JAP&T
TPA-Timişoara

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

Journal of Agroalimentary Processes and Technologies 2018, *24* (4), 258-262

Journal of Agroalimentary Processes and Technologies

Impact of thermal treatment on bioactive compounds of red beet (*Beta vulgaris* L.) preparations by hot air drying

Georgiana Petruț[1], Anamaria Pop[1*], Sevastița Muste[1], Adriana Păucean[1], Mureșan Vlad[1], Simona Man[1], Crina Mureșan[1], Andruța Mureșan[1]

[1]University of Agricultural Sciences and Veterinary Medicine, Faculty of Food Science and Technology, 3-5 Mănăştur street, 3400, Cluj-Napoca, Romania

Abstract

There is an increased interest in preserving fruits and vegetables by drying. Redbeet is generally processed before consumption which influences the stability of betalains in turn which affects the acceptability and health properties. Red beet has high concentration betalains that are used as food colorants and food additives due to their health promoting properties.

The red beetroot raw materials were purchased from the food market (local farmers from Cluj-Napoca) and the reagents from Sigma Aldrich or Merck (Darmstadt, Germany). After preliminary cleaning, peeling and slicing, red beetroot were dehydrated at diferent temperature 55°C, 65°C, 70 °C for 6 hours in a Hot Air Dryer Machine. Total phenolics content was assesed by Folin-Ciocalteu spectrophotometric method using a UV-VIS, JASCO V530 spectro photometer (International Co.,Ltd.,Japan). The radical scaveging activity (RSA%) was assesed by DPPH spectophotometric methods. In parallel, a marketing study was conducted to highlight consumer preference for this type of product that is recommended to consume in the form of snack.

The highest content of total polyphenols was recorded for red beetroot dehydrated at 70 °C with 172.67 (mg. GAE / 100g sample) followed by the sample dehydrated at 65 °C with 140.23 (mg. GAE / 100g sample) and the lowest value recorded for sample dehydrated at 55 °C with 104.96. Regarding the antioxidant activity, the scavenging efficiency of red beetroot dehydrated against the DPPH radical was the strongest due to their high polyphenol content: 47.31 (% RSA) at 70 °C followed by the sample dehydrated at 65 °C with 45.70 (% RSA) and the lowest value recorded for sample dehydrated at 55 °C with 39.29 (% RSA).

Afore mentioned studies indicate that the processing of red beet has influence on betalains and antioxidant activity.

Keywords: antioxidants, Beta vulgaris, functional snacks

1. Introduction

A potentially attractive alternative is to use hairy root cultures. Various technologies are used to improve the taste, color and texture of food products, as well as to inactivate and toxic substances. Nevertheless, it still remains to determine how and to what extend individual technological processes disturb biologically active constituents of vegetables.

Literature report increased levels of biologically active compounds and antioxidant activity induced by the treatment applied [12], yet other point to their reduced values observed in the final product obtained [18]. Therefore, deciding the content of biologically active compounds in both fresh and processed products is decisive for the formulation of new dietary plans. Such material is also important for consumers with an progressively developing nutritional awareness [16].

Corresponding author: *e-mail:* anamaria.pop@usamvcluj.ro

One of phenolic compounds presented in red beet, betalains decreases oxidative damage of lipids and improves antioxidant status in humans. Antioxidant activity in red beet is associated involvement of antioxidants in the scavenging of free radicals and consequently in the prevention of diseases like cancer, cardiovascular diseases. The use of betalains as food colorant is approved by European Union and betalains are labeled as E-162. Betalains can be used as food additives which either avoid the food discoloration or to enrich food [5].

Drying is an alternative to the consumption of fresh fruits and vegetables, and allows their use during the off-season. It can be used in various forms as red food colorants, e.g. to progress the colour of ice cream, tomato paste, desserts, jams and jellies, sauces, sweets and cereals [9], as well as in dried forms like chips, tea, powder in bakery, food supplements, etc.

This study is part of a research direction regarding the influence of temperature variation on bioactive compounds in dehydrated red beetroot.

2. Materials and Methods

2.1. Materials

The red beetroot raw materials were purchased from the food market (local farmers from Cluj-Napoca) and the reagents from Sigma Aldrich or Merck (Darmstadt, Germany). After preliminary cleaning, peeling and slicing, red beetroot were dehydrated at diferent temperature 55°C, 65°C, 70 °C for 6 hours in a Hot Air Dryer Machine. The products were made in the laboratory of vegetable products preservation of UASMV, Cluj-Napoca and analysed in the Food Quality Control and Sensory Evaluation laboratories of the Faculty of Food Science and Technology.

2.2. Methods

In this study, a variable experiment was conducted to determine the specific effects of temperature variation on bioactive compounds on the physicochemical properties important for in dehydrated red beetroot. Also, sensory evaluation was conducted to determine the most important qualities to consumers and to establish the ideal prototype for the industrial-scale production.

2.2.1 Physicochemical analysis: Titratable acidity, moisture content and ash and were determined according to AOAC method (2000) [4]. The standard compounds (gallic acid, quercetin) and reagents: 2,2-diphenyl1-picrylhydrazyl, Folin-Ciocalteu, methanol, aluminium chloride, sodium carbonate, sodium nitrite and sodium hydroxidewere purchased from Sigma Aldrich or Merck (Darmstadt, Germany).

Used method for quantification of antioxidant capacity is the 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay, which measures the ability of the compound to scavenge the DPPH stable radical [17]. The reactions for free radicals capture make a change in sample colour, after blue to yellow and a relative decrease in absorbance. The antioxidant activity is express as antiradical activity of samples. Absorption of the samples was measured on a Shimadzu UV-1700 at 515 nm and the antioxidant activity was calculated as follows: % DPPH scavenging activity = $[(A_0 – A_1)/A_0]\cdot100$, where A_0 was the absorbance of the control reaction and A_1 the absorbance in the presence of the sample.

Total phenolics compounds were determined spectrophotometrically using a modified FolinCiocalteu method [14]. All spectrophotometric measurements were performedusing a Shimadzu UV-1700 PharmaSpec spectrophotometer.

2.2.2 Sensory evaluation: Hedonic testing of the dehydrated red beetroot was achieved in the Sensory Evaluation Laboratory of the Faculty of Food Science and Technology. Sensory profiling of samples was done by 28 panellists with age between 22-26 years. Samples of *Beta vulgaris* L. (PB, PB1, PB2, PB3) were thermally processed for 6 hours before tasting.

The panellists estimated the sample formulations for taste, colour, texture odor, and global acceptability using a 9-point hedonic scale, 9 being “like extremely”. Fresh water was used to cleanse the palate between samples.

3. Results and Discussions

3.1 Physicochemical analysis

To realize the purposes were analysed comparatively several prototypes.

The samples encoding is explained as follows:
PB - blank test.
PB – dried samples by free convection at 55 °C for 6 hours.
S2 – dried samples by free convection at 65 °C for 6 hours.
S3 – dried samples by free convection at 70 °C for 6 hours.

Next obtaining all models of dehydrated red beetroot, they were subjected to a set of physicochemical analysis.

The drying rate was calculated as the quantity of water removed per unit of drying time and per unit of dry solid. By investigative table 1, it was noticed that the drying rate increases with temperature, and higher values of the drying rate were recorded at 70 °C. At 55 °C the drying process receipts place very slowly; this phenomenon was described by several authors [7,12]. When the capillary forces rule the migration of water, variations in the pore sizes within the substrate complicate the estimate of the mass transfer efficiency. The tissue decline passes during drying can be attributed to the further restricted mass transfer. Diffusion is also altered by the tortuosity of the material [13]. The effective moisture diffusivity is the transfer of moisture from the dried food products under the influence of concentration and density differences. The diffusion similarly corresponds to the trend of water molecules dispersion below the action of excitation energy converted into heat. Water diffusivity also increases with the improvement of the drying temperature in the convection method and the combined method. Porosity is amplified by the thermal variations of the membrane components from the cell structure induced by the Hot Air Dryer Machine. This will lead to enhanced water diffusivity in the dried vegetal product

The ash, moisture, acidity, protein as well as the antioxidant capacity of the tested *Beta vulgaris* L. preparationsis presented in table 1.

The highest content of total polyphenols was recorded for red beetroot dehydrated at 70 °C with 172.67 (mg. GAE / 100g sample) followed by the sample PB2 (dehydrated at 65 °C), with 140.23 (mg. GAE / 100g sample) and the lowest value recorded for sample dehydrated at 55 °C (PB1) with 104.96. Concerning the antioxidant activity, the scavenging efficiency of red beetroot dehydrated against the DPPH radical was the strongest due to their high polyphenol content: 47.31 (% RSA) at 70 °C (PB3), followed by the sample dehydrated at 65 °C (PB2), with 45.70 (% RSA) and the lowest value recorded for sample dehydrated at 55 °C (PB1) with 39.29 (% RSA).

Table 1. Physico-chemical parameters evaluated on dehydrated red beetroot and control sample.

		Dehydrated red beetroot on		
Drying conditions	-	**55°C**	**65°C**	**70 °C**
		for 6 hours in a Hot Air Dryer Machine		
	PB	**PB1**	**PB2**	**PB3**
Total polyphenols (mg GAE/100g dw)	101.30±0.001	104.96 ±0.045	140.23± 0.051	172.67 ±0.007
Antioxidant activity (%)	29.46 ±0.002	39.29± 0.001	47.31±0.001	45.70± 0.002
Total acidity,	0.027 ±0.007	0.017± 0.002	0.017±0.008	0.015± 0.009
pH	7.5±0.002	7.40±0.006	7.40±0.009	7.30±0.005
Ash, %	6.66± 0.003	12.00± 0.002	14.48±0.003	15.49± 0.007
Protein content, %	40.25 ±.004	45.30± 0.004	46.20±0.007	47.23± 0.001
Moisture content, %	75.85 ±0.00	10.04± 0.008	8.01±0.001	7.09±0.002

The rise in antioxidant activities of treated samples, shows that the antioxidant activity depends not only on the presence of betalains but also other polyphenols which could have been increased during the actions. Treatment of samples has led to better extractability and increased antioxidant activity after treatments. Temperature is the important factor influencing betalain stability. Previous studies done reported betalain degradation with increase in temperatures [8].

Overall, the increase of antioxidant activity occurring at least in the considered conditions. Also allowing to [3], gastronomic causes a significant increase in antioxidant activity in tropical green leafy vegetables.

3.2 Sensory analysis

It is very significant that the organoleptic properties of remained acceptable to consumers and the quality level similar to the current commercially available products.

Figure 1. Dehydrated red beetroot by the Hot Air Dryer Machine on functional snacks

The results of sensorial evaluation of dehydrated red at different temperature of compared to the control sample are shown in figure 2. Dehydrated beta vulgaris L. at 55 ° C / 6 hours has a hedonic score of 6.5, which means that the tasters did not like this assortment, which is why they classified it as "lightly enjoyable". At this assortment, comments were made on the remaining beet taste. The hedonic score is between 8 and 9 for PB3 (chips dewatered at 70 ° C / 6 hours), which suggests that they are preference between "very pleasing" and "extremely pleasing" with more inclination towards "very pleasing". This conceptualization of hedonic and utilitarian product values as distinct and independent constructs in consumer research literature [6]. From the perspective of self-determination theory) while perceived usefulness provides extrinsic motivation (means to an end) to its users to use the system, perceived enjoyment, playfulness and flow provide intrinsic motivation (an end in it self) [1, 2].

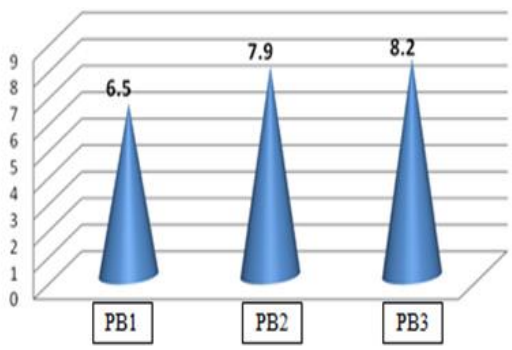

Figure 2. Acceptability scores of dehydrated red beetroot

4. Conclusions

Afore mentioned studies indicate that the processing of red beet has influence on betalains and antioxidant activity. These studies with thermal processing involve optimization of such procedures to validate quality of phytochemicals parameters.

Also, all analysed samples were favourably evaluated by tasters, but the most most appreciated by consumers was the dehydrated red beetroot at 70 °C for 6 hours.

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.

References

1. Adarsh Kumar Saiindarlal Kakar. Why do users prefer the hedonic but choose the Utilitarian? Investigating user dilemma of hedonic–utilitarian choice. *Inter. J. of Hum.-Computer St*., **2017**, *108*, 50-61.
2. Adefegha S.A, Oboh G. Cooking enhances the antioxidant properties of some tropical green leafy vegetables, *Af. J. of Biotech*., **2009**, *10*, 632-63.
3. AOAC. Official Methods of Analysis, 17th Ed. Ass. of Official Analy. Chem. Inc.Washington, 2000, USA.
4. Delgado-Vargas F, Jiménez A.R, Paredes-López O. Natural pigments: Carotenoids, anthocyanins, and betalains — characteristics, biosynthesis, processing, and stability. *J. Critical Rev. in Food Sc. and Nutr.* **2000**, *40*, 173-289.
5. Diefenbach S, Kolb N, Hassenzahl M. The hedonic' in human-computer interaction: history, contributions, and future research directions. *Proceed. of the 2014 Conf. on Desig. Inter. Syst.*, **2014**, 305-314.
6. Figiel A. Drying kinetics and quality of beetroots dehydrated by combination of convective and vacuum-microwave methods, *J. of Food Eng.*, **2010**, *98*, 461-470.
7. Garcia-Barrera F.A, Reynoso C.R, Gonzalez de Mejia E. Stability of betalains extracted from garambullo (Myrtillocactusgeometrizans). *J. Food Sc. and Technol. Inter.*, **1998**, *4*, 115-120.
8. Kaur K, Singh A.K. Drying kinetics and quality characteristics of beetroot slices under hot air followed by microwave finish drying. *Af. J. of Agricul. Research*., **2014**, *12*, 1036-1044.
9. Ravichandran K, Saw T.M.M.N, Mohdaly A.A.A, Gabr M.M.A, Kastell A, Riedel H, Smetanska I. Impact of processing of red beet on betalain content and antioxidant activity. *J. Food Res. Inter*., **2013**, *50*, 670-675.

10. Santacruz-Vázquez C, Santacruz-Vázquez V. The spatial distribution of β-carotene impregnated in apple slices determined using image and fractal analysis, *J. of Food Sc. and Tech.*, **2015**, *52*, 697-708.
11. Singleton VL, Orthofer RM, Lamuela-Raventos RM. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *J.Meth. in Enzy*. **1999**, *299*, 152–178.
12. Sorour H, El-Mesery H. Effect of microwave and infrared radiation on drying of onion slices, *Inter. J. of Research in Applied*., **2014**, *2*, 119-130.
13. Tomasz Sawicki Wiesław Wiczkowski. The effects of boiling and fermentation on betalain profiles and antioxidant capacities of red beetroot products. *J. Food Chem*., **2018**, *259*, 292-303.
14. Waters DM, Jacob F, Titze J, Arendt EK, Zannini E. Fibre, protein and mineral fortification of wheat bread through milled and fermented brewer's spent grain enrichment. *J. Eur. Food. Res. Technol*., **2012**, *235*, 767–778.
15. Wiczkowski W, Szawara-Nowak D, Topolska J. Changes in the content and composition of anthocyanins in red cabbage and its antioxidant capacity during fermentation, storage and stewing. *J Food Chem*., **2015**, *167*, 115-123.