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Plant-based alternatives to cheese - antioxidant, nutritional and sensory characteristics

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Abstract

High interest in plant-based foods has grown due to concerns about human health, sustainability and animal welfare. When it comes to conventional dairy production, there are three major areas of concern: environmental impact, human health and animal welfare. Therefore, plant-based cheese alternatives offer a more sustainable and ethical option for consumers. The first objective of this work was to obtain a vegan alternative to cheese, using cashew nuts as the basic raw material, in three assortments: a simple version (PBC1), one with the addition of dry basil and dry thyme (PBC2), respectively one with sweet paprika and black pepper (PBC3). Another objective of the work was to analyze the finished products regarding the content of total polyphenols (Folin-Ciocalteu assay), antioxidant activity (CUPRAC method) and antiradical activity (DPPH assay), as well as to determine the proximate composition, energy value and sensory properties (5-point hedonic scale method). The PBC3 product variant with the addition of sweet paprika and black pepper proved to have the highest total polyphenols content (4.64±0.08 mg GAE/g) as well as the strongest antioxidant (9.81±0.14 mg Trolox/g) and antiradical activity. The three product assortments had very close proximate composition and energy value, and compared to conventional milk cheeses, they were lower in protein, richer in carbohydrates and cholesterol-free. The sensory analysis highlighted the fact that all product variants were well accepted by the panelists, obtaining scores above 4 for all organoleptic characteristics.

Keywords: cashew nuts, plant-based cheese, polyphenols, antioxidant activity

1.Introduction

Cheese is a staple food for humans, being an important source of protein, calcium and other important nutrients. In recent years, due to the growing number of lactose intolerant consumers as well as those adopting a vegan dietary style, various plant-based alternatives to milk and dairy products have appeared on the market, with consumer demand for them continuing to grow [1-3]. Interest in plant-based foods has grown both because of health concerns and for sustainability and animal welfare reasons. In terms of conventional dairy production, there are three major areas of concern: environmental impact (greenhouse gas emissions, soil and water pollution and land use), human health (exposure to zoonotic diseases and increased antibiotic resistance) and animal welfare (treatment of farm animals, including disease, injury and mental, emotional well-being). As a result, plant-based products offer a more sustainable and ethical option and are rapidly gaining popularity among consumers [1]. To obtain plant-based alternatives to cheeses, several raw materials can be used such as: soya beans, chickpeas, different types of nuts, different seeds; the resulting products are cholesterol-free, contain less fat but also less protein compared to dairy cheeses [4]. Today's market can replace any kind of cheese from Parmesan, Cheddar, Ricotta, to cream cheese. The cashew tree (*Anacardium occidentale*) produces nuts, the kernels of which have grown considerably in

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economic importance in recent decades. The kernel is the main product for which cashew nuts are harvested. It has been estimated that about 60% of cashew nuts are consumed as snacks, mostly roasted and salted. The remaining 40% is used instead in confectionery and bakery products, often as a substitute for hazelnuts and almonds [5]. Cashew nuts are high in lipids, monosaturated and polyunsaturated fatty acids, especially oleic acid (ω-9) and linoleic acid (ω-6). Cashew nuts have been shown to lower cholesterol and coronary heart disease risks due to their low-density lipoprotein content. Coronary heart disease reduction has been correlated with cashew nut consumption due to the presence of other compounds such as tocopherols, squalene and phytosterols. Analysis of the amino acid profile revealed glutamic acid, aspartic acid and leucine to be the most abundant. Compositional studies showed high levels of potassium, magnesium and calcium. Phenolic compounds are also well represented in cashews [6-9].

The main aim of this work was to obtain a vegan alternative to cheese based on cashew nuts, in three versions: a simple one (PBC1), one with added parsley and dried thyme (PBC2) and the third with sweet paprika and black pepper (PBC3). A second objective of the work was to analyse the finished products in terms of total polyphenol content and antioxidant activity, as well as proximate composition, energy value, sensory properties.

2.Materials and method

The following raw and auxiliary materials (purchased from the local market) were used to make the cashew cheese assortments (PBC1, PBC2, PBC3): cashew nuts, lemon juice, inactive yeast flakes, olive oil, Himalayan salt, plain water, agar-agar, dried basil, dried thyme, garlic powder, sweet paprika, black pepper.

Cashew cheese obtaining method

The recipes used to prepare the vegan cashew cheese varieties are shown in Table 1.

Table 1. Recipes used to obtain the cashew cheese assortments

Cashew cheese assortment / Raw and auxiliary materials (%)	PBC1	PBC2	PBC3
Cashew	39	36	36
Lemon juice (g)	8	7	7
Olive oil (g)	6	5	5
Garlic powder (g)	1	1	1
Himalayan salt (g)	2	2	2
Plain water (g)	39	36	36
Agar-Agar (g)	5	5	5
Dried basil (g)	-	4	-
Dried thime (g)	-	4	-
Sweet paprika (g)	-	-	4
Black pepper (g)	-	-	4

Figure 1. The varieties of cashew-based cheese alternatives obtained

For the preparation of the cashew cheese assortments, first all the raw materials needed for each recipe were weighed, then the cashew nuts were hydrated for 4 hours in warm water. After the nuts were hydrated, they were strained and then blended together with salt, spices and 2/3 of the amount of water. Separately, agar-agar gel was made using the remaining 1/3 water and boiling the mixture until thickened. The hot gel was poured over the mixture in the blender and homogenized with the other components. The obtained mixture was poured into moulds previously greased with a little oil and after complete cooling was placed in the refrigerator at 4 C for at least 4 hours. After removal from the moulds samples were taken for analysis.

Figure 1 shows the three types of finished products obtained.

Assessment of total polyphenol content, sensory analysis and antioxidant activity

The Folin-Ciocalteu method for the determination of total polyphenol content (TPC), antioxidant activity by Cupric Reducing Antioxidant Capacity assay (CUPRAC) and the 5-point hedonic scale sensory analysis method were applied as presented by Dumbrava *et al.*, (2020) [10]. Antioxidant activity measured by 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity (RSA) was determined according to the methodology presented by Dumbrava *et al*, (2022) [11].

Assessment of proximate composition and energy value

Proximate composition and energy value for cashew cheese assortments, were determined using the Nutritional Database USDA

Statistical analysis

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

3.Results and discussion

Total polyphenol content

Results for TPC of raw materials and finished products determined by the Folin - Ciocatelteu method are shown in Table 2.

Of the raw and auxiliary materials, black pepper (used to make the PBC3 cashew cheese variant) had the highest TPC (20.72 ± 1.76 mg gallic acid/g), followed by dried thyme (15,93±1,50 mg gallic acid/g) and sweet paprika (14,12±0,68 mg gallic acid/g). Lemon juice was the lowest in TPC (1.58±0.06 mg gallic acid/g). Between the finished products, the PBC3 version with sweet paprika and black pepper had the highest TPC (4.64±0,08 mg gallic acid/g).

TPC of cashew nuts: 3.68±0.10 mg gallic acid/g, is slightly higher than the values reported by Soares *et al.* (2013): 3.46 - 3.25 mg gallic acid/g [12]. For sweet paprika, the TPC is higher than the values found by Ponder *et al.* (2021) [13] for different types of conventional and organic paprika: 152.64±11.27 - 798.45±12.57 mg gallic acid/100g, but lower than the range reported by Škrovánková *et al*., (2017)) [14]: 14.67 ±0.1 - 22.25 ±0.3 mg gallic acid/g, while for black pepper the value from our paper falls within the range specified by the same authors: 12.03 -22.88 mg GAE [14].

Rashidinejad *et al*., (2015) [15] studying skimmed and pasteurized cow's milk cheese, found for the fresh product TPC values of 2.80 mg gallic acid/g. We find that the cashew cheese variants presented in this paper have higher TPC values than cow's milk cheese, especially the PBC2 and PBC3 varieties. Sik *et al.* (2023) [16] reported much lower TPC values for different dairy cheeses (0.32 – 1.24 mg gallic acid/g), compared to the vegan variants in this paper.

Table 2. Total polyphenols content of raw materials and finished products

Sample	Total polyphenols content (mg gallic acid/g)
Cashews	3,68±0,10
Lemon juice	1,58±0,06
Garlic powder	3.55 ± 0.07
Dried thyme	15,93±1,50
Sweet paprika	14,12±0,68
Dried basil	8,02±0,23
Black pepper	20.72 ± 1.76
PBC1	3,06±0,03
PBC2	3,82±0,05
PBC3	4.64±0,08

Antioxidant activity analysis

The antioxidant activity determined by the CUPRAC method as well as the DPPH free radical scavenging activity (RSA) for raw materials and finished products, respectively, is shown in Table 3.

Table 3. Antioxidant and antiradical activity of raw materials and finished products

Sample	Dilution	Antioxidant activity (mg Trolox/g)	RSA (%)
Cashews	1:100	13.08±0.18	90.81±0.51
Lemon juice	1:100	11.24 ± 0.12	92.63±0.53
Garlic powder	1:100	12.72 ± 0.14	93.82±0.58
Dried thyme	1:100	39.42±0.34	90.16±0.46
Sweet paprika	1:100	52.89±0.84	89.21±0.38
Dried basil	1:100	49.75±0.72	89.03±0.48
Black pepper	1:100	58.86±0.91	94.81±0.58
PBC1	1:100	6.85±0.06	83.15±0.44
PBC2	1:100	8.23±0.12	85.64±0.42
PBC3	1:100	9.81±0.14	87.53±0.46

Among the raw materials, it is found that black pepper, followed by sweet paprika dried basil and dried thyme, respectively, had the best antioxidant (58.86±0.91, 52.89±0.84, 49.75±0.72 and 39.42±0.34 mg Trolox/g respectively). In terms of DPPH free radical scavenging activity, black pepper had the strongest action, followed by garlic powder, lemon juice and cashew nuts respectively (94.81±0.58%, 93.82±0.58%, 92.63±0.53% and 90.81±0.51 respectively). In terms of finished products, PBC3 showed the best antioxidant (9.81±0.14 mg Trolox/g) and antiradical activity (87.53±0.46 %).

Proximate composition and energy value

Calculations on proximate composition and energy value for vegan cashew cheese assortments led to the results shown in Figure 1 and Figure 2.

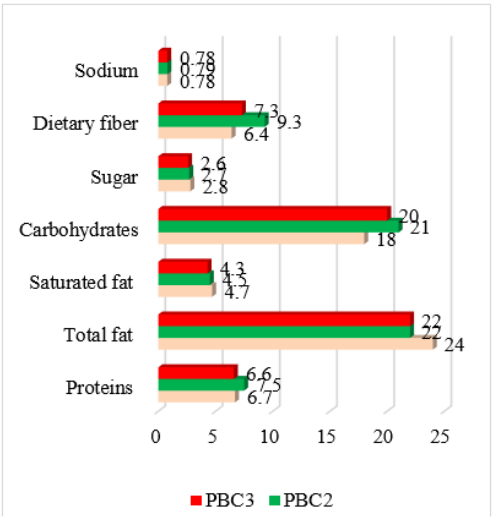

Figure 1. Proximate composition of cashew cheese assortments (g/100g)

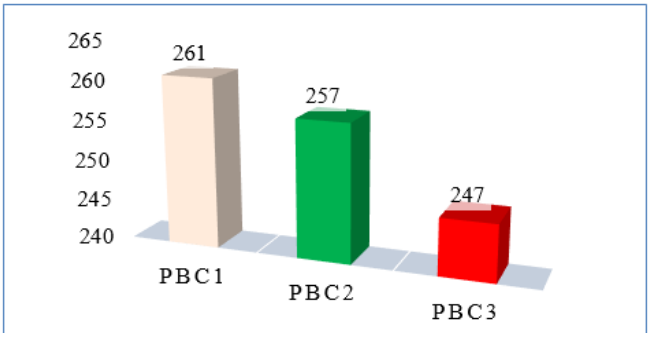

Figure 2. Energy values (kcal/100g) of finished products

The proximate composition of the three cashew-based cheese alternatives is very similar, with PBC2 being slightly higher in protein (7.50 g/100g), total carbohydrates (21.00 g/100g), dietary fiber (9.30 g/100g) and PBC1 being higher in total fat (24.00 g/100g). In terms of energy value, the most calories are provided by PBC1 (261 kcal/100g) and the least by PBC3 (247 kcal/100g). A lower protein content is found in the cashew cheese varieties proposed in this study, compared to fresh cow cheese, for which Sik et al. [16] found higher values (16.84 to 22.02 g/100g), but unlike dairy cheeses, the PBC1, PBC2 and PBC3 alternatives are cholesterol-free and have a good dietary fiber content.

Sensory analysis

The overall values obtained from the sensory analysis, carried out by a panel of 30 tasters, of the three cashew cheese varieties are shown in Figure 3.

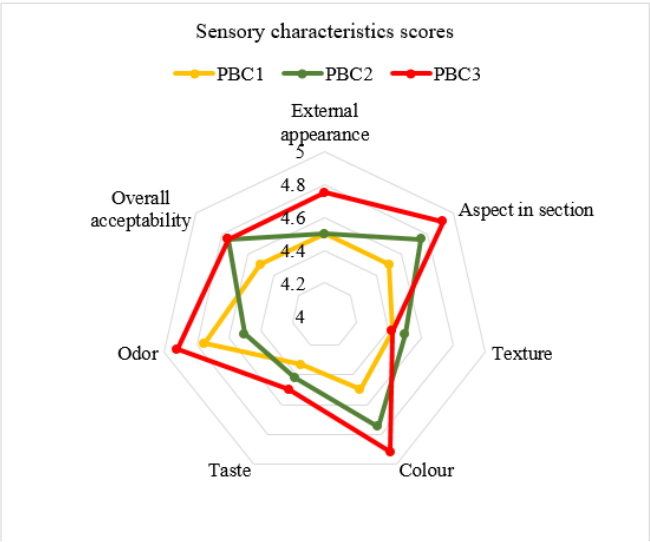

Figure 3. Global values of the sensory evaluation

All three finished products scored between 4.33 (good) and 4.92 (very good) on all characteristics analysed by the tasters.

For external appearance, appearance in section, taste, smell and colour, the vegan cheese variant PBC3 was rated higher (4.75; 4.92; 4.5; 4.92 and 4.92 respectively). For overall acceptability, PBC2 and PBC3 scored equally: 4.75.

4.Conclusions

Three innovative vegan cashew cheeses were made: one plain (PBC1), the second with added basil and thyme (PBC2) and the third with added sweet paprika and black pepper (PBC3), using a simple manufacturing technology. Of the raw and auxiliary materials, the highest content of total polyphenols was found in black pepper, followed by dried oregano and sweet paprika, and of the finished products, the PBC3 had the highest concentration of these compounds. The best values of antioxidant (CUPRAC method) and antiradical activity (DPPH assay), among raw and auxiliary materials, were found at black pepper and for finished products, at the PBC3 assortment. The proximate composition and energy value of the three vegan cashew cheeses were very similar, with the products being lower in protein than dairy cheeses but free of cholesterol and lactose. It should also be noted that cashew cheese contains more carbohydrates, a significant part of which is dietary fiber, this being lacking in dairy cheeses. Sensory analysis resulted in good scores for all organoleptic characteristics in the three cashew cheese varieties, with the highest rated being PBC3. Whereas the vegan cashew cheeses proposed in this paper have a fairly high content of total polyphenols, good antioxidant and antiradical activity, good energy value, are cholesterol-free, lactose-free and with a good content in dietary fiber, as well as being well sensory appreciated, they can be recommended as a tasty and healthy alternative to classic cheeses, both for people with a vegan diet and for those with lactose intolerance, cholesterol restrictions or for those who want to consume new products.

Conflict of Interest. Author has declared that no competing interests exist.

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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