

Assessment of the chlorophylls, carotene and xanthophylls content from two innovative assortments of vegan creams

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Abstract

The purpose of this paper was to obtain two innovative assortments of vegan creams (one with green lentils, spinach, broccoli, basil - VC1- and the second, with green lentils, avocado, basil – VC2) and to determine the content of chlorophylls, carotene and xanthophylls from the finished products obtained as well as from the raw materials used. After the spectrophotometric analysis it was found that between the two assortments of vegan creams obtained, the VC1 variant had a much higher chlorophyll (chlorophyll a: $282.48 \pm 1.36 \mu\text{g/g}$, chlorophyll b: $20.34 \pm 0.07 \mu\text{g/g}$) and carotenoids ($55.46 \pm 0.42 \mu\text{g/g}$) content than the VC2 variant (chlorophyll a: $51.22 \pm 0.29 \mu\text{g/g}$, chlorophyll b: $17.11 \pm 0.06 \mu\text{g/g}$, carotenoids: $21.72 \pm 0.20 \mu\text{g/g}$). This is because VC1 contains, besides the green lentil, spinach and broccoli, vegetables with a much higher content of chlorophylls and carotenoids than avocado. For green lentils, spinach and broccoli, after boiling 8-10 minutes for use in recipes, there was a decrease in both the concentration of chlorophylls and carotenoids compared to the raw products.

Keywords: green lentils, vegetables, chlorophyll, carotene, xanthophylls.

1. Introduction

In the last years we have witnessed an accelerated increase, at the world level, in the number of people adopting a vegetarian or even vegan diet [1-3]. Thus, the need for new food products that meet the nutritional requirements of vegetarians and vegans has been increasing. The balanced vegan diet is usually rich in dietary fiber, pectin, vitamins, iron and other mineral elements, unsaturated fatty acids, quality proteins [4,5]. A diet rich in fruits and vegetables, seeds, whole grains, according to the World Health Organization and Food and Agriculture Organization (WHO / FAO), is associated with a significant reduction in the risk of cardiovascular disease, cancer, osteoporosis, diabetes [6,7].

The green lentil (*Lens culinaris* L.) belongs to the *Leguminosae* family and is widely used in cuisines, especially in the Mediterranean and Indian regions. The lentil, with the grain covered with a soft coating, requires a short cooking time (23-26 min) and thus the losses of nutrients are smaller than in the case of cooking the grains with a strong

coating [8-10]. Lentil is rich in protein and carbohydrates, but is poor in lipids, having a low energy value [10]. Spinach (*Spinacia oleracea*) is one of the most important and nutritious vegetables consumed raw or cooked, offering a very good amount of vitamins B6, riboflavin, folate, niacin, soluble dietary fiber, omega 3 fatty acids and minerals. Spinach is also rich in iron, vitamin K, flavonoids, carotenoids, chlorophylls, vitamin C. The use of spinach in our daily lives is of great importance to prevent many diseases, such as: anemia, cancer, eye disease, osteoporosis, gastrointestinal disorders [11]. Broccoli (*Brassica oleracea* var. *Italica*) is a member of the *Brassicaceae* family and is very close to cauliflower. This delicious vegetable contains several nutrients such as vitamins A, C, D, carotenoids, chlorophylls, calcium, dietary fiber, iron and antioxidants. Numerous epidemiological studies indicate that *Brassicaceae* vegetables, in general, and especially broccoli, protect people against certain diseases, because they are rich sources of glucosinolate and have a high content of flavonoids, vitamins and mineral nutrients.

Glucosinolates, when the tissue is damaged, are hydrolyzed by myrosinase to biologically active isothiocyanates, such as sulforaphan, indole-3-carbinol and phenethyl isothiocyanate, the most responsible compounds for anticancer activity in broccoli [12]. Avocado (*Persea Americana*) is considered one of the main tropical fruits because it contains fat-soluble vitamins that are less common in other fruits, in addition to high levels of protein, potassium and unsaturated fatty acids. This fruit has been recognized for its health benefits, especially due to the compounds present in the lipid fraction, such as omega fatty acids, phytosterols, tocopherols, carotenoids. Chlorophylls a and b have been identified in avocado pulp tissue [13]. *Ocimum basilicum* L. - the common basil of the family *Lamiaceae* (*Labiatae*) is an annual species, herbaceous with aromatic odor, characteristic, being one of the most known and appreciated species of aromatic plants. The species is also used as a medicinal plant in the treatment of a wide range of diseases [14]. The aroma, but also the fact that the basil contains vitamin C, chlorophyll and carotene, make the basil to be used fresh and dried as a condiment. Basil synthesizes and accumulates terpenic and phenolic compounds whose antioxidant action is highly appreciated [15]. The purpose of this paper was to obtain two assortments of innovative vegan creams, one with green lentils, spinach, broccoli and basil and the second with green lentils, avocado and basil, as well as to determine the content of chlorophyll and carotenoid pigments in them and in the raw materials used.

2. Materials and Methods

Obtaining of vegan creams

The following raw and auxiliary materials (purchased from the local market) were used to obtain vegan creams: green lentils, fresh spinach, fresh broccoli, fresh basil leaves, avocado, fresh lemon, extra virgin olive oil, pink Himalayan salt. Two assortments of vegan creams (VC1 and VC2) were made using the recipes presented in table 1.

The raw materials were washed, cleaned, then weighed from each required quantity according to the recipes. The avocado was peeled and the pulp was homogenized in the blender. The broccoli, spinach and green lentil were boiled in salted water for 8-10 minutes, then they were drained of water and placed in the blender, according to the recipes, along with the other ingredients, mixing together until they were obtained a fine paste.

From the obtained vegan creams were then taken samples to determine the content of chlorophylls, carotene and xanthophylls.

Table 1. - Recipes used to make the two variants of vegan creams

Raw and auxiliary materials (g)	Vegan cream assortment	
	VC1	VC2
Green lentil	100	100
Fresh spinach	100	-
Avocado	-	100
Fresh broccoli	100	100
Fresh basil leaves	3	3
Fresh lemon juice	5	5
Extra virgin olive oil	10	3
Pink Himalayan salt	4	4

Chlorophyll, carotene and xanthophylls determination

Quantitative determination of chlorophylls, carotene and xanthophylls was performed both from finished product samples and from raw materials, according to the working methodology presented by Dumbrava *et al.* (2016) [16]. All experimental determinations were performed in triplicate and the results were expressed as mean and standard deviation.

3. Results and discussion

Chlorophyll content

The obtained results regarding the content of chlorophyll a, chlorophyll b and total chlorophylls from the obtained vegan creams and from the raw materials are presented in table 2.

We can see that the VC1 vegan cream variant is over 4 times richer in total chlorophylls ($302.78 \pm 1.43 \mu\text{g/g}$), than the VC2 variant ($68.33 \pm 0.35 \mu\text{g/g}$). This is due to the fact that the VC1 variant has broccoli (total chlorophylls in boiled broccoli: $329.77 \pm 1.74 \mu\text{g/g}$) and spinach (total chlorophylls in boiled spinach: $387.88 \pm 1.84 \mu\text{g/g}$), vegetables with a much higher total chlorophyll content than avocado pulp ($59.06 \pm 0.30 \mu\text{g/g}$), which is part of the VC2 variant. We also find that for both raw materials and finished products, the "a" chlorophyll content is much higher than that of "b" chlorophyll. Also, it is found that boiling reduces the concentration of chlorophylls from green lentils, broccoli and spinach. As for chlorophyll "a", the largest loss was found in the case of boiled spinach (22.22%), and the smallest for boiled green lentils (5%).

Chlorophyll "b" was lost most in boiled broccoli (69.21%) and least in boiled green lentil (15%). The highest losses of total chlorophyll were reported in boiled spinach (25.84%), and the lowest in boiled green lentil (8.19%).

Carotenoids content

Carotene and xanthophylls concentration determined in the raw materials and vegan creams are presented in table 3.

Table 2.. Chlorophyll a (Chl a), chlorophyll b (Chl b) and total chlorophylls (Total Chl) in obtained vegan creams and in the raw materials

Sample	Chl a (µg/g)		Chl b (µg/g)		Total Chl (µg/g)	
VC1	282.48±1.36		20.34±0.07		302.78±1.43	
VC2	51.22±0.29		17.11±0.06		68.33±0.35	
Raw green lentil	61.20±0.32		28.40±0.10		89.60±0.42	
Boiled green lentil	58.14±0.30	5 % losses	24.12±0.08	15% losses	82.26±0.38	8.19% losses
Fresh broccoli	372.28±1.92		50.16±0.28		422.44±2.20	
Boiled broccoli	314.33±1.68	15.57% losses	15.44±0.06	69.21% losses	329.77±1.74	21.94% losses
Fresh spinach	464.73±2.32		58.32±0.31		523.05±2.63	
Boiled spinach	361.46±1.75	22.22% losses	26.42±0.09	54.67% losses	387.88±1.84	25.84% losses
Avocado pulp	48.22±0.26		10.84±0.04		59.06±0.30	
Fresh basil leaves	280.36±1.34		90.14±43		370.50±1.77	

Table 3. Carotenoids concentration in obtained vegan creams and in the raw materials

Sample	Carotenoids (µg/g)	
VC1	55.46±0.42	
VC2	21.72±0.20	
Raw green lentil	15.82±0.16	
Boiled green lentil	10.24±0.11	35.27 % losses
Fresh broccoli	82.15±0.68	
Boiled broccoli	65.34±0.54	20.46 % losses
Fresh spinach	98.17±0.72	
Boiled spinach	73.84±0.60	24.78 % losses
Avocado pulp	28.46±0.27	
Fresh basil leaves	39.52±0.36	

According to the experimental results, the VC1 vegan cream variant also has a higher carotenoids (carotene and xanthophylls) concentration (55.46±0.42 µg/g) than the VC2 variant (21.72±0.20 µg/g), because VC1 contains, besides the green lentils, boiled spinach and boiled broccoli, raw materials with a higher content of carotenoids (73.84±0.60 µg/g, respectively 65.34±0.54 µg/g) than avocado pulp (28.46±0.27 µg/g), present in VC2 variant.

As we can see, boiling decreases the concentration of carotene and xanthophylls from green lentils, broccoli and spinach. The highest carotenoid losses were reported in boiled green lentils (35.27%), and the lowest in boiled broccoli (20.46%).

4. Conclusions

From this research paper, the following conclusions can be drawn:

1. There were made two innovative assortments of vegan creams, one with green lentils, broccoli and spinach (VC1) and the second with green lentils and avocados (VC2) and were analyzed from the perspective of the content of chlorophyll, carotene and xanthophylls pigments, compared to the raw materials used.
2. The total chlorophyll and chlorophyll "a" content was significantly higher in vegan cream with broccoli and spinach (VC1) than in that with avocado (VC2).
3. Regarding the concentration of carotene and xanthophylls, also the variant of VC1 vegan cream was significantly richer than VC1.
4. A decrease in the concentration of chlorophyll and carotenoid pigments was observed following the boiling process of the raw materials. The largest losses of total chlorophyll and chlorophyll "a" occurred after boiling spinach, and the smallest after boiling green lentils. The highest loss of chlorophyll "b" was reported in the case of boiled broccoli. In the case of carotene and xanthophylls, the greatest losses were recorded after boiling the green lentils.

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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