

Effect of drying methods for inner parameters of red beetroot (*Beta vulgaris* L.)

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Abstract. In compliance with consumer expectations, careful processing and preservation are increasingly used with fruits and vegetables. The aim is that during these treatments the valuable nutritional characteristics of the raw materials change as little as possible. Drying has been used for the preservation of raw materials for a long time, which can distinguish two different groups based upon pressure. These are the atmospheric and the more careful vacuum drying.

During the research, Alto F1 beetroots were being dried in vacuum and under atmospheric pressure at different temperatures. Vacuum drying took place at 40, 50, and 60 °C, while atmospheric drying at 60, 70, and 80 °C. All drying processes lasted 150 minutes. During drying, changes of moisture content and water activity were monitored. After drying, colour measurement was realized and the inner parameters were investigated, such as polyphenol, betalain, and antioxidant capacity. These measured parameters were compared in the case of atmospheric and vacuum drying.

Keywords and phrases: beetroot, atmospheric drying, vacuum drying

1 Introduction

Although the consumption of vegetables is becoming more and more prevalent, the consumption of beetroot in our country is very low despite that numerous researches demonstrate its cancer-preventive, antioxidant, and anti-inflammatory effect. In addition, its nutritional content is very favourable; besides the high fibre and mineral content, vitamin C and folic acid are substantial. Especially in fresh or in bottled form, it is applied to colour yogurts and cookies because of its large amount of pigments (betanin, vulgaxantin I-II). The consumption of dried red beet is becoming more and more common. Beetroot (*Beta vulgaris* L. ssp. *esculenta* Gurke var. *rubra* L.) has already been grown since antiquity. The wild ancestor of beetroot is *Beta vulgaris* var. *maritima*, which can be found mainly around the Mediterranean Sea. The Romans, Greeks, and Egyptians were familiar with its wild variety used for direct consumption – this has been known only since the XIX–XX. centuries (Hájas, 1976).

Although healthy lifestyle receives more and more emphasis, so the beneficial effects of the consumption of beetroots is well-known, the consumption per capita is only 0.5 kg a year. This amount is higher in other European countries. People in Northern Europe, Japan, the UK, and Germany show a preference for consuming beetroots (Balázs, 2004).

Beetroot has excellent physiological properties. Its macro- and micronutrient content is remarkable and its vitamin content is high. Its vitamin A and C content is substantial and its vitamin B is outstanding. Vitamin B1 (thiamine), vitamin B2 (riboflavin), and vitamin B3 (niacin) can be found in most root vegetables with dark green leaf, such as in beetroot. Beetroots play a vital role due to their remarkable folate content. Folic acid helps to prevent cancer and in cooperation with vitamin B contributes to the proper functioning of the nervous system (Takácsné, 2002).

Betalain – water-soluble, nitrogen-containing plant pigments – gives the red colour of red beet (Ravichandran *et al.*, 2013). Beetroot has a lot of positive properties for the human body. It has antioxidant, anti-inflammatory, hepatoprotective, and anticancer effects (Nemzer, 2011). The colouring effect of betalain shows similarity with the anthocyanin compounds (Csapó & Csapóné, 2003). Betalains can be divided into two groups based on their colour: red-purple betacyanin and yellow betaxanthin (Georgiev *et al.*, 2010).

2 Materials and methods

2.1 Materials

The Alto F1 beet variety was grown in the Experimental Plant of Tan's economy at the Faculty of Horticultural Sciences, Szent István University. During cultivation, beetroots were treated with Genesis fertilizer, which contains the followings: 27% nitrate, 5% MgO, and 7% CaO. Beetroots used in the experiment were harvested in July 2014. After harvesting, they were washed, peeled, and sliced into 2 mm slices, and then they were stored in frozen state at 18 °C for 2 weeks.

2.2 Methods

Drying lasted 150 minutes. The following drying instruments were used: MEMMERT-VO vacuum drying and LP-322 type drying oven. Based on the experimental plans, drying was done in vacuum at 40, 50, and 60 °C (sample codes: 40V, 50V, 60V) and in drying oven at 60, 70, and 80 °C (sample codes 40L, 50L, 60L). After drying, beetroots were extracted. Nutrition characteristics were assessed in the dried and extracted beetroots.

Sampling was done every 30 minutes in each case. Subsequently, moisture content – Kern DBS 60-3 – and water activity – LabMaster-aw – of the samples were determined. The chemical tests (polyphenol content (*Singleton & Rossi*, 1965), antioxidant capacity (*Benzie & Strain*, 1996), betacyanin (*Castellar et al.*, 2003) and betaxanthin content (*Stinzinget et al.*, 2005), and the physical measurements (rewetting, colour measurement – Minolta CR 200) were carried out only in the case of dried beetroots. During rewetting, the absorption index, or rehydration ratio (RR) is the ratio of rehydrated product weight (Wr) and the dry weight of the product (Wd) of the dried beetroot samples.

3 Results and discussion

The aim of my work was to compare the nutritional characteristics of the dried beetroots using vacuum drying and drying oven. During the evaluation of the results, the received values were compared.

Figure 1 shows the changes of the moisture content. During the same drying time, the moisture content of the 60V, 60L, 70L, and 80L samples are almost identical. Vacuum drying at 40 and 50 °C would require a longer drying period to reach a moisture content under 10%.

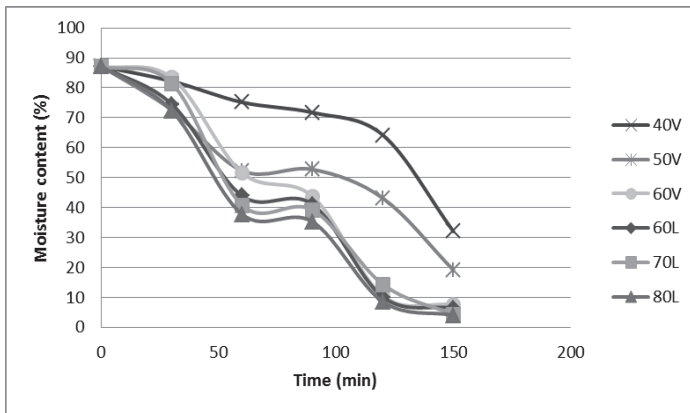


Figure 1: Moisture content in the case of different drying parameters

Table 1 presents the final moisture content after drying.

Table 1: Moisture content and water activity

	Moisture content (%)	Water activity
40V	32.000	0.791
50V	19.100	0.567
60V	7.557	0.400
60L	6.416	0.453
70L	4.262	0.405
80L	4.023	0.310

Figure 2 shows the water activity of the samples during drying. Sampling was taken every 30 minutes. The initial water activity of the raw material was the same ($a_w = 0.892$) in all cases.

Among the samples, the 40V shows the smallest change. In the case of vacuum drying, a substantial reduction of water activity occurred only after 90 minutes of drying, but with the drying oven this set in after 60 minutes of drying.

Figure 3 contains the rewetting rate of the dried samples. It can be observed that the 60V shows the highest rewetting rate, which is due to mild drying. In the case of the 50V (RR = 2,8) and 40V (RR = 2,272), rewetting rate becomes increasingly smaller as in these samples the final moisture contents were 19.1% and 32%; so, during rewetting, these samples absorbed less water.

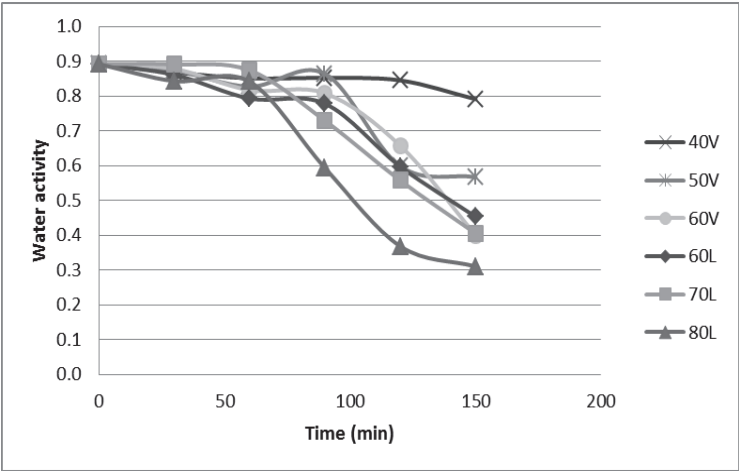


Figure 2: Water activity in the case of different drying parameters

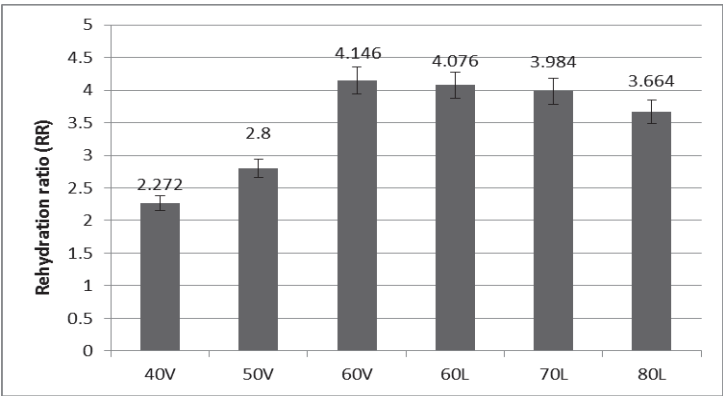


Figure 3: Rehydration ratio of the dried samples

As the drying temperature is raised, the colour difference values (ΔE) of the consecutive samples are compared to each other in *Table 3*. Between the 40 V and 50V, 60V and 60L, and 70L and 80L samples, the deviation is clearly visible, while the difference between the 50V and 60V and 60L and 70L samples is barely noticeable.

Table 2: Results of the colour measurements in the case of dried samples

Parameters	40V	50V	60V	60L	70L	80L
a*	7.46	5.23	4.46	1.38	1.49	1.28
b*	1.87	1.46	1.23	0.61	0.60	0.54
L*	21.42	18.72	19.48	20.17	20.33	22.17

Table 3: Values of the colour differences between each sample pair

Samples	ΔE	Differences perceptible to the eye
40V–50V	3.52	Clearly visible
50V–60V	1.10	Barely noticeable
60V–60L	3.22	Clearly visible
60L–70L	0.19	No noticeable
70L–80L	1.86	Noticeable

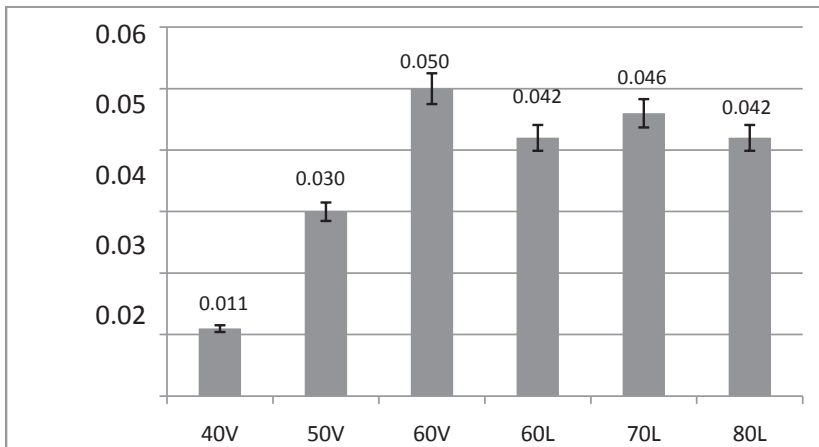


Figure 4: Antioxidant capacity of the dried samples

Figure 4 contains the antioxidant capacity of the dried samples. The highest antioxidant capacity (0.05 mg/100g) can be seen in the 60V sample, but the antioxidant capacity of the 70L samples (0.046 mg/100g) is slightly smaller.

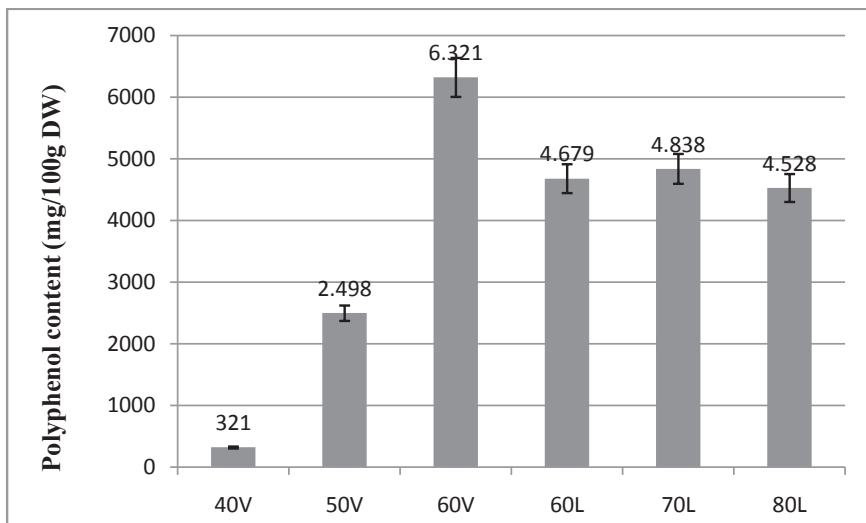


Figure 5: The polyphenol content of the dried samples

Figure 5 shows the polyphenol content of the dried samples. The 60V sample shows the highest polyphenol content. Polyphenol contents yield almost the same values in the case of atmospheric drying.

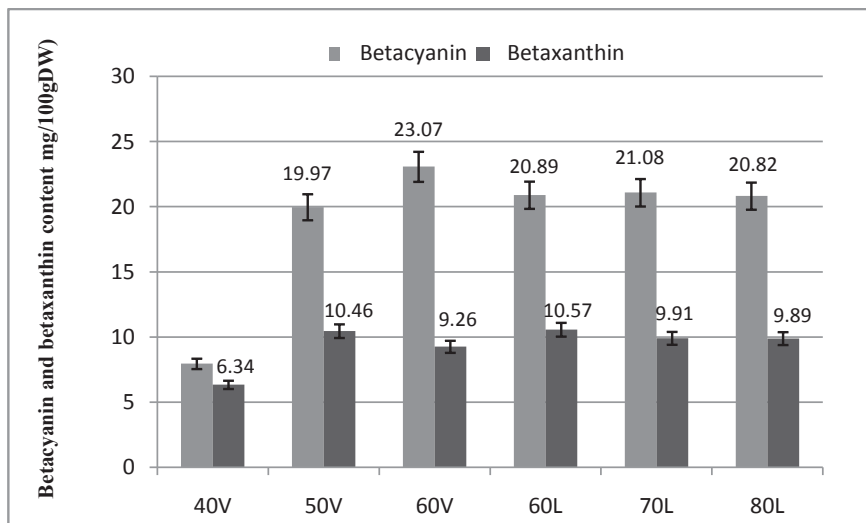


Figure 6: Betacyanin and betaxanthin contents of the dried samples

Based on *Figure 6*, there is a substantial difference between the 40V and the other samples. Betacyanin values do not show remarkable deviation, except for the 40V sample. Betaxanthin content is the highest in the case of the 60V sample.

4 Conclusions

Based on the measurements, vacuum drying is a more favourable method to preserve the nutritional characteristics, but it is necessary to dry the samples for the same moisture content and water activity because high moisture content and water activity affect the extraction and stability of betalain. In the future, it is worth drying samples with same moisture content and investigating the effects of more drying methods and temperatures.

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