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Researches regarding the influence of coconut flour addition on the nutritional value of gluten – free cookies

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Abstract

The results presented in this paper are part of a comprehensive study, which aims to develop innovative flour products, specially designed for people intolerant to gluten and for people with diabetes, respectively, but that can be consumed as well by the persons that want to adopt a healthy eating style. Celiac disease or gluten sensitive enteropathy is a chronic disease of the small intestine caused by gluten intolerance - the protein present in classic cereals. In this context, in order to reduce the risks associated with ingestion of gluten, alternatives to replace conventional flours with unconventional ones, are looked for. Based on these considerations, the aim of this study was to optimize the recipe for obtaining protein gluten-free cookies, based on coconut flour (CF). Sensory and physico-chemical characteristics of the protein gluten-free cookies with coconut flour added in a proportion of 25%, 50% and 75%, values reported on the total amount of the mixture of flours, were evaluated. The results showed that the addition of 50% CF to the dough has improved the sensory and physico-chemical characteristics of the samples of the cookies obtained, and consequently increased their nutritional value.

Keywords: coconut flour, whole rice flour, protein gluten-free cookies, cookies quality, high nutritional value

1. Introduction

The diet is not only an essential condition for life, but also an opportunity and equally a risk [1].

Currently correcting and improving lifestyles, hence the "style" of food has become a priority and a constant concern, due to the many diseases that have developed as a consequence of the eaten food and its adjuvants [2].

Studies performed in recent years show that the evolution of human society is largely determined by the quantity and quality of food used for daily nutrition [3]. In this respect, modern science of food and nutrition shows increasing importance to both preventative role of nutrition in disease onset and production of food for people with increased sensitivity to certain foods. Thus, due to the reactions they produce, food intolerances have become a major problem for the population [4, 5]. Currently, both nationally and internationally, there is a growing concern regarding celiac disease, both in its medical aspects and to ensure adequate nutrition and food, gluten-free offering for this category of the population [6].

Celiac disease is widespread throughout the world and affects approximately 1: 100 and 1: 300 people, the ratio between men and women is 2: 1(World Gastroenterology Organisation Practice Guidelines, 2007) [6, 7].

In Romania, the prevalence of celiac disease is 2.2% with equal distribution between genders, with the predominance of urban patients, aged between 30 and 60 years [8]. Celiac disease or gluten sensitive

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enteropathy is a chronic autoimmune intestinal disease (own immune system causes disorder) that occurs in people with a certain genetic predisposition, and could occur at any age [7, 9]. Pathogenic process is caused by gluten intolerance - the protein present in cereals such as wheat, barley, rye and oats. This means that, when a person intolerant to gluten consumes products that contain it (food, supplements or drugs), the host immune system is activated to synthesize antibodies, and anti-gliadins which are secreted in the gut (the immune system attacks through antibodies), [9] causing an inflammatory reaction on the mucosa surface [10]. After diagnosis, the patient is recommended a gluten-free diet for the entire period of his life. This type of diet prevents mortality and reduces the incidence of gastrointestinal illness

associated, but it is difficult to follow [11] because it requires the total removal of food products containing gluten. Also, the main risk of adopting a gluten-free diet is a low uptake of vitamins and minerals such as iron, calcium, thiamin, riboflavin, niacin and folic acid [12]. Thus, the creation of different types of food cereal based, is absolutely necessary due to the growing number of people affected by food intolerances in general and to gluten, especially.

Currently, the directions of development of technologies and varieties of gluten free flour products for people intolerant to gluten are based on reducing the gluten content and increasing the levels of the soluble protein. This can be achieved by replacing the wheat flour with gluten-free flour, which is a challenge because each type of flour behaves differently in the process of baking [13].

On the market there are many types of gluten-free flour mixes and even ready-made mixtures. The use of different grains and different flours makes it necessary to find possibilities for the gluten role be taken by other flour ingredients, by the addition of different components in various treatments on flour and dough, or by changing the baking method [14].

Gluten is the main structural protein in flour composition, responsible for the elastic characteristics of dough and it contributes to the appearance and crumb structure of many baked goods [15]. Eliminating gluten causes serious problems to bakers because currently many gluten-free products on the market are of poor quality [16]. This is a major challenge for the food engineer and baker, which led to the search for alternatives to gluten. The absence of gluten in dough production presents a great influence on dough rheology, production process and final quality of the gluten-free product. Gluten-free breads are much less cohesive and elastic than those of wheat, are very smooth and difficult to process, stickier, less elastic, with a batter consistency [17, 18].

The obtained products exhibit some deficits quality when compared with traditional products: the crumb is more brittle, also lighter in color and due to low activity of binding carbon dioxide during leavening, their volume, in most cases is low [19]. Currently, the international market available to people following a gluten-free diet, offers a wide range of gluten-free products: bread and bakery products, pasta, crackers, biscuits, cookies, waffles, etc., but these are expensive [18].

In this regard, in recent years, on a national level were studied different experimental gluten-free systems in order to develop gluten-free products, studies which involved a diverse approach and included the use of various types of alternative flours (amaranth, buckwheat, corn, millet, rice, sorghum, wild rice, quinoa, chickpeas, chestnuts, hazelnuts, almonds), starch, dairy, gums and hydrocolloids, other non-gluten proteins, prebiotics and combinations thereof, as alternatives to gluten, to improve the structure, taste, acceptability and shelf life of gluten-free products [20].

In the category of alternative flours goes the coconut flour which does not contain gluten and which represents an important source of nutrients, in particular fibers and proteins, no *trans* fatty acids and has a low glycemic index. Coconut flour contains 61% fiber, which is the highest percentage of dietary fiber found in any flour [21, 22] and can play an important role in controlling cholesterol and blood sugar levels, and prevent colon cancer. Coconut flour is made from coconut which is classified as a "functional food" because it provides many health benefits beyond its nutritional content [23].

Replacing flour with coconut flour is made up to a certain level in order to maintain the nutritional quality of foods, to keep nutrients levels adequate, to correct or prevent specific nutritional deficiencies among the population or among groups at risk of certain deficiencies, to increase the added nutritional value of a product and to provide certain technological functions in food processing [24]. A special interest exhibits the oil obtained from coconut, too, due to its curative properties when comparing to any other assortment of dietary oil and is extensively used in traditional medicine in Asia and the Pacific [23, 25]. Coconut milk, also, is an important source of proteins, such as albumin, globulin, prolamin and glutein [26].

Based on these observations, this study aimed at creating a floury gluten free – product - *protein gluten-free cookies* – optimized type nutritionally, that would not exhibit the allergen factor, but would contain the nutrients necessary for correcting malabsorption deficiencies created by illness, aimed to be consumed by children and adults who suffer from celiac disease.

2. Materials and Methods

2.1. Materials

Raw and auxiliary materials used in this study were purchased from profile stores.

2.2. Methods

2.2.1. Proximate composition of whole rice flour and coconut flour

For determining the average chemical composition of flours (whole rice flour - WRF, coconut flour - CF) and flours combinations (75:25%, 50:50%, 25:75%) used in this study, the following chemical characteristics were determined: moisture determined according to standard method A.O.A.C. 1995 [27]; fat content by extraction with Soxhlet apparatus according to standard method A.O.A.C. 1995 [27]; protein content by the Kjeldahl method according to standard method A.A.C.C. 2000, No. 46-10 [28]; fiber content according to standard method A.O.A.C. 1995, No. 32-10 [27]; carbohydrate content according to standard method A.O.A.C. 1995 [27]; energy value according to standard method A.O.A.C. 1995 [27].

2.2.2. Protein gluten-free cookies preparation

Cookies dough was prepared from whole rice flour (control) and coconut flours combinations (25%, 50%, 75%, and 100%) using flour (100%), konjac flour (10%), protein powder (15%), cardamom (2.5%), erythritol (35%), stevia extract (5%), butter (50%), coconut oil (7.5%), coconut milk (50%), egg (50%), baking powder (7.5%). After homogenisation, powdery components (edible gluten-free flours, protein powder, cardamom, baking powder) were blended with the liquid butter, coconut oil, coconut milk, foamed eggs and sweeteners. The resulting mixture was subjected to kneading operation until a firm and homogeneous dough was obtained and then allowed to rest for 15 minutes at 4°C. The dough thus obtained was rolled (thickness of 1 cm) and cut into circular portions by using a round shaped cutter (6 cm). After baking at 120°C for 25 minutes, cookies were cooled to room temperature and then packed in bags of polypropylene and evaluated after 24 hours.

2.2.3. Sensory evaluation of protein gluten-free cookies

The sensory evaluation of cookies was carried out by a panel of ten untrained judges and a panel of ten trained judges, respectively, using 9-point Hedonic scale. The data were subjected to one-way analysis of variance technique (ANOVA) of using completely randomized design and reported in the tables as an average of triplicate observations. The numerical scores assigned were the following:

9: Like extremely
8: Like very much
7: Like moderately
6: Like slightly
5: Neither like nor dislike
4: Dislike slightly
3: Dislike moderately
2: Dislike very much
1: Dislike extremely

The judges evaluated the cookies samples for their color, appearance, taste, texture, chewing ability and overall acceptability. Sensory scores of the various judges were given on hedonic scale. In the score sheet, maximum score was nine and it was considered as excellent, minimum score was 1 and it was considered as poor and the intermediate scores were fair (2,3,4), good (5,6) and very good (7,8) [29].

2.2.4. Physical parameters of protein gluten-free cookies

The diameter from the physical parameters of cookies was determined by placing six cookies edge to edge and by measuring it with ruler of mm and by rotating at an angle of 90°. This was repeated once more and average diameter was reported in millimeters (AACC, 2000) [28]. The thickness by placing cookies on top of one another. The total height was measured in millimeters with a ruler. The measurement was repeated thrice to get an average value and results were reported in mm (AACC, 2000) [28]. Spread factor was determined from the calculated ratio of diameter to thickness according to the method of Shrestha and Noomhorm, 2002 [30].

2.2.5. Chemical evaluation of protein gluten-free cookies

The protein gluten-free cookies samples obtained according to the method described in *paragraph 2.2.2.*, were submitted to chemical evaluation aiming: moisture, fat, protein, fiber, carbohydrate, ash, alkalinity and energy according to A.O.A.C. and A.A.C.C. standard method (*paragraph 2.2.1.*) [27, 28].

3. Results and Discussion

3.1. Proximate composition of flours

The chemical composition and energy content of the raw materials are summarized in *Table 1*.

By centralizing the statistical obtained results regarding the chemical composition of flours and mixtures of flours used in this study (*Table 1*), it may be noted that along with the increasing ratio of CF added there is a significant increase in the content of fat, fiber, ash, and a decrease in humidity, content of carbohydrates and protein. These differences proportionally increase or decrease with the increase of CF ratio in the studied mixes.

Thus, from the data presented in *Table 1* it can be seen that both WRF and CF, contain appreciable amounts of substances with high functional potential, namely WRF contains 8.2 ± 0.3% protein and CF contains fiber (13.62 ± 0.45%) and ash (1.69 ± 0.22) reflecting the content of minerals (sodium, magnesium, potassium, etc.) [22]. And in terms of the functional potential of WRF with the addition of CF mixtures, the experimental results showed that it can be allowed the mention of "source of protein", "source of fiber" and "mineral sources", thus the protein content ranges from 7.19 ± 0.13% and 7.80 ± 0.16%, the fiber between 4.23 ± 0.11% and 10.40 ± 0.14% and ash content between 1.45 ± 0.21% and 1.59 ± 0.16%, respectively, which was consistent with the results presented by Poonam, 2013 [23].

The water content (*Table1*) of WRF compared to that of CF was 8.33 ± 0.38% versus 3.23 ± 0.20%, and in mixtures it decreased from 7.16 ± 0.08% (WRF: CF - 75: 25%) to 4.42 ± 0.16 (WRF: CF - 25: 75%), which makes the use of these mixtures in manufacturing technology of gluten-free protein cookies to determine the extension of their freshness.
Regarding the fat content of the analyzed samples, from the data presented in *Table 1* it can be seen that the WRF has a much lower fat content (2.43 ± 0.32%) than CF (63.99 ± 0.11%), content that decreases significantly in the studied flour mixtures, from 48.28 ± 0.29% (WRF: CF - 25: 75%) to 7.16 ± 0.08% (WRF: CF - 75: 25%), which gives them a lower storage stability.

The obtained results regarding the carbohydrate content of the analyzed samples reveals that WRF has a significant content of carbohydrates of 78.72 ± 0.10% in comparison to CF containing only 10.45 ± 0.26%, and in the case of flour mixtures this content decreases from 61.34 ± 0.35 % (WRF: CF - 75: 25%) to 27.22 ± 0.27% (WRF: CF - 25: 75%), which contributes to lower their glycemic index [25].

It is also known that coconut flour helps increasing the energy value of products [22], thus substituting whole rice flour with coconut flour in the cookies recipe, there will be an increase both of the value of their energy and the nutritional one, too, providing health benefits to consumers of protein gluten-free cookies. Thus, if WRF has an energy value of 369.54 ± 0.04% through the addition of CF, the energy value increases to 572.15 ± 0.03 kcal in WRF: CF - 25:75.

3.2. Sensory evaluation of protein gluten-free cookies
Partial substitution of wheat flour with other flours causes significant changes in terms of texture, flavor,

color, appearance and overall acceptability of the obtained products [31]. By substituting 25%, 50% and 75% WRF with CF in the recipe for the manufacture of protein gluten-free cookies, led to the obtaining of samples with optimum sensory attributes, according to STAS 1227-3/1990.

Experiments conducted in the laboratory belonging to Faculty of Food Processing at the Banat`s University of Agricultural Sciences and Veterinary Medicine "*King Michael I of Romania*" from Timisoara, showed a direct correlation between the dough composition, working technological parameters and qualitative properties of these cookies assortments.

Following the sensory analysis of the four assortments of cookies (Control cookies – CC; Cookies with 25% CF – C25CF; Cookies with 50% CF – C50CF; Cookies with 75% CF – C75CF) performed on a group of 20 people, using the 9-point Hedonic scale, it resulted that protein gluten-free cookies assortment with 50% CF was the most appreciated in sensory terms.

Sensory characteristics of protein gluten-free cookies based WRF and CF are presented in *Table 2.*

Sensory rating of protein gluten-free cookies for color shows that replacement of WRF with CF affects the color, which decreases from 6.82±0.04 in CC to 6.33±0.04 in C75CF samples.

The color of C50CF cookies (6.55±0.03) was rated significantly lower than blank cookies (6.82±0.04) showing that the replacement of WRF with CF affects the color. Regarding the appearance, the C50CF samples with an well-defined shape, undistorted crust surface that showed no cracks, were preferred among the other cookies assortments. Values for taste (7.86±0.06) and aroma (7.76±0.07) were high in C50CF, values that were attributed to the distinctive aroma of the CF.

As for the texture of the protein gluten-free cookies with CF, the sensory evaluation data indicated that C50CF were significantly crisper than CC, exhibiting a crunchy bite, softness and easily broken texture. Control cookies were attributed with a lower overall acceptability score than that of coconut flour cookies by the panelists, the mild and sweet flavor of coconut being preferred. The highest value for this attribute was recorded in C50CF (7.44±0.04) as compared to blank cookies (6.35±0.03).

According to data shown in *Table 2*, it can be observed that the cookies samples sensory evaluated fit into the first two quality categories "*very good*" and "*good*" [29]. Thus, summarizing the data obtained, 50% CF resulted to be the optimum proportion to be added, in order to obtain good protein gluten-free cookies sensory assessed.

3.3. Physical parameters of protein gluten-free cookies

After the sensory examination protein gluten-free cookies samples were subjected to physico analysis. The experimental results obtained in this study, are given in *Table 3.*

According to the results presented in *Table 3* the average weight of CFC samples, ranged from 11.62 ± 0.02 g in C25CF, up to 12.94 ± 0.03 g in C75CF, in comparison with CC, which registered an average weight of only 10.54 ± 0.03 g, thus being ascertained that the weight of analyzed cookies increased with the increasing ratio of CF in flour mixtures.

Also, according to the results obtained (*Table 3*) regarding the diameter and average thickness of analyzed cookies samples, it was ascertained that: the average diameter of CFC samples decreased from 60.53 ± 0.03 mm for C25CF to 60.12 ± 0.02 mm for C75CF, compared to CC which exhibited an average diameter of 60.62 ± 0.02 mm and the average thickness of the CFC samples increased from 9.92 ± 0.02 mm for C25CF to 10.21 ± 0.02 mm for C75CF, compared to CC exhibiting an average thickness of 9.72 ± 0.02 mm. The results obtained in this case, point out that the addition of CF in the batter causes a decrease in the diameter and an increase of the thickness in cookies samples compared to blank, variations that are proportional with the added CF ratio. According to studies carried out by Poonam et.al. 2013, [23] cookies spread ratio is an important quality parameter, the higher the spread ratio is, the higher the product yield will be. According to data obtained in this study (*Table 3)* the spread ratio for CC was 6.23 ± 0.01 compared to 5.86 ± 0.02 for C75CF sample, thus being found a decrease of this ratio proportional with the increase in the percentage of CF added. The results are comparable with other studies, according to, the cookies thickness has increased, while the diameter and spread ratio decreased proportionally with the ratio of rice, bran-fenugreek blends, fenugreek flour and different bran mixtures [32].

As shown in *Table 3*, the CCF samples soaking capacity decreases from 35.23 ± 0.03 g (C25CF) to 25.63 ± 0.04 g (C75CF), compared to CC which recorded a soaking capacity of 40.12 ± 0.02 g, this demonstrating that the addition of CF promotes the absorption of smaller amounts of water in the product.

3.4. Chemical evaluation of protein gluten-free cookies

Chemical evaluation of protein gluten-free cookies WRF and CF-based are shown in *Table 4.*

Table 1. Chemical composition of raw materials

Chemical composition (%)	Flours combination (%)				
	WRF:CF (100:0)	**WRF:CF (0:100)**	**WRF:CF (75:25)**	**WRF:CF (50:50)**	**WRF:CF (25:75)**
Moisture	8.33±0.38	3.23±0.20	7.16±0.08	5.63±0.67	4.42±0.16
Fat	2.43±0.32	63.99±0.11	17.53±0.30	33.48±0.26	48.28±0.29
Protein	8.2±0.3	6.89±0.28	7.80±0.16	7.55±0.19	7.19±0.13
Fiber	0.94±0.16	13.62±0.45	4.23±0.11	7.26±0.09	10.40±0.14
Carbohydrates	78.72±0.10	10.45±0.26	61.34±0.35	44.31±0.23	27.22±0.27
Ash	1.35±0.36	1.69±0.22	1.45±0.21	1.54±0.11	1.59±0.16
Energy value (kcal)	369.54±0.04	645.30±0.04	434.36±0.03	508.72±0.04	572.15±0.03

All determinations were done in triplicate and the results were reported as average value ± standard deviation (SD).

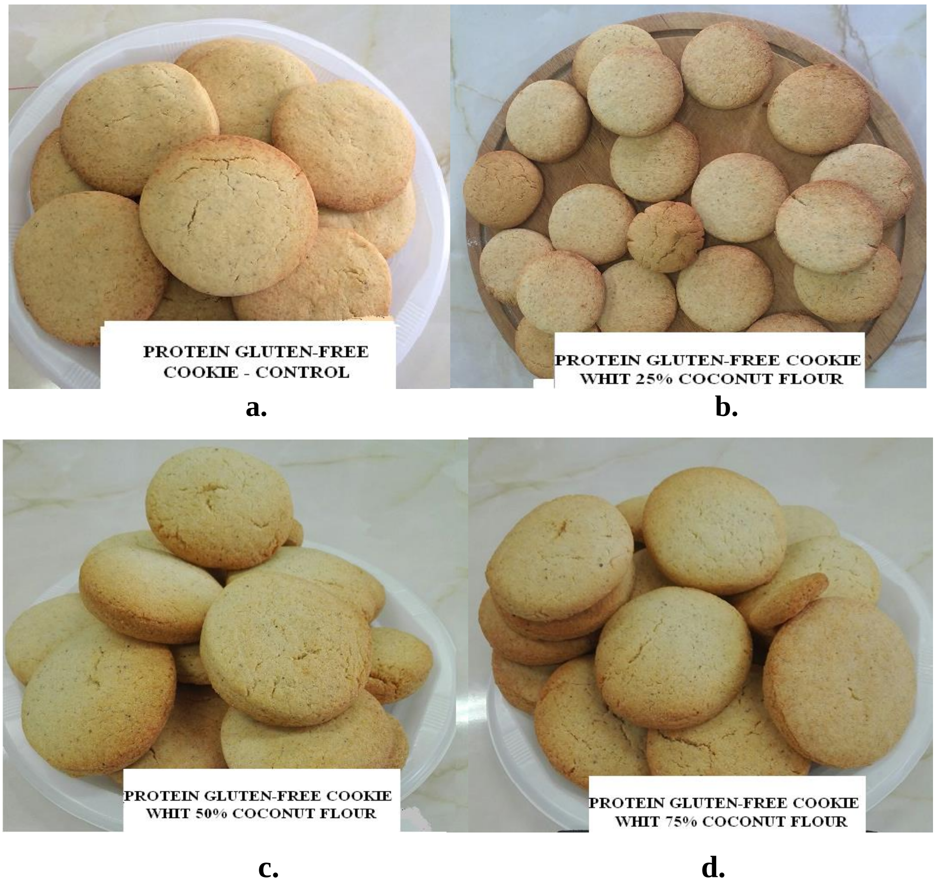

Figure 1. The assortments of protein gluten-free cookies: a. Control cookie; b. Cookie whit 25% CF; c. Cookie whit 50% CF; d. Cookie whit 75% CF.

Table 2. Qualiti attributes scored in sensory assessment of ptotein gluten-free cookies

Parameter	**Cookies samples evaluated**			
	Control cookies (CC)	**Cookies whit 25% CF (C25CF)**	**Cookies whit 50% CF (C50CF)**	**Cookies whit 75% CF (C75CF)**
Color	6.82±0.04	6.63±0.07	6.55±0.03	6.33±0.04
Appearance	6.42±0.03	6.98±0.07	7.52±0.03	6.56±0.06
Aroma	6.24±0.05	7.31±0.03	7.76±0.07	7.53±0.04
Taste	6.83±0.04	7.46±0.02	7.86±0.06	7.75±0.03
Texture	6.65±0.03	7.33±0.04	7.54±0.03	7.31±0.03
Overall acceptability	6.35±0.03	7.29±0.03	7.44±0.04	7.15±0.03

All determinations were done in triplicate and the results were reported as average value ± standard deviation (SD).

Table 3. Physical properties of ptotein gluten-free cookies

Parameter	**Cookies samples evaluated**			
	Control cookies (CC)	**Cookies whit 25% CF (C25CF)**	**Cookies whit 50% CF (C50CF)**	**Cookies whit 75% CF (C75CF)**
Weight (g)	10.54±0.03	11.62±0.02	12.84±0.02	12.94±0.03
Diameter (mm)	60.62±0.02	60.53±0.03	60.42±0.02	60.12±0.02
Thickness (mm)	9.72±0.02	9.92±0.02	10.12±0.03	10.21±0.02
Spread ratio	6.23±0.01	6.12±0.02	5.96±0.02	5.86±0.02
Water impregnation capacity (g)	40.12±0.02	35.23±0.03	30.42±0.02	25.63±0.04

All determinations were done in triplicate and the results were reported as average value ± standard deviation (SD).

Table 4. Chemical evaluation of protein gluten-free cookies

Chemical composition (%)	**Cookies samples evaluated**			
	Control cookies (CC)	**Cookies whit 25% CF (C25CF)**	**Cookies whit 50% CF (C50CF)**	**Cookies whit 75% CF (C75CF)**
Moisture	4.27±0.02	4.63±0.02	5.26±0.02	5.94±0.03
Fat	18.64±0.03	19.56±0.03	23.32±0.05	27.14±0.04
Protein	10.07±0.05	11.94±0.05	16.74±0.04	21.58±0.02
Fiber	0.76±0.02	5.63±0.04	6.54±0.04	7.35±0.04
Carbohydrates	69.06±0.04	61.24±0.04	51.56±0.03	43.94±0.03
Ash	1.44±0.04	1.67±0.02	1.84±0.04	2.04±0.04
Energy value (kcal)	474.27±0.08	488.59±0.08	493.08±0.06	506.35±0.04

All determinations were done in triplicate and the results were reported as average value ± standard deviation (SD).

From the data presented in *Table 4* it can be seen that the CFC samples moisture was invariably higher than that of CC samples (4.27 ± 0.02%), ranging from 4.63 ± 0.02% in C25CF to 5.94 ± 0.03% in C75CF, but all values obtained are within the limits stipulated by the literature (max. 9%). An explanation for these values of CFC samples, higher than those of CC, is the ability to absorb a greater amount of water by the fibers found in CF compared to the WRF, values that are mentioned by Singthong et.al., 2011 [33], ranging between 4.48 - 8.31%.

As for the fat content of the CFC samples, values were higher than in CC samples (18.64±0.03%), ranging from 19.56 ± 0.03% for C25CF sample, to 27.14 ± 0.04% for C75CF sample, values attributed to the high fat content that is found in CF (63.99 ± 0.11%).

The carbohydrate content of the samples analyzed in this study, decreased proportionally with the percentage of CF added, that is, from 61.24 ± 0.04% (C25CF) to 43.94 ± 0.03% (C75CF) compared to sample CC sample, which exhibited a content of 69.06 ± 0.04% carbohydrates.

Summarizing the results obtained regarding the chemical composition of cookies samples analyzed in this study (*Table 4*), it was concluded that the addition of CF in the formulation recipe for the CFC, resulted in a significant increase in the content of nutrients and thus, the obtained products can be characterized as having a high functional potential and considered a "*protein source*", "*fiber source*" and "*mineral source*".

Thus, in the case of the CFC samples, the protein content varies from 11.94 ± 0.05% and 21.58 ± 0.02% compared to 10.07 ± 0.05% in the CC sample, the fiber content ranges between 5.63 ± 0.04% and 7.35 ± 0.04% compared to 0.76 ± 0.02% in the CC sample, and the ash content recorded values between 1.67±0.02% and 2.04 ±0.04% compared to 1.44 ± 0.04% in CC sample and correspondingly the higher content of minerals in coconut flour may be responsible for their increased values. These results were consistent with the results presented by Poonam, 2013 [23].

4. Conclusions

The chemical compositions of whole rice flour (WRF), coconut flour (CF) and mixtures WRF: CF - 25: 75%, WRF: CF - 50: 50%, WRF: CF - 75: 25% obtained in this study revealed their valuable nutritional potential in the technology for obtaining protein gluten-free cookies.

The results obtained in this study indicate that the addition of 50% CF in dough can be successfully used in the functional cookies obtaining technology, thus, by this addition we can see the improvement of both sensory characteristics and physico-chemical properties of cookies samples obtained.

Since the overall acceptability was unchanged and the substitution of whole rice flour with coconut flour improved the nutritional content, our results show that replacing whole rice flour up to 50% with coconut flour results in acceptable cookies.

Nutrition analysis showed that substitution of whole rice flour up to 50% with coconut flour leads to obtaining cookies that are an excellent source of dietary fiber, minerals (sodium, magnesium, potassium, etc.) and a good source of protein. Since many gluten-free products are neither naturally rich nor enriched or fortified, this study confirms that coconut flour substitution improves the nutritional value of gluten-free cookies.

Also, by correlating the results obtained, it can be appreciated that established recipes from this study can be successfully applied on an industrial scale, and recommend coconut flour as an alternative for patients with celiac disease.

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

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