STUDY ON THE ENRICHMENT OF THE NUTRITIONAL VALUE OF DEHYDRATED APPLES

STUDIU PRIVIND ÎMBOGĂȚIREA VALORII NUTRITIVE A MERELOR DESHIDRATATE

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Abstract

In order to preserve a horticultural product for as long as possible, various preservation methods can be used to extend its shelf life and preserve its nutritional value. Drying food is one of the oldest methods of preserving food for later use, being simple, safe, low cost and preserves nutrients after process. Dried fruits are well-known for their nutritional and dietary properties, such as natural and concentrated sources of sugars, vitamins A, C, niacin, riboflavin and folic acid, potassium, iron and copper, as well as organic acids, phytonutrients with antioxidant properties. Most commercially available dried apple slices are not enriched, leading to an underrating of this healthy and natural snack.

The aim of this study was to enrich the nutritional value of sliced apple dried used only natural products: fresh lemon juice, beetroot peel powder and cinnamon. The product represents the perfect combination of sweet and sour, with an interesting balanced taste, being an alternative healthy snack for consumers.

Keywords: dehydration process, nutritional, quality, healthy snack.

Rezumat

Pentru a păstra un produs horticol cât mai mult timp, se pot folosi diferite metode de conservare cu scopul de a prelungi durata de depozitare și de a păstra valoarea nutritivă a acestuia. Deshidratarea este una dintre cele mai vechi metode de conservare a alimentelor pentru utilizare ulterioară, fiind simplă, sigură, cu costuri reduse prin intermediul căreia se conservă substanțele nutritive după proces. Fructele deshidratate sunt bine cunoscute pentru proprietățile lor nutriționale și dietetice, cum ar fi surse naturale și concentrate de zaharuri, vitaminele A, C, niacină, riboflavină și acid folic, potasiu, fier și cupru, precum și acizi organici, fitonutrienți cu proprietăți antioxidante. Majoritatea feliilor de mere deshidratate existente în comerț nu sunt îmbogățite nutritiv, ceea ce duce la o subestimare a acestei gustări sănătoase și naturale. Scopul acestui studiu a fost de a îmbogăți valoarea nutritivă a feliilor de mere deshidratate folosind doar produse naturale: suc proaspăt de lămâie, pudră de coajă de sfeclă roșie și scorțișoară. Produsul reprezintă combinația perfectă

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între dulce și acrișor, echilibrată și interesantă, fiind o alternativă de gustare sănătoasă pentru consumatori.
Cuvinte cheie: deshidratare, nutritiv, calitate, gustare sănătoasă.

INTRODUCTION

In areas with a temperate climate, apple culture is very widespread and well-known, with apples occupying the first place in terms of production volume, their demand on the market and, last but not least, their qualitative-food value.

One of the first techniques for storing food for later use is drying it. It can be either an alternative to preserving or freezing, or to supplement these methods, being simple, safe and a low-cost method that preserves nutrients after finished process [Beceanu, 2010; Beceanu, 2011].

Apples are cultivated extensively around the world, and there is a great market for the wide range of types. The tastes and textures of apples are what consumers appreciate most about them. Apple consumption has been associated with the prevention of chronic diseases [Jakopic *et al*., 2009] due to their high antioxidant capacity and important source of polyphenols [Lotito and Frei, 2004].

Recovery of plant byproducts (fruits and vegetables) such as peels, seeds or pomace, can fulfill the requirements for production of natural pigments at industrial level for food potential.

These byproducts are a rich source of natural pigments (anthocyanins, betalains, carotenoids, chlorophylls, etc.) being an important source of nutrients for consumer health [Sharma et al, 2021].

Fresh apples have a high nutritional value due to their very balanced composition and biochemical components being easily accessible to the human body and organoleptic, visual, sensory and taste characteristics.

The main components of *apple (Malus domestica)* are represented by: water 80-85%, total sugars 6.5-17%, proteins 0.3%, lipids 0.4%, minerals 0.32%, organic acids 0.65%, minerals 0.32%, vitamin C 4.6 mg/100g product, vitamin A 3 µg., vitamin B1 0,017 mg., vitamin B_2 0.026 mg., vitamin B_3 0.091 mg., Ca 6 mg., 0.12 mg. Fe, 5 mg Mg, 11 mg P, 107 mg. K, 1 mg Na, 0.04 mg Zn, etc. [Irimia, 2013].

Apple fruits can be consumed fresh for a long time when stored properly or can also be processed into products like dried apples, apple sauce, marmalades, jelly, etc. Also, apple fruits are known for their taste attributes, nutritional, medicinal, and prophylactic values [Irimia, 2013].

Beetroot *(Beta vulgaris L.)* is famous crop with an important phytochemical compound, for its juice value and medicinal properties, having a bright crimson color. The intense red color of beetroots derives from high concentrations of betalains [Gandia et al. 2010], which are used as natural colorants in the food industry. Also, it is an important vegetable due to benefits in humans' health, especially for their anti-inflammatory properties [Georgiev et al., 2010], important antioxidant capacity and anti-bacterial activity [Mello et al, 2014; Sharma et al, 2021].

Cinnamon *(Cinnamomum zeylanicum,* and *Cinnamon cassia)* primarily contains vital oils and other derivatives, such as cinnamaldehyde, cinnamic acid, and cinnamate. In addition to being an antioxidant, anti-inflammatory, antidiabetic, antimicrobial, anticancer, lipid-lowering, and cardiovascular-disease-lowering compound [Rao and Gan, 2014].

Cinnamon is mainly used in the aroma and essence industries due to its fragrance, which can be incorporated into different varieties of foodstuffs, perfumes, and medicinal products [Huang et al, 2007].

Lemon (*Citrus limon*). The biologically activity of lemon fruit is determined by its high content of phenolic compounds, mainly flavonoids (e.g, diosmin, hesperidin, limocitrin) and phenolic acids (e.g., ferulic, p-hydroxybenzoic acids). The essential oil is rich in bioactive monoterpenoids such as D-limonene, β-pinene, γ-terpinene. It has recently been scientifically proven that the therapeutic activities of *C. limon* include anti-inflammatory, antimicrobial, anticancer and antiparasitic activities [Szczykutowicz et al, 2019].

Therefore, the aim of this research was undertaken to explore natural and safe food ingredients such as natural pigments by using byproducts of fruits or vegetables with potential health benefits.

MATERIALS AND METHODS

Experimental protocol for obtain dried apples slices. The base for the product were fresh and healthy apples, with the right size and degree of maturation. Product uses only natural ingredients which consists in sliced healthy apples dipped in fresh lemon juice combined with beetroot peel powder and seasoned with cinnamon powder.

Drying process. To produce dried fruits was used simple hot air dehydration equipment, with optimized work efficiency and performance in a reasonable time. The dehydrated fruits were kept in the dehydrator for 6 hours at 37 degrees Celsius in order not to affect the chemical composition.

Chemical parameters. The following chemical parameters have been evaluated: soluble solids concentration, total sugar, humidity, total dry matter, total acidity, *p*H, ascorbic acid content, antioxidant activity in concordance with standards of fruits and vegetables [Beceanu, 2010; Irimia, 2013; Murariu et al., 2017].

The antioxidant capacity of the samples in this study was assessed using methanol, 6-hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid, and 2,2-Diphenyl-1-picrylhydrazyl (analytical grade, Sigma Aldrich, Germany) as reagents and the DPPH method, which is briefly described by Vasile *et al*., (2020). express as mMol Trolox Equivalents (TE)/ gram dry weight (g D.W.)

Chromatic parameters. The colorimetric parameters were evaluated using a HunterLab colorimeter (MiniScan® XE Plus). Lastly, the display of the scientific equipment indicates three variables: L* (brightness) and two-color characteristics (a* and b*):

L*: 0 for black, 100 for white;

a*: negative values for green shades or positive values for red shades;

b*: shades of blue (negative values) or yellow (positive values).

In addition, c* (chroma), h*(tone) and ΔE* (tone difference) were calculated by using L*, a* and b* parameters with equation (1), (2) and (3).

$c^*=\sqrt{(a^{*2}+b^{*2})}$ (1) [Pătraşcu et al., 2013]

$h^*=\arctg(b^*/a^*)$ (2) [Patsilinakos et al., 2018]

$\Delta E^*=\sqrt{(L^{*2}+a^{*2}+b^{*2})}$ (3) [Hanbury and Serra, 2011]

RESULTS

The dried apples slices have been analyzed in terms of chemical and colorimetric parameters according to the standards applied in food industry.

The results shown in Tables 1 and 2 confirm that product present considerable nutritional values due to the chemical compounds and antioxidant capacity especially.

Table 1

Chemical parameters of dried apples slices

	Parameters	Quantity	Unit
1	Dry matter soluble content	56±0.2	°Bx
2	Total sugars	23.88±0.15	g
3	Water content	19.8±0.12	%
4	Dry matter total content	80.2±0.05	%
5	Total acidity	2.14±0.2	g malic acid/100 g product
6	*p*H	4.1±0.5	*p*H units
7	Ascorbic acid content	44.88±0.2	mg/100 g product
8	Antioxidant activity	151.90±1.03	mMol TE/g D.M.

Table 2

Colorimetric parameters

	Parameters	Quantity	Unit
1	L*	4.98±0.30	CieLab parameters
2	a*	20.4±0.11	
3	b*	6.02±+0.02	
4	c*	23.01±3.18	
5	h*	0.26±0.00	
6	ΔE*	14.26±3.50	

According to Irimia, 2013, fresh apples contain 12-14% total dry matter (depending on the variety) and dehydrated apples slices obtained a value of 56% due to the other ingredients used.

Also, fresh apples water content varies between 80-85% while dehydrated apples slices obtain 19.8% due to the drying process. In general, dehydrated fruits should have a low water content, between 4-20%.

The total antioxidant activity (TAA) of beetroot is significantly correlated with the concentration of vitamins (e.g., ascorbic acid) and bioactive chemicals (e.g., betalains, etc.). The samples in this research had notably high antioxidant levels 151.90 mMol TE/g D.W.). Using the DPPH approach, Bucur *et al*. [2016] demonstrated that TAA red beetroot can be as much as 35.88% IC50 if the test sample is fresh rather than frozen. Due to the complexity of the food matrix (fresh

apples, red beet peels, lemon juice and cinnamon powder), which include natural antioxidants, it can be observed that there is an enrichment of the nutritional value of the product.

The results acquired for the L* parameter (4.98±0.30) showed a light product (brightness) with yellow (related with positive value for b* parameter 6.02±+0.02) and red (due to positive values obtained for a* parameter, 20.4±0.11) colors.

Additionally, there is a correlation between red color of dried apples slices test and its bioactive components, including betalains, which are significant sources of red pigments found in beetroot or beetroot peel.

CONCLUSIONS

To enhance the quality and color of products, vegetable waste can be valued and used to generate natural colors.

The beetroot coloring improves quality of the sliced apple due to its intense red color, as evidenced by colorimetric analysis, but also by the contribution of bioactive compounds with benefits on the human body.

Dried apple slices shown high antioxidant activity due to the high nutritional value of the by-products used and also due to chemical compounds of the other components used in technology.

The modern consumer's demand for such products and their attractiveness to the market will also have a significant impact.

Recent research indicates that apples, when compared to other common fruits, are a great source of bioactive phenolic phytochemicals, which may have unique nutraceutical effects.

The results contribute to the enrichment of the literature and to the optimization of the technology to obtain nutritionally enriched dehydrated fruit.

The dehydrated apples slice meets the requirements of the consumer for a quick and healthy snack for all ages.

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