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Assessment the total polyphenols content and antioxidant activity of some innovative vegan biscuits

Delia-Gabriela Dumbravă[1*], Mariana-Atena Poiană[1], Camelia Moldovan[1], Diana-Nicoleta Raba[1], Mirela -Viorica Popa[1], Giulia Mădălina Golea[1], Ionela Diana Puiu[1], Corina Dana Mișcă[1]

[1] *Faculty of Food Engineering, Banat´s University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania"from Timişoara, Calea Aradului 119, Timisoara 300645, Romania.*

Abstract

In this paper we aimed to obtain two variants of innovative vegan biscuits, with coffee and *Stevia rebaudiana*: the first (V1), using a mixture of white rice flour and oat flour and the second (V2), using a mixture of oat flour and oat flakes. As a sweetener was used a powder of dried leaves of *Stevia rebaudiana* mixed with brown sugar (from sugar cane) and as fat: palm oil, soybean oil and cocoa butter. The total polyphenols content (Folin-Ciocâlteu method) and antioxidant activity (CUPRAC method) were determined for the finished products, raw and auxiliary materials. For the two varieties of biscuits the nutritional and energy values were calculated and water storage capacity was determined. The biscuits variant V1 had a slightly higher total polyphenol content (4.85±0.18 mg gallic acid/g) than the V2 variant (4.23±0.24 mg gallic acid/g) and also a better antioxidant activity (23.47±0.08 mg Trolox/g for V1 and 19.32±0.12 mg Trolox/g for V2).

Keywords: biscuits, oat flour, rice flour, polyphenols, antioxidant activity

1. Introduction

Bakery products are the most popular processed foods in the world [2], of which, biscuits are the largest category of snacks, as they are made from simple, cheap and easily accessible raw materials. They are widely consumed due to their very acceptable taste and also, the low activity of the water in them allows a long shelf life [3]. Biscuits are bakery products, with a crunchy texture and golden-brown color, being manufactured in a variety of shapes and sizes and may contain dried fruits, nuts and food coloring [13]. One of the major concerns of biscuit producers is to determine how to improve the formulation of biscuits with appropriate ingredients and to increase the nutritional and functional properties of biscuits to meet consumer requirements [15]. The nature and quantity of the ingredients in the dough determine the quality of the biscuits.

Several researchers have described the major effect that the main ingredients used in biscuit dough have on the finished product [1,4,5,12,17]. The use of different types of flour plays an important role in obtaining the biscuit dough, which influences the rheological and baking characteristics [16]. Many studies have investigated the properties of gluten-free biscuits using different types of flour, such as white rice flour with buckwheat flour [19] and brown rice flour [14]. Rice flour is a very good source of polyphenols as other antioxidants and brings a high quality protein intake but, unfortunately, rice protein cannot generate an elastic network as wheat gluten does [11]. Oat flour has pronounced effects on dough properties yielding a higher water absorption but lower dough stability and extensibility compared with wheat flour.

Corresponding author: *e-mail:* dumbrava_delia@yahoo.com

Oats brings an important nutritional contribution having the best amino acid profile among all the cereals, in addition to an overall high protein content but also a high level of total polyphenols and a very strong antioxidant activity [9,18].

The purpose of this work was to obtain two assortments of innovative vegan biscuits with coffee, in which wheat flour was replaced with brown rice flour and oat flour (V1 -variety), respectively with oat flour and oat flakes (V2-variety) and as a sweetener was used raw sugar (from sugar cane) in small quantity, along with dried leaf powder of *Stevia rebaudiana*. Also the total polyphenols content and antioxidant activity were determined, both for the finished products and for the raw and auxiliary materials, and for the two assortments of biscuits the water storage capacity was determined and the nutritional and energy values were calculated.

2. Materials and Methods

The following raw and auxiliary materials, all procured from the local market (supermarket), were used to obtain the coffee biscuits: brown rice flour, oat flour, oat flakes, cocoa butter, soybean oil, palm oil, instant coffee, water, dried leaf *Stevia rebaudiana* powder, raw sugar, vanilla powder.

Two variants of biscuits were made (V1 and V2), using the quantities of materials presented in table 2.1.

Table 2.1. The quantities of raw and auxiliary materials used to obtain the two types of biscuits

Biscuits variety / **Materials**	**V1**	**V2**
Brown rice flour (g)	175	-
Oat flour (g)	90	250
Oat flakes (g)	-	15
Cocoa butter (g)	10	10
Soybean oil (g)	15	15
Palm oil (g)	10	10
Instant coffee (g)	5	5
Water (g)	100	100
Raw sugar (g)	30	30
Stevia rebaudiana powder (g)	3	3
Vanilla powder (g)	0.5	0.5
Baking powder (g)	5	5

In order to obtain the dough of the two types of vegan biscuits, was mixed the brown rice flour with oat flour (for V1), respectively the oat flour with oat flakes (for V2) then add water, backing powder, instant coffee, cocoa butter. soybean oil, palm oil, raw sugar, *Stevia rebaudiana* powder and vanilla powder. All the ingredients mix well and then knead the dough and leave to rest for 20 minutes. The dough was then spread into a thin layer and the biscuits were cut using the cookies shapes. The biscuits are placed in a tray lined with baking paper and placed in the preheated oven at 180 ^{0}C for 10 minutes.

To quantify of the antioxidant activity (CUPRAC method) and total polyphenols (Folin-Ciocâlteu method) for the raw and auxiliary materials and for finished products, were used the same working methodologies as those presented by Dumbrava *et al*., (2016) [6].

To determine the biscuits soak capacity during storage, 2 biscuits were weighed on the technical balance, then placed in a water bowl and left to soak for 15-20 minutes. After this time, the biscuits are removed from the water and reweighing in a capsule on the technical balance [20].

Soaking with water is expressed in grams and is calculated with the relation:

$$\text{Soaking (g, water)} = M_2 - M_1$$

where: M_1 - mass of biscuits before soaking,

M_2 – mass of biscuits after soaking.

Energy and nutritional values of the two vegan biscuits assortment were obtained by calculation using the data from: "USDA Food Compozition Databases" [21].

All experimental determinations were performed in triplicate. The results were expressed as mean and standard deviation (mean±SD).

3. Results and Discussion

Total polyphenols content: The total polyphenols content of the raw and auxiliary materials and of the finished products, determined by the Folin-Ciocalteu method, is presented in table 3.1.

Table 3.1. Total polyphenols content of finished products, raw and auxiliary materials

Sample	Total polyphenols content (mg gallic acid/g)
V1 biscuits	4.85±0.18
V2 biscuits	4.23±0.12
Brown rice flour	0.84±0.04
Oat flour	0.62±0.03
Oat flakes	0.90±0.06
Cocoa butter	0.29±0.01
Soybean oil	1.32±0.08
Palm oil	0.38±0.02
Instant coffee	19.28±0.38
Raw sugar	0.90±0.05
Stevia rebaudiana powder	17.28±0.32

Table 3.2. Antioxidant activity of finished products, raw and auxiliary materials

Sample	Antioxidant activity (mg Trolox/g)
V1 biscuits	21.28±0.22
V2 biscuits	18.15±0.17
Brown rice flour	106.34±0.86
Oat flour	91.21±0.72
Oat flakes	96.35±0.78
Cocoa butter	8.64±0.08
Soybean oil	10.11±0.11
Palm oil	7.75±0.06
Instant coffee	76.24±0.56
Raw sugar	4.58±0.03
Stevia rebaudiana powder	36.48±0.28

Table 3.3. Biscuits soak capacity during storage

Sample	Biscuits soak capacity during storage (g, water)
Biscuits V1	1.05±0.04
Biscuits V2	5.58±0.21

Table 3.4. Biscuits nutritional and energy values (per 100g of product)

Biscuits variant / Biscuits parameters	V1	V2
Total fat (g)	14.20	16.91
-Saturated fat (g)	4.73	4.95
Total carbohydrates (g)	67.40	62.68
-Dietray fibers (g)	4.14	5.25
-Sugar (g)	9.17	9.91
Protein (g)	7.69	11.37
Sodium (g)	0.01	0.02
Energy value (kcal)	422.10	441.11

The two variants (V1 and V2) of finished products had very close total polyphenol concentration (4.85±0.18 and respectively 4.23±0.12 mg gallic acid/g). Of the raw and auxiliary materials, instant coffee had the highest content of total polyphenols (18.28±0.38 mg gallic acid/g), value close to those found by Han *et al*., (2016) [8] for different coffee extracts (19.03±0.35 - 47.29±0.96 mg gallic acid/g). *Stevia rebaudiana* leaf powder also had a high content of total polyphenols (17.28±0.32 mg gallic acid/g), our results being within the range of values (3.85-15.50 mg gallic acid/g) specified by Gaweł-Bęben *et al*., (2015) in their paper [7]. Among the fats used, soybean oil had the highest concentration of total polyphenols (1.32±0.08 mg gallic acid/g). Brown rice flour, oat flour and oat flakes had very close values for the total polyphenols concentration (0.84±0.04, 0.62±0.03 and respectively 0.90±0.06 mg gallic acid/g).

Antioxidant activity: The antioxidant activity of the two types of biscuits and the raw materials, determined by the CUPRAC method is presented in Table 3.2.

Regarding the antioxidant activity, V1 biscuit variant had the highest value (21.28±0.22 mg Trolox/g), this variant of biscuits having in composition brown rice flour, raw material that registered the highest value of antioxidant activity (106.34±0.86 mg Trolox/g) of all the raw and auxiliary materials used. Ilowefah *et al*., (2018) determined for the antioxidant activity of brown rice flour obtained under different conditions values within the range 55.00-297.50 mg Trolox/g [10]. We can also observe that oat flakes, oat flour, instant coffee and Stevia rebaudiana powder present an important antioxidant activity, contributing to the global antioxidant activity of the finished products.

Biscuits soak capacity during storage: From the determinations regarding the biscuits soak capacity during storage, were obtained the results presented in Table 3.3.

It can be observed that biscuits variant V2, without brown rice flour, have a soaking capacity much higher (5.58±0.21g) than biscuits type V1 (1.05±0.04g), the latter being more resistant to long storage and thus having a longer shelf life.

Energy and nutritional values: The calculation of the nutritional and energy values for the two biscuit variants led to the results presented in the table 3. 4.

There were no significant differences between the nutritional and energy values of the two types of biscuits obtained, but we can see that the V1 version of the biscuits proved to be somewhat poorer in calories (422.10 kcal/100g/) than the V2 version (441.11 kcal/100g). Biscuits with rice flour (V1) contain less fat (14.20 g/100g) than those without rice flour (V2) (16.91 g/100g), but have more total carbohydrates (67.40g/100g in V1 and 62.68 g/100g in V2). At the same time, biscuits with oat flakes (V2) contain a little more dietary fiber, a little more sugar and more protein than biscuits with rice flour (V1).

4. Conclusion

Two variants of innovative, vegan biscuits were obtained, one with brown rice flour and oatmeal, and the second with oat meal and oat flakes. The other ingredients were qualitatively and quantitatively identical.

Total polyphenols content of the two variants of vegan biscuits was quite high and close in value, the highest concentration being found in the assortment with rice flour. At the same time, this type of biscuits also had the highest antioxidant activity, due to the content of brown rice flour, raw material with the best antioxidant activity, of all the raw and auxiliary materials used in recipes.

Biscuits made with brown rice flour had a much lower soaking capacity than biscuits without rice flour, and thus being more resistant to long storage.

In terms of energy and nutrition value, also brown rice flour biscuits had the least calories, containing less fat, dietary fiber and protein than biscuits without brown rice flour.

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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