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Antioxidant, nutritional and sensory characteristics of two gluten-free biscuits assortments

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Abstract

Gluten intolerance is one of the current worldwide problems that more and more people are facing. Thus, in recent years, the food industry has sought to develop and bring to the market as diverse a range of gluten-free products, with the best possible nutritional and sensory characteristics. This work had as a first goal to obtain two innovative types of gluten-free biscuits, without added sugar: one based on coconut flour (CB) and the second based on walnut flour (WB). A second aim of the work was to analyze the finished products obtained from a physico-chemical, nutritional and organoleptic point of view. The physico-chemical analysis followed the content of total polyphenols (Folin-Ciocalteu assay) in the finished products and in the raw materials, their antioxidant activity (DPPH method) and moisture content. Coconut flour had a higher content of total polyphenols (98.63±0.26 mg gallic acid/g) than walnut flour (94.26±0.21 mg gallic acid/g), respectively the CB biscuits had a slightly higher content in these compounds (35.41±0.07 mg gallic acid/g), than WB biscuits (34.39±0.07 mg gallic acid/g). Regarding the DPPH free radical scavenging activity, walnut flour and respectively WB biscuits recorded higher values (93.88±0.24 %, respectively 88.47±0.03 %) than coconut flour, respectively CB biscuits. The CB biscuits showed 3 times higher moisture content (30%) than WB biscuits (10%). WB biscuits had a higher total fat content and slightly more protein (17.02 g/100g and 3.31 g/100g respectively) compared to CB biscuits (10.71 g/100g and 3.08g/100g). Conversely, CB biscuits were richer in total carbohydrates (19.65 g/100g), dietary fiber (8.78 g/100g), sugars (4.69 g/100g) than WB biscuits (15.56 g/ 100g, 5.08 g/100g, respectively 0.85 g/100g). The two gluten-free biscuit assortments were well appreciated by the tasters panel (scores for all analyzed sensory characteristics were above 4).

Keywords: gluten -free biscuits, polyphenols, antioxidant activity. coconut flour, walnut flour.

1.Introduction

Modern human society faces a lot of food problems such as different types of food intolerances, restrictions or allergies, so the need to develop specific products for these categories of consumers has become increasingly imperative. Among the modern food problems that more and more consumers are unfortunately facing is gluten intolerance. In order to meet this category of consumers, in recent years, within the national and global food industry, more and more gluten-free food products have been developed, but which to bring the necessary intake of nutrients to consumers and also to correspond from the organoleptic point of view.

More and more types of gluten-free flours have appeared in recent years, including nut flour and coconut flour, from which various gluten-free bakery and pastry products can be obtained [1,2].

Coconuts are the fruits of the coconut palm tree, botanically known as *Cocos nucifera*, which means "nut bearer". Fruit palms are native to Malaysia, Polynesia and southern Asia and are now prolific in South America, India, the Pacific Islands, Hawaii and Florida. The coconut is an important product of the tropical economy, with its enormous range of uses [3]. Coconut flour is a by-product made during the process of making coconut milk.

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It contains a lot of dietary fiber, almost twice as much as wheat bran. This flour can be used just like wheat flour to make a multitude of delicious breads, pies, cakes, snacks and desserts. Although it does not contain gluten, coconut flour is a good source of protein (more than corn flour and the same as wheat flour) [4,5]. Dat [6] reported the proximate composition values for coconut flour as follows: 6,13±0,21 % water, 29,83+-0,52 lipids, 5,77±0,18 % proteins, 1,15±0,01 % ash, 19,82±0,63 % dietary fiber and 37,30 % carbohydrates. Also, coconut flour is a rich source of polyphenolic compounds that give it a good antioxidant activity [7]. Coconut flour is a powerful functional ingredient used in food products with broad health benefits: antidiabetic, prevents cardiovascular diseases, anticarcinogenic, prevents obesity, is suitable for those suffering from celiac disease [8]. Coconut oil is an edible oil present and recovered from the pulp of the coconut. It is unique because it contains lauric acid as the main fatty acid, accounting for 45-53% of the total fatty acid composition. The fatty acid composition of virgin coconut oil determined by chromatography includes saturated fat: lauric acid (45% to 52%), myristic acid (16% to 21%), palmitic acid (7% to 10%), caprylic acid (5% to 10%), capric acid (4% to 8%), stearic acid (2% to 4%), caproic acid (0.5% to 1%) and palmitoleic acid (trace) and unsaturated fats: oleic acid (5% to 8%), linoleic acid (1% to 3%), and linolenic acid (up to 0.2%). Virgin coconut oil is colourless, free from rancidity and has a specific fresh natural coconut aroma [9,10]. There are studies that have proven that coconut oil has anti-obesity, anti-diabetic, anti-carcinogenic and protective effects against chemotherapy [11,12].

The walnut (*Juglans regia* L.) is grown commercially throughout southern Europe, North Africa, East Asia, the USA and western South America. The nut seed (kernel) makes up from 40% to 60% of the nut's weight, depending on the variety. The seed has a high level of oil (52%–70%) in which polyunsaturated fatty acids predominate. In addition to oil, walnuts provide appreciable amounts of protein (up to 24% of the nut seed weight), carbohydrates (12%–16%), fiber (1.5%–2%) and minerals (1.7%–2 %). Slightly astringent aroma of walnut fruits has been associated with the presence of phenolic compounds. Most of the phenolic compounds commonly identified in walnut are phenolic acids and condensed tannins.

The phenolic substances in the walnut are found in the highest concentration in the film surrounding the kernel and are said to have favorable effects on human health due to their apparently antiatherogenic and antioxidant properties [13]. Walnut flour is a new product with potential for use in the bakery industry as a supplement or even as a substitute for wheat flour in the manufacture of bread, biscuits and cakes. Its other use is to provide a source of natural flavor in these foods. It is produced from walnut press cake, a by-product from the cold pressing of walnut kernels. To extract the oil, the walnut kernels are ground, kneaded and then pressed in a hydraulic press to squeeze out the oil. The remaining press cake, which can contain up to 20% residual oil, is then ground to make walnut flour [14].

Due to the massive increase in the modern era of cases of diabetes, obesity and other conditions related to high sugar consumption, healthy solutions are increasingly being sought to replace it in sweet products, including pastries. Erythritol (1,2,3,4-butanetetrol) is one of the currently used healthy sweetener sources. This is a non-caloric sweetener, with anticariogenic, antioxidant, endothelial protective effects [15].

The purpose of this work was to obtain two types of gluten-free biscuits without added sugar: one based on coconut flour (CB), the second based on walnut flour (WB), as well as to determine the content of polyphenols total, antioxidant activity, proximate composition and sensory properties of these innovative products.

2. Materials and method

Two types of gluten-free biscuits were prepared: one based on coconut flour (CB) and the second based on walnut flour (WB), using raw and auxiliary materials procured from the Romanian market, according to the recipes presented in table 1.

Table 1. The recipes used for the gluten-free biscuits obtaining

Raw and auxiliary materials (g)	CB	WB
Coconut flour	250	-
Walnut flour	-	250
Coconut butter	150	150
Erythritol	70	70
Eggs	55	55
Water	750	300
Vanilla Powder	5	5
Lemon peel	5	5
Baking powder	10	10
Salt	3	3

The raw and auxiliary materials corresponding to each individual recipe were weighed and introduced, one by one, into a kitchen mixer (Klarstein Carina Morena 800 W 4l) where they were mixed until completely homogenized.

The dough was stretched into a sheet of approx. 5 mm thick, the biscuits were formed and baked at 180 C for 20 minutes. After cooling, samples were taken from each type of biscuit for physical-chemical and sensory analysis

Assessment of total polyphenol content and sensory analysis. To determine the content of total polyphenols by the Folin-Ciocalteu method, as well as for the sensory evaluation of the products by the 5-point hedonic scale method with 24 panelists, the same working methodologies as those presented by Dumbrava *et al*. (2020) [16] were used.

Assessment of antioxidant activity. For the flours used as well as for the finished products, the 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging activity (RSA) was determined as an indicator of their antioxidant activity [17]. Thus, 2 g of each sample was subjected to extraction with 20 ml of 70% (v/v) ethanol for 2 hours at 25 °C under continuous stirring, following by filtration with Whatman filter paper No 1. Then, a quantity of 1 ml of filtered extract from each sample was introduced into a test tube, over which 2.5 ml of a 0.1 mM DPPH solution in ethanol 70% was added and it was left to rest at room temperature, in the dark, for 30 minutes. Next, the absorbances were read at 517 nm against a reference sample consisting of 70% ethanol. In parallel, a control sample was prepared by mixing 1 ml of 70% ethanol with 2.5 ml of 0.01 mM DPPH solution. RSA (%) was calculated using the following relationship:

$$\text{DPPH scavenging activity (\%)} = \frac{Ac - As}{Ac} \times 100$$

where:
Ac is the control sample absorbance,
As – absorbance in the presence of the sample.

Assessment of moisture content. The moisture content of the biscuits was determined in accordance with SR ISO 1442:2010.

Assessment of proximate composition and energy value. For the proximate composition and energy value determination of the two types of gluten-free biscuits, the Nutritional Database USDA was used.

Statistical analysis. For total polyphenols content, moisture content and for antioxidant activity (RSA) the mean values and standard deviations of all replicates were calculated using Excel software (Microsoft Office 2010).

3. Results and discussion

Total polyphenol content. The results obtained for the total polyphenols content (Folin-Ciocalteu assay) of the flours and of the two types of gluten-free biscuits are presented in Table 2.

Table 2. Total polyphenol content in flours and biscuits

Sample	Total polyphenol content (mg gallic acid/g)
Coconut flour	98,63±0,26
Walnut flour	94,26±0,21
CB	35,41±0.07
WB	34,39±0.07

It is observed that coconut flour had a higher content of total polyphenols (98.63±0.26 mg gallic acid/g) than walnut flour (94.26±0.21 mg gallic acid/g), respectively CB biscuits obtained from coconut flour had a slightly higher content in these compounds (35.41±0.07 mg gallic acid/g), than WB biscuits obtained from walnut flour (34.39±0.07 mg gallic acid/g). Marasinghe *et al*. [7], reported lower values for the total polyphenols content in different types of coconut flour (between 27.53±4.54 mg GAE/g and 62.58±5.99 mg GAE/g) than those obtained in the present work. Also, Labuckas *et al*., [18] found lower total polyphenols content in the 70% ethanolic extracts of flour obtained from three varieties of walnut: 14.9±3.25, 16.3±1.17 and 25.6±4.73 mg GAE/g respectively.

Antioxidant activity analysis. The DPPH free radical scavenging activity (RSA) of the ethanolic extract from flours and from the finished products are showed in Table 3.

Table 3. RSA (%) achieved by the flours and finished products

Sample	RSA (%)
Coconut flour	87,72±0,22
Walnut flour	93,88±0,24
CB	82,83±0.18
WB	88,47±0.03

As can be seen from the Table 3., for the 1:10 alcoholic extracts, both of the flour samples and of the finished products, the DPPH free radical scavenging activity for all analyzed samples are very high. Between the two types of flour, the walnut one had the strongest RSA (93.88±0.24%), although it was poorer in total polyphenols (strong antioxidant compounds) than the coconut flour, this

being due to the presence of other strong antioxidants in walnut flour (tocopherols, carotenoids) in higher amounts than in coconut one. Concerning finished products, the alcoholic extract from WB biscuits had the strongest RSA (88.47±0.03 %).

Moisture content. Table 4 presents the results regarding the moisture content of flours and finished products.

Table 4. Moisutre content of flours and finished products

Sample	Moisture (%)
Coconut flour	6.21±0,04
Walnut flour	9.12±0,08
CB	30±0.18
WB	10±0.12

Walnut flour had a higher moisture content (9.12±0,08%) than coconut flour (6.21±0,04%), and the CB biscuits had a 3 times higher humidity (30±0.08%) than the WB biscuits (10±0.02%), CB biscuits requiring 2.5 times more water than WB biscuits right from the production process. The fact that WB biscuits have less moisture makes them less perishable over time, more resistant to various molds. The results regarding the moisture content of the two types of flour fall within the values reported in the literature data, Dat [6] finding for coconut flour a moisture of 6,13±0,21%, respectively for walnut flour Vanhanen and Savage [14] reporting 10.5±0.9%, while Mao and Hua [19] a value of 9.20±0.02%.

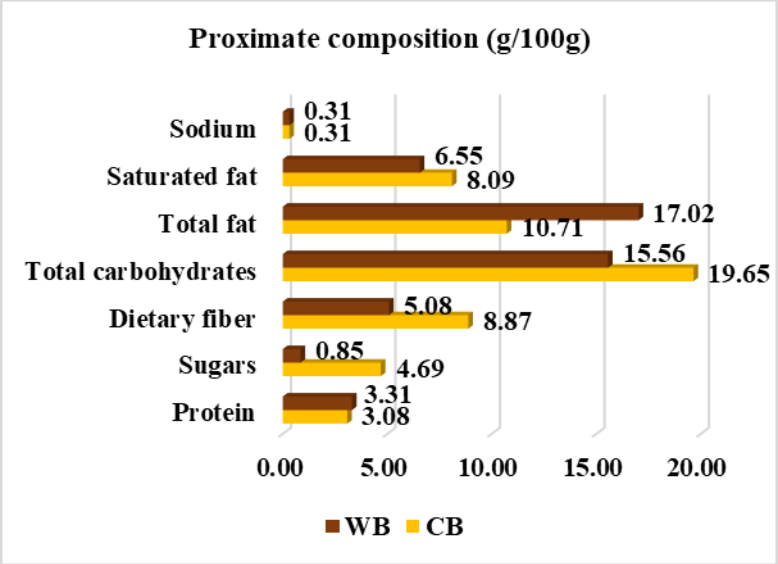

Figure 1. Proximate composition of gluten free biscuits

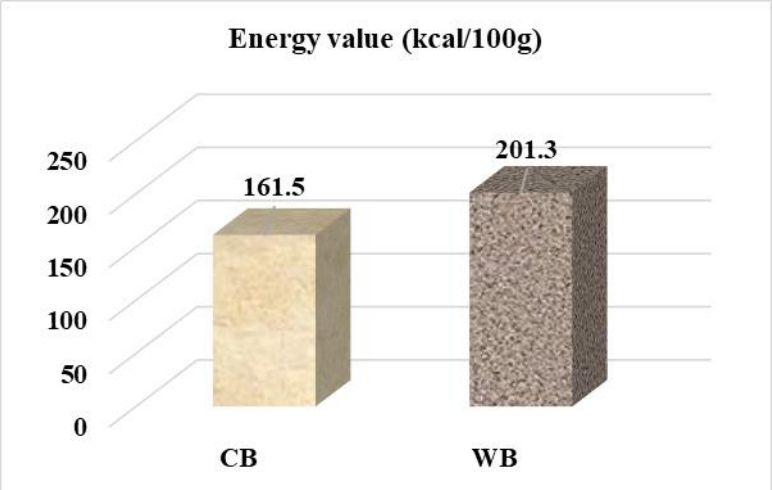

Figure 2. Energy value of gluten free biscuits

Nutritional composition and energy value of gluten-free biscuits. Figures 1. and 2. present the proximate composition and energy value of the two types of gluten-free biscuits.

It can be observed that gluten-free biscuits made from walnut flour (WB) have a higher total fat content and slightly more protein (17.02 g/100g and 3.31 g/100g, respectively) compared to gluten-free biscuits made from coconut flour (10.71 g/100g, respectively 3.08 g/100g). Conversely, CB biscuits are richer in total carbohydrates (19.65 g/100g), dietary fiber (8.78 g/100g), sugars (4.69 g/100g) than WB biscuits (15.56 g/100g, 5.08 g/100g, respectively 0.85 g/100g). The extremely low sugar content of WB biscuits makes them suitable for diabetic diets.

Sensory analysis. The sensory analysis performed on the two varieties of biscuits (CB and WB) led to the results shown in Figure 3.

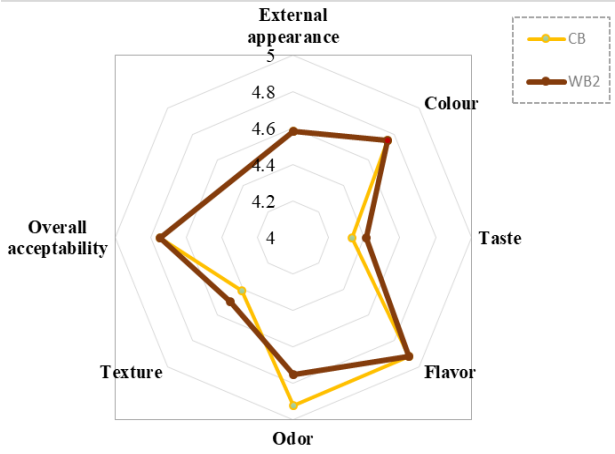

Figure 3. Global values of the sensory evaluation of CB and WB biscuits by using a 5-point hedonic scale

From the results presented in Figure 3, it can be seen that the gluten-free biscuit assortments obtained were well appreciated by the panel of 24 tasters (scores for all the sensory characteristics analyzed were above 4), between the two finished products there were no important differences in terms of organoleptic point of view. In terms of external appearance, color, aroma, smell and general acceptability, both types of biscuits had a score above 4.5 indicating a high level of acceptability, and for texture and taste, the score was also high: between 4.33 and 4.5, indicating a good level of acceptability.

4. Conclusions

Two types of gluten-free biscuits, without added sugar, were obtained: one from coconut flour (CB) and the second from walnut flour (WB), both types of products being sweetened with erythritol. The total polyphenol content analysis showed that coconut flour and biscuits obtained from it had a higher concentration of these antioxidant compounds than walnut flour and biscuits obtained from it. Regarding the antioxidant activity, it was found that walnut flour and walnut flour biscuits had a higher DPPH free radical scavenging capacity than coconut flour and CB biscuits, this being due to the concentration of antioxidants other than the polyphenolic compounds present in walnut flour in higher amounts than in coconut flour. The proximate composition and energy value analysis of the two varieties of biscuits shows that WB biscuits are richer in total lipids, proteins and have a higher caloric intake than CB biscuits, which are richer in total carbohydrates, dietary fiber and sugars. The very low sugar content of biscuits made from walnut flour in particular, but also from those made from coconut flour, makes them suitable for a diet low in sugars recommended especially for diabetics. Sensory analysis of the two varieties of gluten-free biscuits without added sugar showed that both products were well appreciated by the panel of tasters, obtaining scores between 4.33 and 4.92 for all organoleptic characteristics analyzed.

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 or animal subjects (if exist) respect the specific regulation and standards.

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