JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2021, *27*(4), 363-366

*Journal of Agroalimentary Processes and Technologies*

# Innovative raw-vegan chia (*Salvia hispanica* L.) seeds dessert - total polyphenols, ascorbic acid and antioxidant activity analysis

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***Abstract***

The aim of this research work was to obtain two innovative assortments of raw vegan chia (*Salvia hispanica* L.) seeds pudding and to analyze their antioxidant activity (CUPRAC method), their total polyphenols (Folin-Ciocalteu assay) and vitamin C content (iodometric method), compared to raw materials. Also, the finished products obtained were characterized in terms of proximate composition and energy value, these being determined by calculation. The two varieties of chia pudding had as a common base chia seeds, vegan coconut milk, and honey. One of the assortments (P1) had as additions dried goji berries, candied cranberries and carob powder, and the second (P2): coconut flakes, brown raisins, hazelnuts. Regarding the raw materials used, the highest content of total polyphenols and vitamin C was found in dried goji berry (28.27 ± 1.88 mg gallic acid/g, respectively 190.23 ± 5.21 mg ascorbic acid/100g): they also showed the strongest antioxidant activity (235.82±4.08 mg Trolox/g). For the finished products, the highest content of total polyphenols and vitamin C was recorded in the P1 assortment of chia pudding (8.24±0.82 mg gallic acid/g, respectively 52.16±2.24 mg ascorbic acid/100g) which also showed the best antioxidant activity (69.52±2.08 mg Trolox/g), more than twice as large as the P2 assortment (32.41±1.82 mg Trolox/g).

***Keywords***: chia, raw-vegan dessert, ascorbic acid, antioxidant activity, polyphenols.

## 1. Introduction

Vegetarian diets have existed since antiquity, and Pythagoras is one of the oldest and most prominent personalities to record them. However, explicitly vegan diets without milk or eggs appeared only in the early nineteenth century. The term "vegan" was introduced in 1944 by a small group in Scotland, led by Donald Watson, by symbolically cutting the letters in the middle of the word vegetarian. From Scotland, veganism then spread to other countries, but only to a small part of the population, for over 50 years. At one point, around 2011, there was a growing interest in veganism, with more and more people around the world adopting this diet. Raw vegan foods are those foods that are prepared only from raw materials and vegetable auxiliaries, not heat processed. These foods preserve the entire richness of vitamins and enzymes in plant products, bringing extra health and vitality to consumers [1-3].

Chia (*Salvia hispanica* L.), an annual plant in the *Labiatae* family, produces seeds that were one of the staple foods of Central American civilizations in pre-Columbian times. The seeds were widely used by the Aztec tribes for food, medicine and paints. Several studies have shown that chia seeds are very rich in antioxidants and are good sources of protein (19-23%), with a higher content than those of other traditional crops, such as wheat, corn, rice, oats, barley. and amaranth. they contain about 25-38% oil and have the highest known percentage of alpha-linolenic fatty acid, (about 60%). In recent years, chia seeds have become increasingly important for human health and nutrition due to its high content of α-linolenic fatty acid and the beneficial health

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effects of its consumption [4-8]. Chia seeds can prevent diabetes, help regulate blood sugar, and are recommended for people with diabetes. These seeds have the ability to regulate blood cholesterol levels and prevent heart disease, improve brain activity, helps increase satiety index, prevent cardiovascular disease, inflammatory and nervous system disorders. Today, chia seeds offer huge potential in the industries of health, food, feed, pharmaceuticals and nutraceuticals, among others due to its functional components [5].

The purpose of this paper was to obtain an innovative raw vegan dessert product: chia pudding, in two variants: one with the addition of coconut milk, honey, dried goji, candied cranberries, carob powder and the second with the addition of coconut milk, honey, coconut flakes, brown raisins, ground almonds, then analyze them in terms of ascorbic acid content, total polyphenols, antioxidant activity, energy value and proximate composition.

## 2.Materials and Methods

In order to obtain the two variants of chia pudding, the following raw and auxiliary materials were used (purchased from the local market): chia seeds, brown raisins, dried goji berry, candied cranberries, carob powder, coconut flakes, brown raisins, almonds, acacia honey, coconut milk, vanilla powder. Table 1 shows the recipes used to obtain the two assortments of chia pudding.

***Table 1.*** Recipes used to obtain the two varieties of chia pudding

| **Raw and auxiliary materials** | P1 | P2 |
|---|---|---|
| Chia seeds (g) | 55 | 55 |
| Vanilla extract (g) | - | 2 |
| Brown raisins (g) | - | 20 |
| Dried goji berry (g) | 20 | - |
| Candied cranberries (g) | 20 | |
| Coconut flakes (g) | - | 12 |
| Hazelnuts (g) | - | 50 |
| Acacia honey (g) | 40 | 40 |
| Coconut milk (g) | 100 | 100 |
| Carob powder (g) | 4 | - |

### *2.1. Chia puddings obtaining method*

The necessary quantities for recipes were weighed from each ingredient (hazelnuts were previously chopped). The puddings were prepared at cold by first mixing the coconut milk with the chia seeds in a suitable bowl, and then leaving the mixture to stand for 30 minutes to allow the chia seeds to swell and the pudding to coagulate.

Then all the other ingredients were added one by one, stirring constantly. From the two varieties of chia pudding were then taken samples to determine the content of vitamin C, total polyphenols and antioxidant activity.

### *2.2. Determination of vitamin C, total polyphenol content and antioxidant activity*

In order to determine the content of vitamin C (adapted iodometric method), total polyphenols (Folin-Ciocalteu assay) and antioxidant activity (CUPRAC method) were used the working methods presented by Dumbrava *et al*., (2016) [9]. All experimental determinations were performed in triplicate, and the results were expressed as a mean and standard deviation (mean ± SD).

### *2.3. Determining of the proximate composition and energy value*

For the two varieties of chia pudding obtained, the proximate composition and energy value were determined by calculation, using "USDA Food Compozition Databases" [10].

## 3. Results and discussion

### *3.1. Vitamin C content analysis*

The results on the vitamin C concentration in the two varieties of chia pudding and in the raw materials are presented in Table 2.

***Table 2.*** Ascorbic acid content in the chia puddings and in the raw materials

| **Sample** | **Ascorbic acid content (mg/100g)** |
|---|---|
| P1 | 52.16±2.24 |
| P2 | 22.25±1.78 |
| Chia seeds | 1.71±0.12 |
| Brown raisins | 9.72±0.88 |
| Dried goji | 190.23±5.21 |
| Candied cranberries | 90.35±4.27 |
| Carob powder | 0.41±0.08 |
| Acacia honey | 48.30±2.41 |
| Coconut milk | 7.85±0.76 |
| Coconut flakes | 1.48±0.08 |

From Table 2 we can see that among the raw materials used, the highest content of vitamin C was found in dried goji (190.23±5.21 mg/100g), followed by candied cranberries (90.35±4.27 mg/100g). Carob powder was the poorest in vitamin C (0.41±0.08 mg/100g) of the raw materials. Regarding the two finished products obtained, the highest content of ascorbic acid was found in chia pudding P1 (52.16±2.24 mg/100g) - more than twice as large as in P2 pudding (22.25±1.78 mg/100g).

Yossa Nzeuwa *et al*., (2019) [11] have reported for goji berries from different regions of China and Nepal vitamin C contents between 33.15 and 113.86 mg/100g, and Ilić *et al*., (2020) [12] found for fresh red goji berries a content of 33.4 mg ascorbic acid/100g FW (which corresponds to 153.08 mg/100g DW). Kulczyński *et al.*, (2019) reported for chia seeds a vitamin C content of 1.6 mg/100g, very close to what we found (1.71±0.12 mg/100g).

### *3.2. Analysis of total polyphenol content*

Total polyphenol content determination of the two varieties of chia pudding and of the raw materials, by the Folin-Ciocâlteu method, led to the results presented in table 3.

***Table 3***. Total polyphenols content in the chia puddings and in the raw materials

| Sample | Total polyphenols content (mg gallic acid /g) |
|---|---|
| P1 | 8.24±0.82 |
| P2 | 4.11±0.44 |
| Chia seeds | 2.32±0.18 |
| Brown raisins | 6.73±0.52 |
| Dried goji | 28.27±1.88 |
| Candied cranberries | 9.59±0.63 |
| Carob powder | 18.02±1.04 |
| Acacia honey | 0.68±0.08 |
| Coconut milk | 1.92±0.15 |
| Coconut flakes | 2.85±0.14 |
| Hazelnuts | 3.25±0.21 |

Of the raw materials, dried goji were the richest in total polyphenols (28.27±1.88 mg gallic acid/g), followed by carob powder and candied cranberries (18.02±1.04 mg gallic acid/g). The lowest content of total polyphenols was found in acacia honey (0.68±0.08 mg gallic acid/g).

In terms of finished products, P1 pudding with goji and cranberries had the highest content of total polyphenols, more than 2 times higher than in P2 pudding. Ilić *et al*., (2020) [12] found for red goji berry 162.4 ± 11.5 mg gallic acid/100g FW, and Yossa Nzeuwa *et al*., (2019) [11] have reported for the dried goji from different Asian regions a varied content of total polyphenols between 8.36 mg gallic acid/g DW and 14.13 mg gallic acid/g DW. In 2017, Saphier *et al*., studied the content of total polyphenols in chia seeds, showing that it is higher than in flax seeds and depending on the extraction conditions, the value varied between 0.339 and 3.5 mg gallic acid/g.

### *3.3. Antioxidant activity analysis*

The antioxidant activity of the assortments of chia pudding and of raw materials, determined by the CUPRAC method, is presented in table 4.

***Table 4.*** Antioxidant activity of chia puddings and of raw materials

| Sample | Antioxidant activity (mg Trolox/g) |
|---|---|
| P1 | 69.52±2.08 |
| P2 | 32.41±1.82 |
| Chia seeds | 35.87±1.27 |
| Brown raisins | 21.36±0.90 |
| Dried goji | 235.82±4.08 |
| Candied cranberries | 122.28±2.57 |
| Carob powder | 77.07±2.33 |
| Acacia honey | 70.02±1.84 |
| Coconut milk | 7.92±0.48 |
| Coconut flakes | 10.85±0.65 |
| Hazelnuts | 14.86±0.41 |

The experimental data show that, among the raw materials used, the highest antioxidant activity was reported in dried goji (235.82±4.08 mg Trolox/g) and candied cranberries (122.28±2.57 mg Trolox/g), followed by carob powder (77.07±2.33 mg Trolox/g) and acacia honey (70.02±1.84 mg Trolox/g). In the case of the finished products obtained, chia pudding with carob powder and a mixture of dried goji and candied cranberries (P1) showed an antioxidant activity (69.52±2.08 mg Trolox/g) more than twice as high as chia pudding with brown raisins and almonds (P2: 32.41±1.82 mg Trolox/g). This is due to the higher content of total polyphenols and ascorbic acid in P1 pudding, compounds with strong antioxidant activity.

### *3.4. Proximate composition and energy values analysis*

Table 5. shows the results of the proximate composition and energy values obtained by calculation for the two variants of chia pudding.

***Table 5.*** The proximate composition and energy values of the two varieties of chia pudding

| Sample | P1 | P2 |
|---|---|---|
| Protein (g/100g) | 5,42 | 6,81 |
| Total fat (g/100g) | 10,83 | 22,58 |
| - saturated fat (g/100g) | 1,71 | 2,26 |
| Total carbohydrates (g/100g) | 36,67 | 29,96 |
| - dietary fiber (g/100g) | 8,75 | 8,24 |
| - sugar (g/100g) | 25,00 | 17,92 |
| **Energy value (kcal/100g)** | **242,5** | **321,86** |

From the table above it can be seen that the pudding variant P1 is richer in carbohydrates (36,67g/100g) and lower in calories (242.5 kcal/100g) than the variant P2 (29,96 g carbohydrates/100g, respectively 321.86 kcal/100g), but the P2 variant is richer in protein (6,81g/100g) and lipids (22,58g/100g) than the P1 variant (protein: 5,42 g/100g, lipids: 10,83 g/100g).

## 4. Conclusions

- An innovative raw-vegan product was obtained: chia pudding in two variants: one with the addition of coconut milk, honey, dried goji, candied cranberries, carob powder (P1) and the second with the addition of coconut milk, honey, brown raisins, hazelnut mix, cashews, almonds, coconut flakes, vanilla essence (P2).
- Both finished products had a very high content of vitamin C, but the P1 assortment had the concentration of ascorbic acid more than twice higher than the P2 assortment. In the case of the raw materials used, the highest content of vitamin C is in dried goji berries, followed by candied cranberries.
- In the case of chia pudding P1 the total polyphenol content was the highest, almost twice as high as in the case of pudding P2.
- Chia pudding P1 had more than twice the antioxidant activity of chia pudding P2.
- Regarding the proximate composition, it is noted that the first assortment of chia pudding P1 has had with 79,36 kcal less energy value than the second assortment (P2). In P1 it was a higher amount of carbohydrates than in P2, but less protein and lipids than in P2.

**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.

**Acknowledgements:** This work was supported by proving the equipment's of the Faculty of Food Engineering Timişoara – "*Food Science*"- Research Center.

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