in solid state they could entrap air, incorporating it during mixing and they enable the dough to keep shape at the elevate temperature reached during processing and hold its shape for longer Tarancón et al., 2013). Shortening contribute to the quality of bakery products affecting flavour and structure, tenderness, moist mouthfeell and lubricity, (Clyde and Stauffer, 1996).
Coconut oil is obtained from the tropical fruits of coconut palm (*Cocos nucifera*) and it is used in bakery due to its properties like: providing longer shelf-file for the food products, antiviral, antibacterial and antiprotozoal effects (Appaiah, 2014).

Sugar is simple carbohydrates used in bakery to sweeten products but also for tenderness, browning and hydrophilic capacity. It is known that increased consumption of sugar has resulted in obesity and other several nutritional and medical problems (Abdalbasit, 2014). There are made efforts to substitute sugar with low caloric sweeteners. *Stevia rebaudiana* is novel source of stevioside a natural and proper sweetener due to its capacity to sweet approximately 300 times higher than sucrose (Allam, 2001). It contains over 30 types of steviol glycosides that are noncaloric. Extracts of *Stevia rebaudiana* is combined with erythritol for a better taste. Erythritol is a natural substance found in many vegetables and fruit. It is sugar alcohol, all-natural, that is naturally obtained from sugars by fermentation (Vaclavik, 2014).

MATERIALS AND METHODS

Materials

Corn flour and palm oil (shortening) were purchased from Boromir Group (Sibiu, Romania) Other ingredients was purchased from local market: oat flour (Bauck Hof), coconut oil (SC Naturking SRL), sugar (Agrana Romania SA), stevia rebaudiana with erythritol (Sly Nutritia SRL), powdered milk (Dr. Oetker RO SRL), baking powder (Dr. Oetker RO SRL) and fresh eggs.
The moisture of corn flour and oat flour were 12.8 and respectively 11.0%, ash content was 0.49 and 1.36%. The high ash content of oat flour indicates a high extraction rate of flour. The acidity was 0.32 and 0.50 ml NaOH 1n / 100 g for corn and respectively oat flour indicating low lipid content and short keeping time for corn flour and a low activity of lipase in oat flour.

Biscuit preparation

The ingredients were used to tailor 4 different formulations of biscuits. The biscuit samples varied in type of fat (palm or coconut oil) and sweetener (sugar or stevia rebaudiana with erythritol). Details of GFB (Gluten Free Biscuits) recipe are presented in table 1. A mixture of flour, 50% corn flour+50% oat flour was used to create the four batters for GFBs.
The fat and sugar were mixed in a mixer (Kitchen Aids) for 2 minutes at speed 2. The eggs were homogenized with a hand blender for few seconds and then aided to the fat and sugar composition. The time for blending was 1 minute at speed 4. After that, water and mixture of flour, powdered milk and baking powdered was added. The blending time was 3 minute at speed 1. Following a rest time of 20 minute in the refrigerator, the dough was sheeted to a final thickness of 5 mm, rectangular shape L-90 mm, l-30 mm. Dough pieces were placed on a baking paper in a tray and baked for 16 minute at 175^0C in heated oven. After 30-40 min cooling at room temperature, the GFBs were placed in sealed jars and stored at room temperature until further examination.

Table 1. Recipe of GFB

Ingredients	**B1**	**B2**	**B3**	**B4**
Corn flour, g	150	150	150	150
Oat flour, g	150	150	150	150
Shortening (palm fat), g	105	105	-	-
Coconut fat, g	-	-	105	105
Sugar, g	45	-	45	
Stevia rebaudiana with erythritol (Sweet&Safe), g	-	45	-	45
Powder milk, g	6	6	6	6
Baking soda, g	3	3	3	3
Egg, g	50	50	50	50
Water, ml	90	90	90	90

Physicochemical and textural analyses

Weight (W) of biscuits was measured as average of values of 3 individual biscuits with a digital weighing balance.
Volume of biscuits was calculated using measured geometric dimensions of baked biscuits. Density (ρ) was calculated.

Textural analysis was done by measuring the breaking point at speed 1 mm/s with a build-in apparatus. We used a 1 kg load cell and heavy duty platform. For the instrumental texture analysis we applied the force perpendicular to the sample which is sustained by two horizontal arms. We registered the force needed to broken the biscuits. The distance between the horizontal arms was 40 mm.

The moisture content for corn and oat flour, for B1, B2, B3 and B4 was determinate by drying samples at 130±2^{0}C, 40 min in oven.

Water activity (a_w) was measured with Novasina LabMaster-aw.

All measurements were done at least in triplicate.

Sensory evaluation

Eight semi trained panellist evaluated the biscuit samples. Age range of panellist was 21-22 years. The panellists evaluated the overall acceptance of each sample after they were instructed. They used a 9-point hedonic scale in which 1 corresponded to "entirely disliked", 5 to "neither liked nor disliked" and 9 to "entirely liked".

RESULTS

The mass of biscuits from samples B1 and B2 is almost similar, but for B3 and B4 is quite different. The biscuit with coconut fat and stevioside mix weigh less than biscuit made with sugar (Table 1). The combination of coconut fat and stevioside mix created a more aerated structure than coconut fat with alternative sweetener. The denser biscuits were obtained when we used regular shortening (palm fat) with alternative sweeteners. Biscuits prepared with regular fat were denser than biscuits prepared with coconut fat.

Water activity and moisture of GFB samples are presented in Figures 1 and 2. Water activities of samples were low enough to ensure the microbial stability against regular microorganism during storage. Te moisture of samples prepared sugar was lower than the moisture of samples prepared with alternative sweetener but water activity did not followed the same pattern. This indicates that fats interact in different way with the water from the composition of biscuits. The composition of biscuits is complex and water could be bonded in different structures.

This complex interaction of ingredients is reflected in the textural properties of biscuits too (see Figure 3). No pattern could be observed in the hardness of biscuits. Sugar provided hardness in biscuits with prepared with shortening. The samples prepared with coconut fat had very close hardness despite the different sweeteners used. The hardness of the samples depends on the way of interaction of ingredients, the water content and internal structure. We expect that a dense structure will provide higher mechanical resistance but we observed that the high density biscuits (B2) had the lowest hardness. This sample had the highest moisture content but water availability was not the highest. The lightest sample (B4) did have the second highest hardness, almost half than highest.

The sensory evaluation of GFB is presented in Figure 4. The B1 sample is the most acceptable for the panellist. The score is a little bit under 7 for this biscuit. The second one is B2. Probably the panellists were accustomed with this taste due to the use of shortening from palm oil in many bakery products. We observed that the samples prepared with shortening had higher scores in general which lead us the conclusion of that coconut fat did not function as the regular fat used in biscuits manufacturing and biscuits shortening are better solution for tailoring biscuits recipe. The sample B1 with highest firmness had the highest scores when textural properties were sensorial analysed.

Panellist appreciated the firmness of sample B1 and B2 prepared with shortening while biscuits prepared with less firm coconut were too friable. The sweetness of sample B1 was better appreciated but close to sweetness of samples with alternative sweetener. The aspects, colour, taste and smell of samples with shortening were higher. In general, combination of sugar with coconut oil provided the lowest scores.

Table 2. Physical characteristics of GFBs

Sample / Characteristics	B1	B2	B3	B4
Weight, g	14.79	14.86	17.38	13.22
Volume, ml	15.3	13.2	20.9	17.0
Density, g / ml	0.966	1.13	0.832	0.776
Specific volume, ml / 100 g	103.5	88.5	120.2	128.8

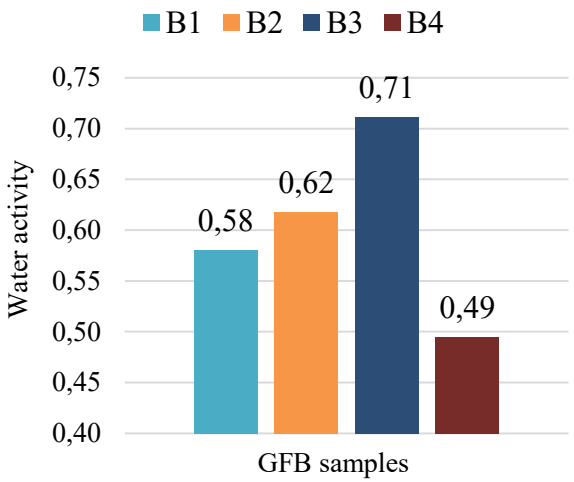

Figure 1. Water activity for gluten free biscuits

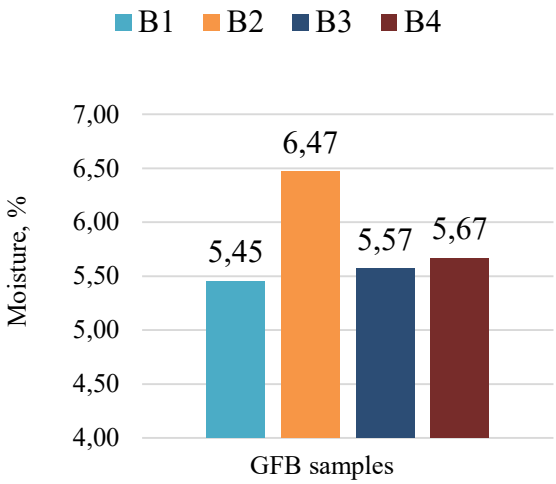

Figure 2. Moisture for gluten free biscuits

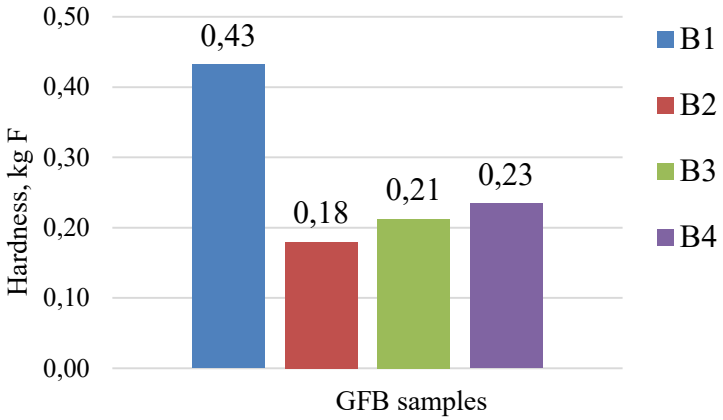

Figure 3. Biscuits hardness, kg Force

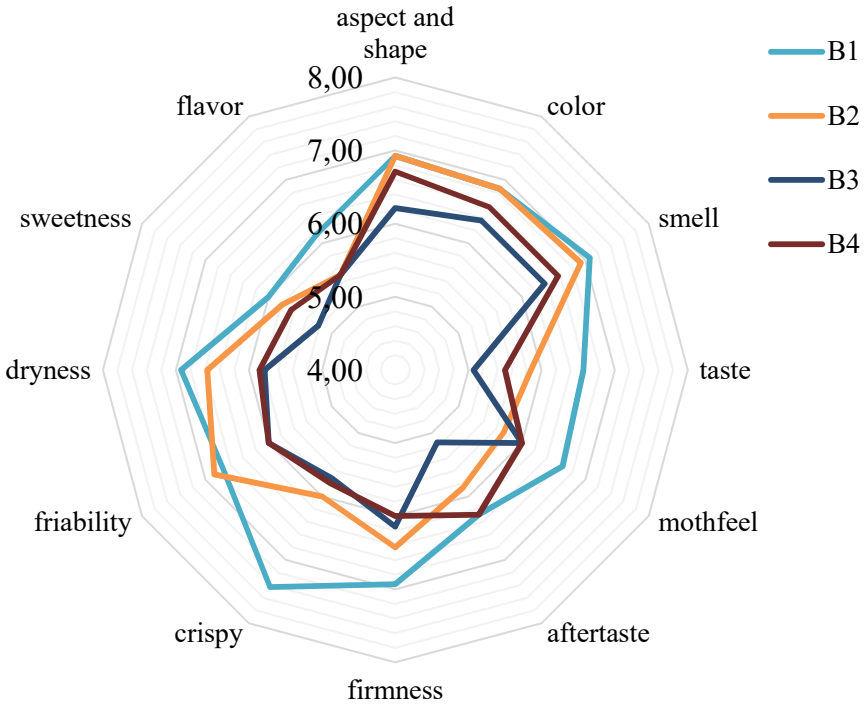

Figure 4. Sensory evaluation for gluten free biscuits

CONCLUSIONS

The demand for gluten free products is increasing and food industries have to develop new products. GFBs made with a mixture of 50% corn and 50% oat flour is suitable for satisfy such demand. The fat used plays an important role and the results show the shortening (palm oil) is better accepted by the panellist (B1 has the higher score). The sugar also is recognized like aroma, taste in contrapart with combination of stevioside and erhytritol. That means the panellist rather accept traditional ingredients than new ingredients with different flavours. The ingredients used for preparation of GFB interact in very complex ways and other studies are necessary to clarify how these ingredients influence the characteristics of biscuits.

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