

## Physical properties As A Tool For Quality Assessment In Fruit Processing

Tiina Lõugas, Moonika Liis, Katrin Laos and Raivo Vokk

Department of Food Processing, Tallinn University of Technology, Ehitajate tee 5, Tallinn  
19086, Estonia

### ABSTRACT

Some physical properties of 6 most common sea buckthorn berries cultivars in Estonia were studied. The dimensions, size distribution and rupture strength of fruits vary with the species. The geometric mean diameter varied from 10.28 mm to 12.57 mm. The strongest berries were obtained from Podarok sadu variety and the weakest were from Avgustinka variety.

### INTRODUCTION

Sea buckthorn (*Hippophae rhamnoides* L., Elaeagnaceae) is a temperate bush native to Europe and Asia<sup>1</sup>. In addition to the medicinal use, the berries of sea buckthorn may serve as a raw material for different food products. Today it is used as an alternative ingredient for functional food; the berries are especially rich in vitamin C, flavonoids and other bioactive compounds.

The strong association between fruit and vegetable intake and cancer or heart disease prevention has been explained by the content of antioxidant phytonutrients<sup>2</sup>. Besides the commonly mentioned antioxidants (vitamin C, tocopherols and carotenoids), flavonoids can also act as cancer preventing nutrients<sup>2</sup> and contribute significantly to the antioxidative activity of the diet<sup>3</sup>.

Berries firmness is one of the most important characteristics for a fresh market cultivar, which is related to both the stage of maturity and the variety itself. Harvested sea

buckthorn berries undergo various processing operations both on the estate and in the factory, requiring basic information on the physical properties of the sea buckthorn berries. The information on physical properties, such as size, weight and crushing strength of berries are required for the development of the grading system for berries.

The objectives of this work were to evaluate fruit physical properties and carotene content in 6 most common sea buckthorn berries cultivars in Estonia.

### EXPERIMENTAL

#### Materials

Sea buckthorn berries were harvested from different cultivars (Botanitcheskaja, Pertchika, Avgustinka, Trofimovskaja, Podarok Sadu, Gibrid Pertchika, marked as BOR, PER, AVR, TRR, PSR and HPR respectively) grown in Estonia and kept frozen for further studies at -40°C. Freeze-thawed sea buckthorn berries were used for all the experiments in this study. The fruits were cleaned to remove foreign matter.

#### Water activity and moisture content

The water activity of berries was measured with AquaLab CX3 (Decagon, USA). The moisture content was characterized using halogen moisture analyser (Mettler Toledo, Switzerland). The

average values of three replications are reported.

#### Dimensions and size distribution of fruit

In order to determine the size and shape of the fruit, three principal dimensions, namely length, width and thickness, were measured using a micrometer. The geometric mean diameter ( $D_g$ ) of the fruit was calculated by using the following relationship<sup>4</sup>:

$$D_g = (LWT)^{1/3} \quad (1)$$

where  $L$  is the length,  $W$  is the width and  $T$  is the thickness.

According to Mohsenin<sup>4</sup>, the degree of sphericity ( $\Phi$ ) can be expressed as follows:

$$(\Phi) = ((LWT)^{1/3}/L)100 \quad (2)$$

This equation was used to calculate the sphericity of fruits in the present investigation.

To obtain the mass, each fruit was weighed by a chemical balance reading to an accuracy of 0.0001g.

#### Puncture resistance

The puncture resistance of sea buckthorn berries was characterized using a texture analyzer TA-XT2i (Stable Micro Systems, UK).

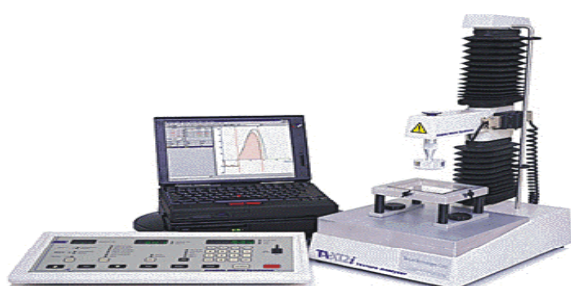


Figure 1. Texture Analyser TA-XT2i (Courtesy of Stable Micro Systems, UK)

The measurements at constant rate 1 mm/s were made with a 5 mm cylindrical probe. The samples were placed centrally on the blank plate, secured on the heavy duty platform, and the probe penetration test is commenced around the mid region of the fruit. The maximum force required to make the puncture on the fruit surface was taken from the force–time curve as shown in Fig.2. The puncture resistance was measured with 15 fruits (replications) and average values are reported.

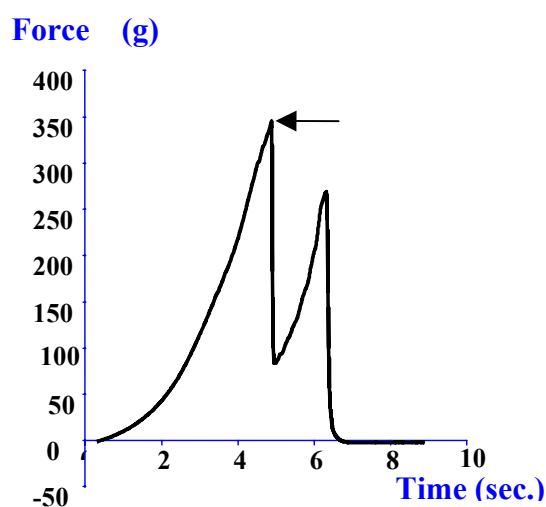


Figure 2. A typical force – time curve for puncture resistance of sea-buckthorn fruit (5 mm diameter solid cylindrical probe, speed:1 mm/s).

#### $\beta$ -carotene content

For the measurement of  $\beta$ -carotene content in different sea buckthorn berry varieties the UV-spectrophotometric method<sup>5</sup> was used.

### RESULTS AND DISCUSSION

#### Water activity and moisture content

Water activity and moisture content was measured in all six species of sea buckthorn berries and the value of water activity is between 0.978-0.986 (Table 1), which is

rather high due to high content of moisture, which is in the range of 84.12-86.87 % (see Table 1).

Table 1. Water activity and moisture content of sea buckthorn berry varieties

	Water activity	Water, %
AVR	0.983	86.87
BOR	0.986	86.86
HPR	0.981	84.74
PER	0.982	85.25
PSR	0.979	86.03
TRR	0.978	84.12

#### Dimensions and size distribution of fruit

Three principal dimensions, namely length, width and thickness, were measured using a micrometer. These data are given in Table 2. The length of the berries is between 12.19-15.24 mm, the longest berries are in Pertchika variety and the shortest are in Podarok Sadu variety. The width of the berries is in the range of 9.23-11.69 mm, the widest berries are in variety Avgustinka and the narrowest are in variety Pertchika.

According to formula 1 there is calculated geometric mean diameter, which is between 10.28-12.57 mm, largest value belongs to Avgustinka variety, the smallest value to Podarok Sadu.

Sphericity is calculated on the assumption of formula 2. The certain values are given in Table 2. This formula takes into account the length, width and thickness of the berries and as a result it is possible to evaluate the shape of the berries. Most spherical berries are in Avgustinka variety; simultaneously most oval berries are in variety Pertchika.

Also there is given the mass of the berries in Table 2. Most lightest berries are in Podarok Sadu variety and they weight 0.51 g. Variety Gibrid Pertchika has the most heavier berries (0.71 g).

#### Puncture resistance

A typical force – time curve for puncture resistance of sea buckthorn fruit is shown in Fig. 2. When the probe moves down onto the fruit, a rapid rise in force is observed. During this stage the sample is deforming under the applied force but there is no puncturing of the tissues. This stage ends abruptly when the probe punctures through the skin and begins to penetrate into the internal tissue of the sample, often called the bioyield point. The bioyield point occurs when the probe begins to penetrate into the fruit, causing irreversible damage. The first peak is the force required to puncture the surface of the sample. The second peak is obtained as a result of the prongs penetrating through the lower surfaces. This peak is due to the movement of the prongs towards the base plate.

It is usually desired that, whilst being ripe, the fruit still maintain a high degree of mechanical strength to protect the fruit from damage, such as bruising, during transport and handling. The rupture force of sea buckthorn berry varieties is shown in Figure 3. As it can be seen, the strongest fruits were from the Podarok Sadu variety (330.22 g) and the weakest was from Trofimovskaja variety (190.76 g).

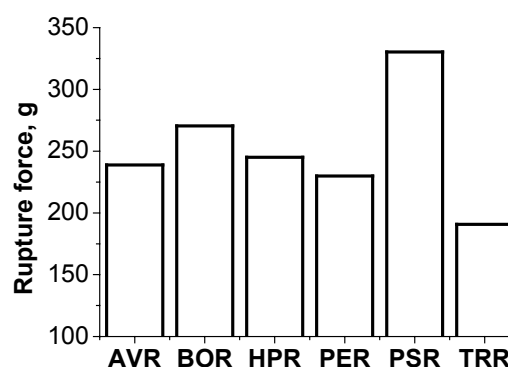


Figure 3. The rupture force of sea buckthorn berry varieties

Table 2. Dimensions and size distributions of sea buckthorn berries

	AVR	BOR	HPR	PER	PSR	TRR
Length, mm	14.53±0.44	12.30±0.67	14.39±0.80	15.24±0.63	12.19±0.66	13.81±0.76
Width, mm	11.69±0.36	9.78±0.54	10.91±0.50	9.23±0.27	9.44±0.37	10.43±0.58
Thickness, mm	11.69±0.36	9.78±0.54	10.91±0.50	9.23±0.27	9.44±0.37	10.43±0.58
Geometric mean diameter, mm	12.57±0,39	10.56±0.58	11.96±0.58	10.91±0.36	10.28±0.45	11.45±0.64
Sphericity, %	86.51±1.01	85.81±1.01	83.12±0.87	71.55±0.80	84.30±0.81	82,97±1.01
Mass, g	0.57±0.02	0.52±0.04	0.71±0.05	0.58±0.04	0.51±0.04	0.64±0.06

How freezing and thawing influence the puncture resistance it can be seen in Figure 4. It appears that rupture force decreases with freezing and thawing.

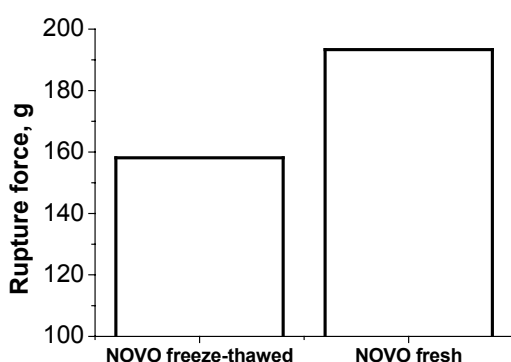


Figure 4. The rupture force of fresh and freeze-thawed sea buckthorn berries

#### β-carotene content

According to the method<sup>5</sup> the content of β-carotene in different sea buckthorn berry varieties was calculated.

The β-carotene content in sea buckthorn berries varies according to the species and is in the range of 9.1-25.3 mg/100g. Results are shown in Figure 5.

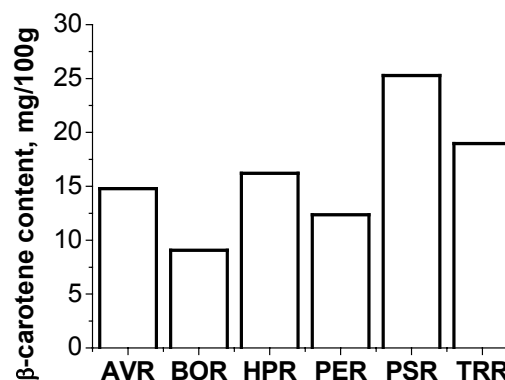


Figure 5. β-carotene content in different varieties of sea buckthorn berries

#### CONCLUSIONS

It is determined the water activity and moisture content of six sea buckthorn varieties, 0.978-0.986 and 84.12-86.87 %, respectively.

Dimensions and size distribution such as mass of the berries is given; also the sphericity of the berries is calculated.

Puncture resistance of sea buckthorn berries is determined.

The β-carotene content in sea buckthorn berries varies according to the species and is in the range of 9.1-25.3 mg/100g.

#### ACKNOWLEDGEMENTS

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