

## Sensory and texture characterisation of plum (*Prunus Domestica*) fruit leather

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The dried fruit leather (pestil) is a well-known traditional healthy food in Bulgaria and Turkey with high antioxidant content. The products were produced and technology was developed based on plum with the addition of pressings (3, 5 and 10%) of *Aronia melanocarpa* Elliot in combination with *Rubus idaeus*, *Rubus fruticosus* and bee honey. Tasting card and intensity scales of sensory indicators were developed for the relative control of nine products. Fruit leather, with addition of 5% pressings (regardless of composition) showed the slightest differences in the organoleptic indicators compared with the control. Instrumental texture parameters were examined by texture profile analysis (TPA). Some correlations were established between the textural and sensory parameters.

**Keywords:** pestil, healthy food, new technology, waste processing, organoleptic parameters, texture profile analysis

### INTRODUCTION

**Pestils** (Fruit leather) are traditional food in some parts of Bulgaria and Turkey. These are prepared from concentrated fruit juices, mashes such as berries, apple, plum, cornel, grapes and others, which are grown regional in the countries. Traditionally used other ingredients are honey, sugar, starch or milk depending on the places. The ingredients and production technology must be studied in parallel way because they influence the physico-chemical and sensory parameters as well [1]. The dried fruit leather has high nutritional value rich in vitamins, minerals and energy. These parameters are highly related to the processing technology (process temperatures for concentration and drying) and to the quality of raw materials [2-5]. The fruit leather can be consumed like a nutritious breakfast, snack or dessert [6].

The **texture** of fruit leathers is affected by the moisture content and drying temperature [4, 7]. The longer drying or higher temperature cause usually harder texture. The differences in texture could also be due to genetic make-up of fruit, rate of water absorption from the surroundings or protein content [8] of the fruits and sugar addition as well [6, 9, 10]. The high sucrose content reinforces the sugar-acid-high methoxyl pectin gelation [6]. The added citric acid decrease the pH which supports the undissociated carboxyl groups of pectins and support the gel structure [6]. Based on the literature there are significant differences between the sensorial and instrumental texture readings [11] because the human mouth is more complex in

measuring like the penetrometers. The texture of the leather can be improved by adding maltodextrin, coconut oil or chopped nuts [9].

The drying of the leather causes **colour** and **appearance** changes of the final product. The lighter leathers tend to darker and turn to brown or lost the yellow-orange colour because the pigments are sensitive to temperature [8]. The browning of the leather could be related to the non-enzymatic vitamin C oxidation or enzymatic oxidation of polyphenols as well [12].

The **aroma** of products results from volatile substances in the fresh food such as esters, ketones, aldehydes, terpenes and others [13, 14]. The loss of these volatiles leads to a decrease in aroma detection. Based on some authors the addition of honey or sugar can be enhance the aroma of leathers [6, 9] but the sugar level above the optimum decrease the flavour rating [10].

The **taste** of the leather can be affected by the sugar level of the raw materials and by added sugar to the optimum level [10]. The aroma and the taste correlates with each other and can be improve with optimum sugar or honey addition [9, 14].

The **plum** fruits are rich in organic acids, pectin, tannins, mineral salts and vitamins and along with its taste qualities have curative effect – stimulated heart function and digestion, helping to dispose of the body of toxic substances and cholesterol. Plums prevent osteoporosis and strengthen bones [15]. **Chokeberries** are high in polyphenolic compounds, such as anthocyanins. The name "chokeberry" comes from the astringency of the fruits, which create a sensation making one's mouth pucker. Their also reduce the blood cholesterol [16, 17]. The black berries contain both soluble and

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insoluble dietary fibre, vitamin C, and vitamin K. Their seeds contain oil which is rich in omega-3 (alpha-linolenic acid) and omega-6 fats (linoleic acid) as well as protein, dietary fiber, carotenoids, ellagitannins and ellagic acid [16-20]. **Raspberries** are also high in fibre, antioxidants and in vitamin C. They have anti-inflammatory properties as well [21].

The aim of this study was develop and characterize the sensory and texture properties of new fruit pestil formulas from plum (*Prunus Domestica*) with the addition of pressings from dried fruits (3, 5 and 10%), *Aronia melanocarpa Elliot* in combination with *Rubus idaeus*, *Rubus fruticosus* and bee honey.

### EXPERIMENTAL DETAILS

#### Technology development

Nine fruit leather (pestil) combination were developed from puree of plum fruit (*Prunus Domestica*), and dried fruits (3, 5 and 10%) chokeberry (*Aronia melanocarpa Elliot*) in combination with raspberry (*Rubus idaeus*),

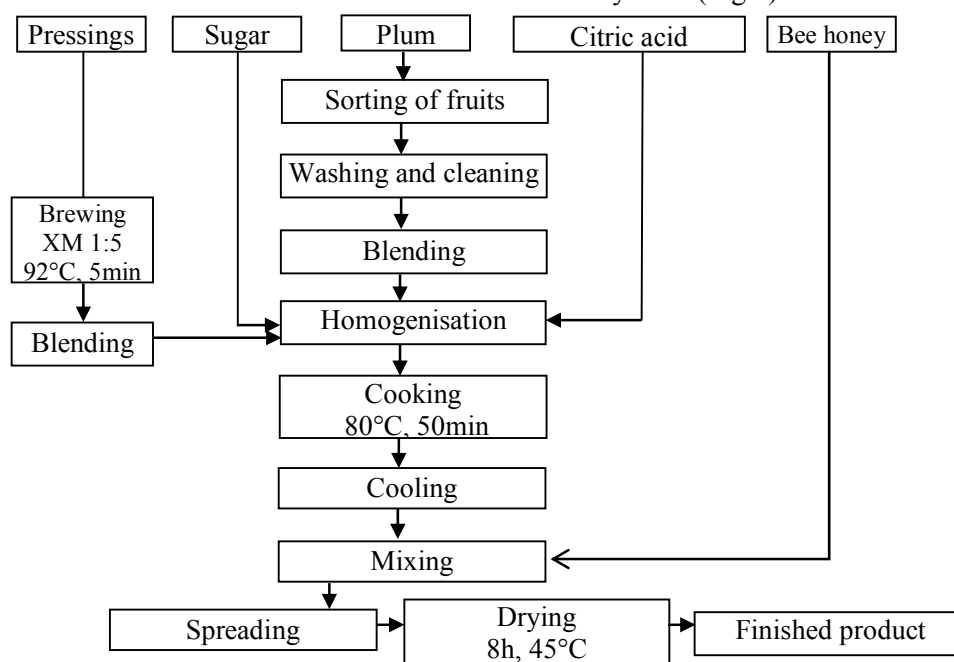
blackberry (*Rubus fruticosus*) and bee honey (3%) (Table 1) [6].

**Table 1.** Formulation of fruit pestils\*

Composition	Suppl., %	Puree of plums, %	Dry content, db%		Aw
			puree	pestil	
Plum	0	74.85	65.80	77.0	0.502
	3	71.85	55.66	66.9	0.542
	5	69.85	54.90	62.0	0.523
Plum+ Chokeberry	10	64.85	54.44	60.0	0.476
	3	71.85	52.14	64.0	0.460
	5	69.85	52.61	62.0	0.472
Plum + Chokeberry with blackberry	10	64.85	61.56	71.0	0.486
	3	71.85	52.10	64.0	0.486
	5	69.85	51.93	61.0	0.476
Plum + Chokeberry with raspberry	10	64.85	61.41	74.0	0.462

\* Sugar 22 %; Honey 3 %, Citric acid 0.15 %.

The puree combinations (without honey) were cooked at 80-85°C temperature up to 55-60% dry content. The prepared puree formulations were dried with convective hot air drying method [5] at 45°C for 7-8 hours to 65-70 % dry content in a laboratory drier (Fig.1).



**Fig.1.** Flow diagram of the developed technology

**Water activity** of the samples is measured by AquaLab Series 3 instrument with chilled-mirror dew-point sensor (Table1).

#### Sensory analysis

Qualitative indicators (appearance, colour, smell, taste, texture) of pestil were studied based on the Bulgarian standard of honey bee (BDS 3050-80) [22]. A consumer acceptance/preference test

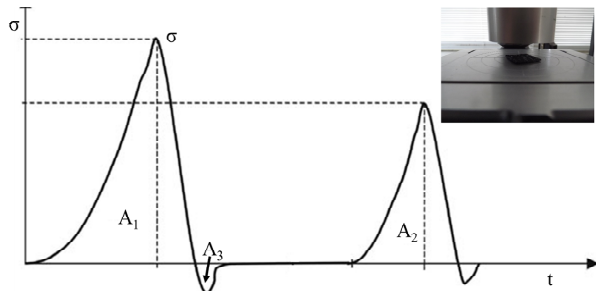
was performed according to method of profiling (EN ISO 8586:2014) [23].

The test-card and acceptance scales were developed for the sensory intensities of the indicators (from 1 to 7) for relative control of the nine (9) developed products. Twelve (12) trained panelist have been selected to ensure the accuracy of the assessment. Randomly coded samples were

presented simultaneously to the evaluators. Sensory profile diagrams were formed based on the statistically analysed data.

*Texture analysis*

The texture of leather sheets was determined using a Stable Micro System texture analyzer; model TA.XT.Plus (Godalming, Surrey, UK). A texture profile curve was obtained with 2 loading and 5 s time for relaxation between them. A cylindrical probe ( $\varnothing=50$  mm) was used. The instrument was set at a test speed of  $1\text{ mm}\cdot\text{s}^{-1}$  and a strain of 70 %. (Fig.2).



**Fig.2.** Texture profile analysis and parameters

Firmness stress ( $\sigma$ ) is determined as the maximum stress coordinate of 1<sup>st</sup> peek of the curve. The adhesiveness (work of detachment –  $A_3$ ) can be defined like the stress, necessary to pull up the measure probe after the 70 % compression

(negative integrated area), cohesiveness defined as the ratio between the 2<sup>nd</sup> and 1<sup>st</sup> loading area ( $A_2/A_1$ ) and gumminess was computed like cohesiveness multiplied by the firmness. (Fig.2) [24, 25].

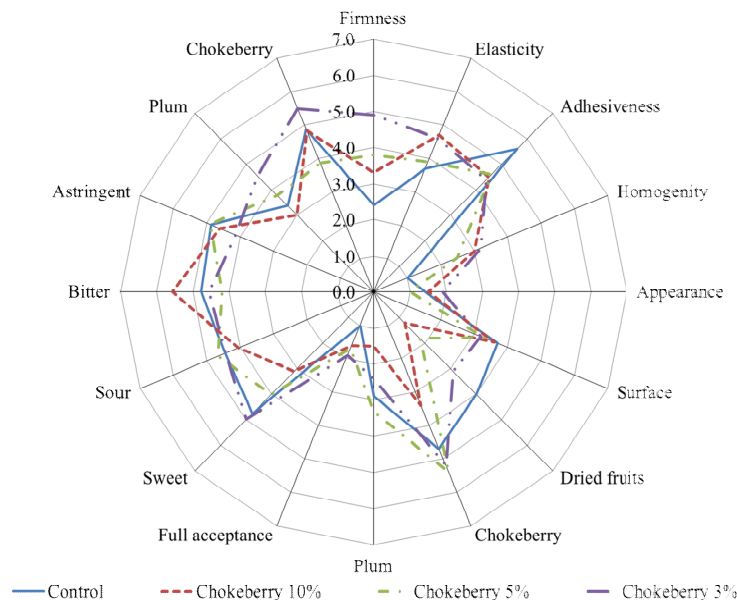
**RESULTS AND DISCUSSION**

*Sensory analysis*

The sensory parameters are one of the most important properties of food products. Fruit leather from plum with 3 % chokeberry based on the points of the panelists for the *consistence* parameters is firmer than with higher concentrations. It has glossy surface, high elasticity and is not sticky. Because of added pressings, they do not show homogeny consistency. The panelists note that these probes have attractive appearance (Fig.3).

The *aroma profile* of chokeberry is highly expressed with 10 % added pressings. The most balanced aroma of fruit leathers comes from plum and 3% dried chokeberry. The indicator of common perception in all developed formulations of chokeberry is highly pleasant (Fig.3).

Based on the *taste profile* of fruit leathers the variant with 10 % chokeberry is the sweetest and shows the nearest plum’s taste like the control. The astringent taste of chokeberry is not perceptible for all concentrations and there is no sour taste (Fig.3).



**Fig.3.** Sensory profile for fruit leather from plum with chokeberry

It has been found that the pestil probes with chokeberry and blackberry (5% and 10%) are characterized with soft *consistency* in comparison with those with 3% additive. These variants are glossy near like the control and have less elastic consistency than the sample with 10 %. The

adhesiveness of these probes are smaller than the control. Although, these probes have attractive appearance (Fig.4).

It was found (Fig.4) that in plum fruit leathers with chokeberry and blackberry in at all concentrations, the *aroma* of dried fruit is strong,

but different from that of the control. Definitely, the aroma of plum prevails over that of chokeberry, while higher concentrations of blackberry flavor is more pronounced. Like samples with chokeberry the indicator of common perception, it is from highly pleasant to pleasant.

The pestils with 5% and 10% of chokeberry and blackberry have most pronounced sweet and sour *taste* but not pronounced bitter and astringent taste. All variants have taste near to the control but with higher concentration of blackberry, they show more dominant blackberry taste. The variants do not show bitter taste (Fig.4).

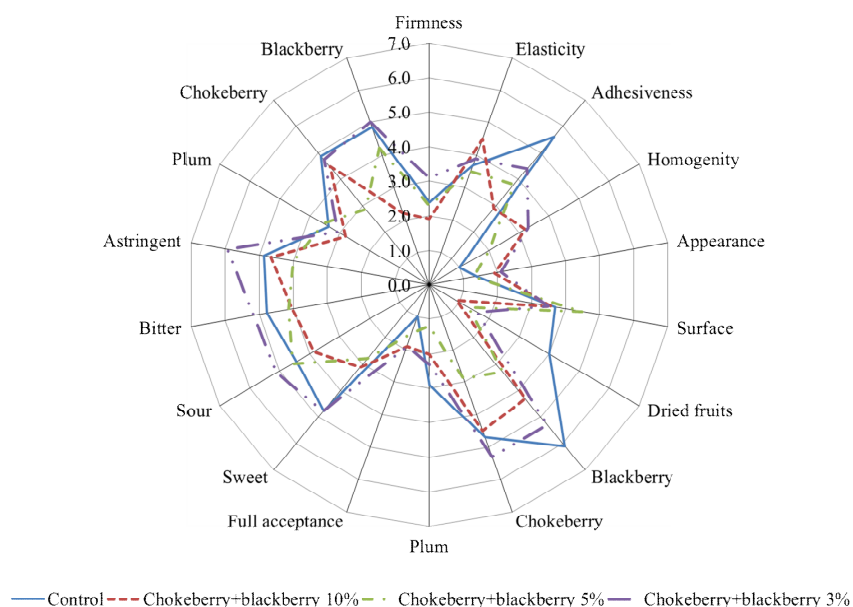


Fig.4. Sensory profile for fruit leather from plum with chokeberry and blackberry

The consistency profile (Fig.5) shows fruit leathers with 10 % chokeberry and raspberry are more in glossy and adhesiveness, but less in

firmness and homogeneity like the control. Their appearance is attractive also like the control.

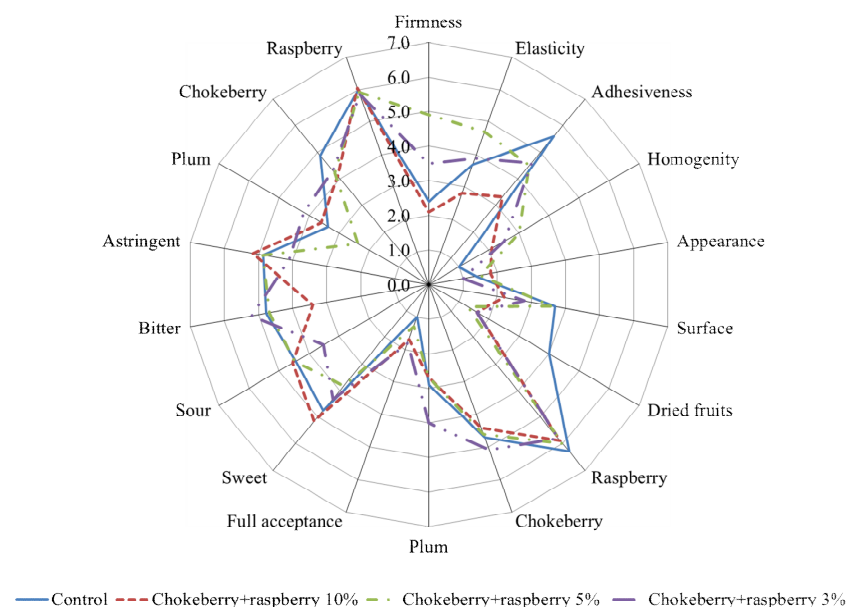


Fig.5. Sensory profile for fruit leather from plum with chokeberry and raspberry

The panelists note that the *aroma* of raspberry is less pronounced. In the variants with raspberry, the plum has with the dominant aroma, not like in the

others. The general perception is from highly pleasant to pleasant (Fig.5).

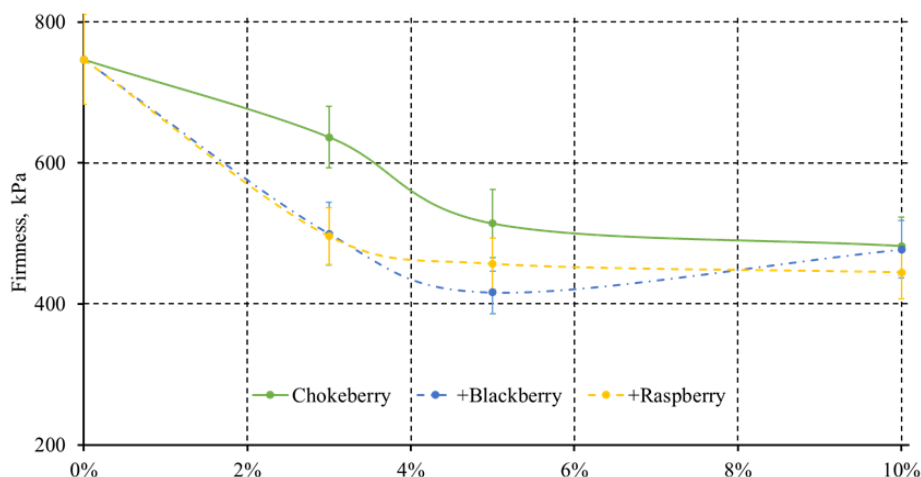
Fruit leathers with 3% and 5% chokeberry and raspberry are sweets, near to the control. The *taste* of the plum is more pronounced for variants with 3% and 10% and pronounced for 5%. Taste of the chokeberry is also a dominant in all concentrations. The taste was stated like not astringent rather bitter for these probes, but with 10% chokeberry and raspberry the taste is not astringent and not bitter as well (Fig.5).

Based on other studies for sensory *consistency* parameters of fruit leather the harder products have with usually higher acceptance level but the adhesiveness and the elasticity are also important performers of mouth filling [1]. The addition of pressings detrimental to the homogeneity but may provide higher appearance level (attractive). The higher adhesiveness level decrease the acceptance of the products [2].

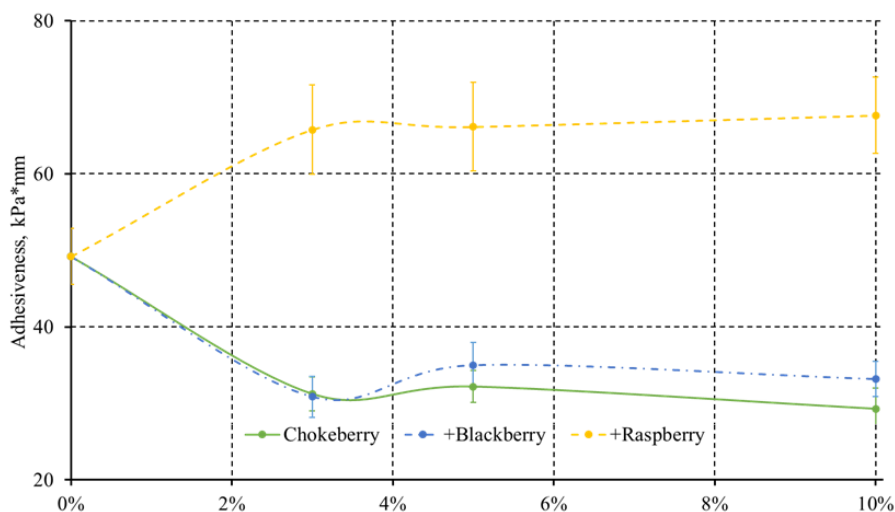
### Texture profile analysis

The instrumental texture analysis gives a more objective results for the texture but just the complex systems of the parameters can be compare with the results of the sensory analysis [11]. These parameters can improve the descriptions of the products with goal to help the development of the technology and better quality indicators of the product.

The product with added pressings has lower *firmness* (Fig.6). It is maybe the result of the brewing during the technological procedure. Based on this result the probes with more added pressings show softer texture but just up to 5% concentration. The softest texture was reached with 5 % chokeberry+blackberry combination. That result is in correlation with the sensory analysis. The higher firmness values obtained with chokeberry is the result maybe the higher pectin content of these fruits.



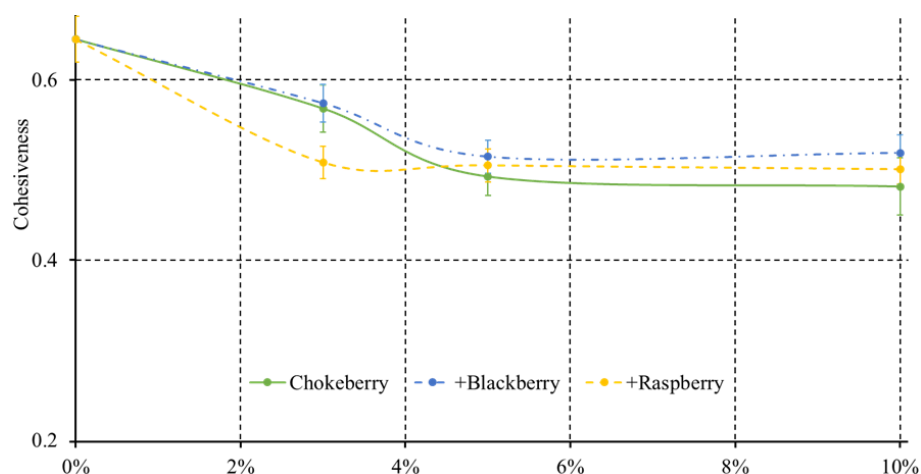
**Fig.6.** Instrumental firmness for fruit leather from plum with added chokeberry, chokeberry + blackberry and chokeberry + raspberry



**Fig.7.** Instrumental adhesiveness for fruit leather from plum with added chokeberry, chokeberry + blackberry and chokeberry + raspberry

The adding of raspberry pressings increased the *adhesiveness* but just up to 3 % concentration. Based on our results the addition of chokeberry and blackberry pressings decreased the adhesiveness but also just in smaller concentrations. The result is very similar like the opinion of the panelists about adhesiveness (Fig.7).

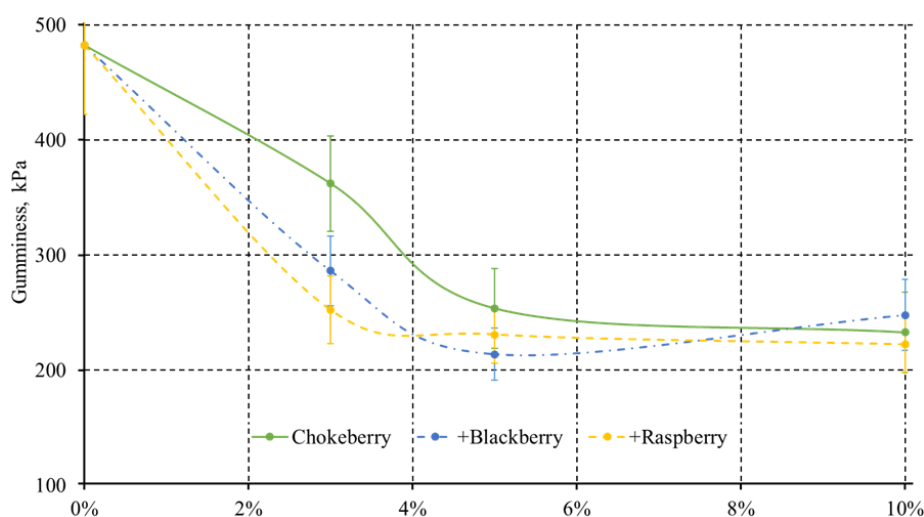
The addition of pressings in smaller concentration lowered the *cohesiveness*. The highest lowering effect was encountered with 3% raspberry. With higher concentrations, the differences between the added pressings are very small. The lowering the cohesiveness means the ability for relaxation is smaller or the differences between the deformability are higher (Fig.8).



**Fig.8.** Instrumental cohesiveness for fruit leather from plum with added chokeberry, chokeberry+blackberry and chokeberry+raspberry

The effect of added pressings for *gumminess* is very similar like for the cohesiveness. There are differences between the samples just with 3 %

added pressings. Added chokeberry pressings show smallest lowering effect (Fig.9).



**Fig.9.** Instrumental gumminess for fruit leather from plum with added chokeberry, chokeberry+blackberry and chokeberry+raspberry

#### Correlation analysis between the parameters

Correlation analysis between the parameters shows higher negative correlation between the concentration of added pressings and cohesiveness and gumminess ( $r = -0.8171$  and  $r = -0.7966$ ). The

adhesiveness does not show correlations with any other parameters. There are very high correlations between hardness and cohesiveness and gumminess ( $r = 0.9209$  and  $r = 0.9910$ ). These results are very similar like in the literature from Al-Hinai et.al for date-tamarind leather [11].

## CONCLUSION

The developed technology drives to stable product with low water activity.

The fruit leather is a soft product and has to be with low adhesiveness for high acceptance from the panelists.

The instrumental texture analysis also leads to a complex parameter system, which has correlation to sensorial texture parameters.

Based on literature reviews for fruit leathers there are not unified criterions about physicochemical characteristics of pestils [6]. This study gives information about texture and sensory parameters of fruit leathers. The used parameter systems can describe the correlations between the consumer acceptance and the texture, ingredients, technology parameters.

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