PHYSICAL PARAMETERS OF SEA BUCKTHORN BERRIES

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ABSTRACT

Physical characteristics of sea buckthorn berries in nine different varieties in two different years (1998 and 2005) grown in Estonia are described.

The moisture content, dimensions and size distribution of the berries and also puncture resistance are determined. The moisture content of the berries is in the range of 80-87%. The geometric mean diameter of the berries varies from 8.64 to 12.57 mm. The lowest value of puncture resistance is 199 g and the highest is 304 g. The freezing has some influence on puncture resistance.

INTRODUCTION

Sea buckthorn (*Hippophae rhamnoides* L., *Elaeagnaceae*) is a temperate bush native to Europe and Asia (Rousi, 1971). It was used as a medicinal plant in Tibet already in 900 A.D. (Lu, 1992). In addition to the medicinal use, the berries of sea buckthorn can be processed into products such as juice and marmalade, and be used for flavouring of dairy products because of the unique taste of sea buckthorn berries. Today it is used as a potential functional food ingredient; the berries are especially rich in vitamin C and flavonoids.

During the last 10 years the cultivation of sea buckthorn in Estonia has become more popular – nowadays sea buckthorn plantations exceed 500 ha. Developed under leading professor Trofimov in institute at the Botanic Garden of Moscow University sea buckthorn varieties have mostly been planted in Estonia.

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

study 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 firmness and fruit retention strength in different sea buckthorn varieties.

MATERIALS AND METHODS

Materials

Sea buckthorn berries were harvested in September 1998 and 2005 from different cultivars grown in Estonia (marked as BOL – Botanicheskaja Ljubitelskaja, VOR - Vorobjevskaja, AVR - Avgustinka, TRR - Trofimovskaja, PSR – Podarok Sadu, OTR – Otradnaja, BOR – Botanicheskaja, HPR – Gibrid Pertchika, PER – Podarok Sadu). After some experiments the berries were kept frozen for further studies at -40° C. The fruits were cleaned to remove foreign matter.

Methods

Moisture content

The moisture content was characterized using halogen moisture analyser HR83 (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 (Mohsenin, 1970):

$$D_g = (LWT)^{\frac{1}{3}} \qquad (1)$$

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

According to Mohsenin (1970), the degree of sphericity (Φ) can be expressed as follows:

$$\Phi = \left(\frac{(LWT)^{\frac{1}{3}}}{L} \right) * 100 \qquad (2)$$

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

To obtain the mass of the berries, 30 fruits were weighed by a chemical balance AB204 (Mettler Toledo, Switzerland) reading to an accuracy of 0.0001g before they were frozen.

Puncture resistance

The puncture resistance of sea buckthorn berries was characterized using a texture analyzer TA-XT2i (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. 1. The puncture resistance was measured with 15 fruits (replications) and average values were reported.

RESULTS AND DISCUSSION

Moisture content

The moisture content was measured in all nine species of sea buckthorn berries. The average values of three replications are reported and are presented in Table 1. The values are in the range of 84.12-86.87 % and 80.33-85.82 % in 1998 and 2005, respectively.

Table 1 The moisture content and the mass of the berries collected in autumn 1998 and 2005

Sea buckthorn berry variety	Moisture content, %		Mass of the berries, g	
	1998	**2005**	**1998**	**2005**
AVR	86.87	85.82	0.57	0.60
BOL		83.66		0.76
BOR	86.86		0.52	
HPR	84.75		0.69	
OTR		82.41		0.65
PER	85.25		0.57	
PSR	86.03	80.33	0.50	0.49
TRR	84.12	83.45	0.65	0.85
VOR		83.83		0.76

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 in 1998 and 10.64-13.71 mm in 2005, the longest berries in 1998 are in Pertchika variety and the shortest are in Podarok Sadu variety, but in 2005 Botanitcheskaja Ljubitelskaja and Podarok Sadu, respectively. The width of the berries is in the range of 9.23-11.69 mm in 1998 and 7.79-9.03 mm in 2005, the widest berries in 1998 are in variety Avgustinka and the narrowest are in variety Pertchika, in 2005 Trofimovskaja and Podarok Sadu, respectively.

Table 2 Dimensions and size distributions of sea buckthorn berries

	Year	Length, mm	Width, mm	Thickness, mm
AVR	1998	14.53±0.44	11.69±0.36	11.69±0.36
	2005	10.77±0.49	8.69±0.42	8.69±0.42
BOL	2005	13.71±0.67	8.60±0.41	8.60±0.41
BOR	1998	12.30±0.67	9.78±0.54	9.78±0.54
HPR	1998	14.39±0.80	10.91±0.50	10.91±0.50
OTR	2005	12.14±0.56	8.52±0.40	8.52±0.40
PER	1998	15.24±0.63	9.23±0.27	9.23±0.27
PSR	1998	12.19±0.66	9.44±0.37	9.44±0.37
	2005	10.64±0.51	7.79±0.36	7.79±0.36
TRR	1998	13.81±0.76	10.43±0.58	10.43±0.58
	2005	13.64±0.50	9.03±0.21	9.03±0.21
VOR	2005	12.52±0.56	8.47±0.38	8.47±0.38

	Year	Geometric mean diameter, mm	Sphericity, %
AVR	1998	12.57±0.34	86.53±1.81
	2005	9.34±0.40	86.75±2.48
BOL	2005	10.01±0.43	73.43±1.83
BOR	1998	10.55±0.53	85.85±2.88
HPR	1998	12.00±0.53	83.43±2.07
OTR	2005	9.60±0.38	79.27±2.81
PER	1998	10.90±0.30	71.59±2.06
PSR	1998	10.28±0.42	84.36±2.13
	2005	8.64±0.36	81.20±2.43
TRR	1998	11.46±0.64	82.92±2.62
	2005	10.36±0.25	75.99±1.57
VOR	2005	9.65±0.40	77.13±2.14

According to the formula 1 calculated geometric mean diameter is between 10.28-12.57 mm in 1998 and 8.64-10.36 mm in 2005, largest value belongs in 1998 to Avgustinka variety, the smallest value to Podarok Sadu, in 2005 Trofimovskaja and Podarok Sadu, respectively.

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 in 1998 are in Avgustinka variety; simultaneously most oval berries are in variety Pertchika, in 2005 also Avgustinka and Botanitcheskaja Ljubitelskaja, respectively.

Also the mass of the berries is given in Table 1. The lightest berries in 1998 are in Podarok Sadu variety (0.51 g), in 2005 the same variety has the lightest berries (0.49 g). Variety Gibrid Pertchika in 1998 and Trofimovskaja in 2005 have the heaviest berries, 0.71 and 0.85 g, respectively.

Puncture resistance

A typical force-time curve for puncture resistance of sea buckthorn fruit is shown in Figure 1. 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.

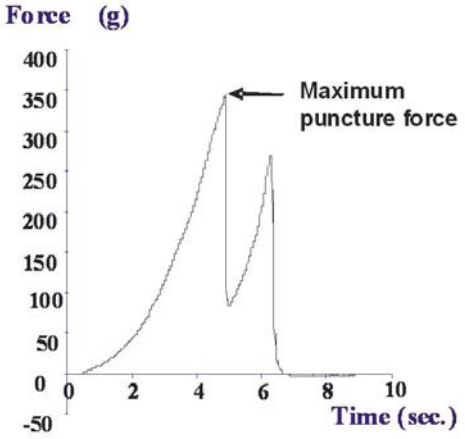

Figure 1
A typical force-time curve for puncture resistance of sea buckthorn fruit (5 mm diameter solid cylindrical probe, speed: 1 mm/s).

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 before and after freezing in two different years is shown in Figure 2.

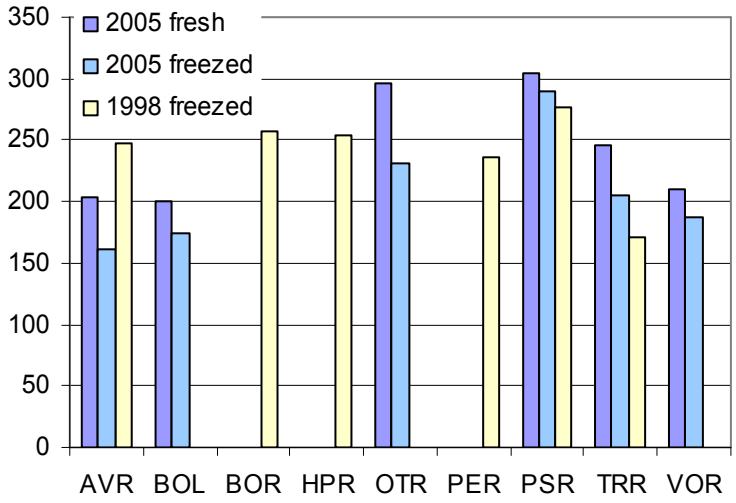

Figure 2
The rupture force of sea buckthorn berries (g)

As it can be seen, the strongest fruits were from the Podarok Sadu variety (303.87 g) and the weakest were from Botanitcheskaja Ljubitelskaja variety (199.43 g). The puncture resistance of the berries is influenced by freezing and defrosting, as it can be seen also on Figure 2. The fresh berries are stronger than the berries which are freezed and melted. The puncture resistance decreases after defrosting differently,

variety Otradnaja has the biggest decrease (65 g) of the puncture resistance. As all the characteristics of the berries are influenced by climatic and other conditions, we can see, that the puncture resistance is not the exception – some varieties of berries collected in 1998 have higher values of puncture resistance after freezing than berries collected in 2005 (see Figure 2, variety Avgustinka).

Physical parameters of some sea buckthorn varieties were determined for better variety selection.

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