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Sensory Profile of Plum Nectars

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Summary

Nectars are beverages formulated with the juice or pulp of one or more fruits, with addition of water and sugar in various proportions depending on local taste, government standards, pH, and fruit composition of the variety used. Recently, the market for such products has greatly expanded. Consumers are looking even more for food with pleasant characteristics in terms of flavor, appearance and aroma. In this study, plum nectar samples, prepared by various recipes, were sensory evaluated to describe and compare its sensory characteristics.

Plum (Prunus domestica L.*) fruit was used to produce cloudy juice with small scale laboratory equipment. Before pressing on hydraulic press, fruits were depitted and chopped and treated with maceration enzymes at 48 ºC during 2 hours. After pressing, cloudy juice was pasteurized and used to produce plum nectars formulated to 12 % Brix with various contents of fruit (30 % or 60 %), with sucrose or fructose and addition of citric or malic acid. All prepared nectars were sensory evaluated by quantitative descriptive analysis (QDA).*

A research using different nectars showed significantly better overall acceptance for a products formulated with 60 % as compared to those produced with 30 % of fruit content ($p<0.05$). The sensory acceptance of nectars was not significantly affected by addition of different sugars or acids ($p<0.05$). Without influence of fruit content, sugar or acid addition, sensory attributes of aftertaste, tartness and off flavour were not expressed.

Nectar with 60 % of fruit content, added sucrose and citric acid was evaluated as the most drinkable with high scores for all desirable attributes. The least accepted nectar was one with fruit content of 30 %, added fructose and mallic acid. Thus, some products presented good sensory acceptance suggesting commercial potential.

Keywords: plum nectar, sensory evaluation, QDA

Introduction

There is a significant growth in the fruit juice market throughout the world, which has attracted the attention of fruit growers, fruit juice producers and distributors (Anonymous, 2010). Europe accounted for the largest part of the global fruit beverage market (46.6 %) in 2009, while North and South America accounted for 36.8 % of the market. In 2009, fruit drinks made up the largest part of the global fruit beverage market (27.8 % of total market value). Nectars made up the second smallest segment (16.3 %), which indicated a major potential for the development of fruit nectars.

According to the Regulations on fruit juices and related products fruit nectar (National Regulations NN 155/08) is defined as any product which is not fermented, but it can ferment, made from juice of one or more types of fruit, and is produced by adding water and sugar and/or honey. It is permitted to add sugar and/or honey in quantities up to 20 % of the total weight of the finished product. In the production of fruit nectar with no added sugar or reduced energy value of nectar, the sugar can be completely or partially replaced by sweeteners. For the production of fruit nectar, the use of sugar prescribed by a special regulation on sugars intended for human consumption is allowed, just like the use of fructose syrup and sugar derived from fruit. In order to correct taste, instead the addition of organic acids, it is allowed to add lemon juice and/or concentrated lemon juice in a quantity up to 3 g/L juice expressed as anhydrous citric acid. Moreover, according to the Regulations, some substances as pectolytic and amilolytic enzymes and tannins can be used, too.

Although plums and plum beverages are characterised as functional foods rich in polyphenolic compounds and are thus considered to possess many beneficial, health-promoting properties, there are not many commercial plum beverage products currently available on the Croatian market. Large quantities of produced plums in Croatia are used for both consumption of fresh and processing, especially for jam products, the production of brandy, and drying.

Plums are known to contain not only various sugars, acids, pectins, tannins and enzymes, but also polyphenolic compounds (Walkowiak-Tomczak et al., 2008), which bear many health-promoting properties (Chong et al., 2010, Hooshmand and Arjmandi, 2009, Thomasset et al., 2006). Plum skin is considered a greater source of polyphenolic compounds than plum flesh (Nunes et al., 2008). Additionally, plum juice was found by Shukitt-Hale et al. (2009) to inhibit age-related cognitive decline in rats. It is, however, known that polyphenolic compounds can contribute to the development of astringency, an important mouthfeel attribute, which can easily become disadvantageous (Robards et al., 1999). Plums also have relatively high organic acid content (Gil et al., 2002). Consumer acceptance of the plum beverages might therefore not only be influenced by possible high levels of acidity, but also by possible high levels of astringency caused by plum skin extract addition (Brossaud et al., 2001).

Sensory analysis is often used to determine the acceptability of a newly developed product. A common sensory technique is quantitative descriptive analysis (QDA), which is often used to describe the sensory characteristics of the samples. These include flavour, mouthfeel, aftertaste and visual aspects of the samples (Lawless and Heymann, 1998). The goal of descriptive analysis is to provide a quantitative specification of the important sensory aspects of a product and to determine the nature and intensity of attributes in a sample under investigation (Kader, 1999; Gimenez et al., 2001). Important quality attributes for fresh consumption were found to be colour attributes, taste and flavour attributes and texture attributes. The quality of processed fruits differs considerably from that of fresh fruits, though the aim of the industry is to conserve the quality of fresh fruits in best way.

Since consumers are looking even more for food with pleasant characteristics in terms of flavor, appearance and aroma, the aim of this study was to sensory evaluate, describe and compare sensory characteristics of plum nectars, prepared by various recipes.

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Table 1. The list of all investigated samples

Sample	Fruit content (%)	Sugar	Acid
A	30	Sucrose	Citric
B	30	Sucrose	Malic
C	30	Fructose	Citric
D	30	Fructose	Malic
E	60	Sucrose	Citric
F	60	Sucrose	Malic
G	60	Fructose	Citric
H	60	Fructose	Malic

Materials and Methods

Materials

Plum (*Prunus domestica* L.**)** fruit, of commercial mature, was used to produce cloudy juice with small scale laboratory equipment (Euclid Ltd., Croatia). Before pressing on hydraulic press, fruits were depitted and chopped and treated with maceration enzymes at 48 ºC during 2 hours. Since the plum nectar should have a minimum of 30 % fruit juice (v/v), after pressing, cloudy juice was pasteurized and used to produce plum nectars formulated to 12 % Brix with various contents of fruit (30 % or 60 %), with sucrose or fructose and addition of citric or malic acid. Besides commonly used citric acid, malic acid was used due to its prevalence in plum fruit in order to investigate its influence on sensory attributes. Previous sensory investigations in our Laboratory showed that fruit products with fructose obtained higher scores for several taste attributes in comparison to the same products with added sucrose. Therefore, the goal was to compare the influence of two different sugars on evaluated sensory attributes. The list of all samples are presented in Table 1.

Methods

Sensory evaluation

All prepared nectars were sensory evaluated by quantitative descriptive analysis (QDA). Sensory analysis of all samples was carried out by a trained panel consisting of fifteen members per two sessions. Their age ranged from 22-50 years old. The procedure was performed according to methods described in ISO 6564, ISO 8587 and ISO 11036 (in a sensory laboratory equipped according to ISO 8589). The vocabulary used in this evaluation was based on a vocabulary for analysis of fresh fruits, previously used in the same laboratory. After a series of discussion sessions, the panellists were requested to list the terms appropriate to describe the colour, odour, taste, consistency and overall sensory impression, whereas a total of ten descriptive terms were generated. The descriptive terms are listed in Table 2.

Table 2. Description of sensory attributes used in sensory evaluation

Sensory attribute	Descriptive term	Description
Colour	Intensity	Total intensity of colour pigments in the sample
Odour	Intensity	Total strength of all odours in the sample
	Off-odour	Not possible to pick out one particular odour type of fruit
Taste	Sour	Acidulous taste
	Sweet	Taste of sucrose
	Harmonious	Related to pleasing combination of elements in a whole: sourness and sweetness together
	Aftertaste	Taste intensity of a food or beverage that is perceived immediately after that food or beverage is removed from the mouth
	Astringency	Drying-out, roughening, and puckery sensation felt in the mouth
Consistency	Homogeneous	Well-arranged or disposed, with no constituent lacking or in excess
Overall sensory impression	-	Assessment based on a combination of all characteristic attributes contributing to sensory quality

The samples were served in two replicates on colorless plastic cups, and in each cup was approximately 30 mL of sample. All samples and replicates were coded with three-digit random numbers and served in randomized order. The panelists rinsed the mouth with salt-free bread and water between each sample. The panelists scored the samples for every characteristic in the vocabulary, using a suitable line intensity scale, with scores awarded on a scale of 0 –10 to show the relative intensity of each attribute, in which 0 indicated total absence ('none') of the sensory attribute and 10 a very definite attribute ('intense').

Statistical data analysis

Descriptive analysis was performed via analysis of variance (ANOVA) using Statistica v. 9 (Statsoft Inc, Tulsa, OK, USA) in order to compare all significant differences between intensity of each sensory attribute of different plum nectars. To that goal, each sensory attribute was a subject to a separate ANOVA, aimed at analyzing the first-line (non-interactive) effects of a number of independent categorical variables (fruit content, sugar, acid). Differences were considered significant at p<0.05.

In addition, principal component analysis (PCA) was applied (Statsoft Inc, Tulsa, OK, USA). The score plot may be regarded as a map of samples, showing the locations of the samples along each model component. It can be used to detect sample patterns, groupings, similarities or differences. Parallel to scores, the estimated loadings may be regarded as a map of variables. The loadings show how well a variable is taken into account by model components. Loading plots can be used to show how much each variable contributes to the meaningful variation in the data, and to interpret variable relationships.

Results and Discussion

Currently, limited literature is available on plum juices or nectars regarding sensory properties. This study characterises and compares eight plum nectars that differ in terms of fruit content (30 % and 60 %), sugar type (sucrose and fructose) and the addition of acid (citric and malic acid).

The ANOVA showed significant differences regarding sensory attributes between fruit content of plum nectars. The results obtained showed that between plum nectars with various fruit content there were significant differences in colour intensity, homogeneous consistency, odour intensity, sour and sweet taste as well as overall sensory impression (p<0.05). Sensory differences were not observed regarding the sugar and acid addition (Table 3).

Spider's web plots of the samples, averaged across the panel, are shown in Figures 1 and 2. Appearance is major determinant of quality and the data pertaining to colour scores in revealed that the plum nectar with higher fruit content (60 % *vs.* 30 %) generally showed an increase of colour score. Among nectars with fructose, those with malic acid were characterized by the slightly higher pronounced colour in comparison

Table 3. *Significant differences in the intensity of sensory attributes arising due to differences in fruit content of nectars (30 % or 60 %), sugar (sucrose or fructose) and acid (citric or malic acid)*

Sensory attributes	Main effects	F_{exp}	p value
Colour intensity	Fruit content	250.58*	0.0001*
	Sugar	0.05	0.8298
	Acid	4.26	0.1079
Homogeneous consistency	Fruit content	16.64*	0.0151*
	Sugar	1.19	0.3352
	Acid	5.23	0.0840
Odour intensity	Fruit content	57.52*	0.0016*
	Sugar	3.26	0.1452
	Acid	1.17	0.3395
Astringency	Fruit content	0.04	0.8379
	Sugar	0,04	0.8379
	Acid	0,04	0.8379
Off-odour	Fruit content	1.00	0.3739
	Sugar	2.77	0.1709
	Acid	1.00	0.3739
Sour taste	Fruit content	9.20*	0.0386*
	Sugar	0.01	0.9311
	Acid	1.90	0.2399
Sweet taste	Fruit content	15.21*	0.0175*
	Sugar	1.24	0.3275
	Acid	1.01	0.3726
Harmonious taste	Fruit content	22.53*	0.0090*
	Sugar	0.22	0.6597
	Acid	0.90	0.3962
Aftertaste	Fruit content	7.00	0.0572
	Sugar	7.00	0.0572
	Acid	0.14	0.7246
Overall sensory impression	Fruit content	9.92*	0.0345*
	Sugar	0.78	0.4276
	Acid	0.14	0.7246

*Significant differences obtained at the significance level of p<0.05

to those with citric acid. Between nectars with sucrose, those with 30 % of fruit content and malic acid and with 60 % of fruit content with citric acid were slightly higher scored for colour intensity but this differences were not significant ($p<0.05$).

Taste is described by five gustatory perceptions, sweetness, sourness, saltiness, umami and bitterness, caused by soluble substances in the mouth (Meilgaard et al., 2007). The five tastes are mainly caused by the presence of respectively sugars, organic acids, salts, monosodium-glutamate, phenolics and alkaloids. Synergistic effects exist between different compounds, so that the sensation of a taste cannot solely be explained by the content of one group of compounds (Stevens et al., 1977; Salles et al., 2003).

Among plum nectars with added sucrose those with 60 % of fruit content were higher scored in sour taste than those with 30 % of fruit content. Among nectars with 60 % of fruit content addition of malic acid influenced on higher scores in sour taste while among nectars with 30 % of fruit content these differences were slightly noticeable in flavor of citric acid. Sweet taste was more frequently perceived than sour taste, which applies to all evaluated samples. Even though there were not observed significant differences, it can be seen that sweeter rated were nectars with 30 % of fruit content than those with 60 % of fruit content. In addition, among nectars with added sucrose, sweeter were the ones with 30 % of fruit content, with no considerably effect of added acid. Similar trend was observed among nectars with added fructose, with the exception of nectar with 60 % of fruit content and added citric acid, which has higher scores for sweet taste compared with one with malic acid.

The scores addressing the harmonious taste were significantly higher in nectars with 60 % of fruit content ($p<0.05$). Among them, addition of malic acid markedly affects on better harmonious taste. Looking at the nectars with 30 % of fruit content, the better harmoniuos taste was observed in samples with sucrose and malic acid just like in samples with fructose and citric acid. Aftertaste was similar and rather mild in all investigated samples with slightly higher expression in nectars with 30 % of fruit content, without marked influence of added sugar or acid. Moreover, odour intensity was higher scored in plum nectars with 60 % of fruit content. Among plum nectars with added fructose, those with malic acid was slightly higher scored comparison to ones with citric acid, while among plum nectars with added sucrose those differences were not as pronounced. Off-odour was almost not detectable as sensory attribute in evaluated nectars. Without influence of added sugar, plum nectars with 30 % of fruit content and citric acid showed better homogeneous consistency in comparison to others. Plum nectars with 60 % of fruit content and malic acid showed lower rated sensory attribute of homogeneous consistency without marked influence of added sugar.

Astringency is a sensory attribute that is described as a drying-out, roughening, and pucker sensation felt in the mouth. Foods that are often astringent include red wine, green and black teas, soy-based foods, and certain fruits, especially when they are not yet ripe. In these foods, astringency is caused by the polyphenolic compounds they contain (Green, 1993). Generally, plum nectars were not assessed as astringent though some differences among samples were observed. Plum nectar with 60 % of fruit content, fructose and malic acid was evaluated as the most astringent, while in nectars with 30 % of fruit content, citric acid and fructose as well as that with 60 % of fruit content, citric acid and sucrose astringency were slightly lower expressed. The lowest astringency was perceived in nectar with 60 % of fruit content, fructose and citric acid. Nevertheless, this variations were not significant ($p<0.05$).

Finally, overall sensory impression was more expressed in nectars with 60 % of fruit content.

In addition, among nectars with added sucrose, nectars with 30 % and 60 % of fruit content and malic acid were perceived as more sensory accepted by panellists. Furthermore, regardless influence of fruit content, nectars with fructose and citric acid were similarly scored for overall sensory impression. Although there were not observed statistically significant differences, between nectars with fructose, in those with 30 % of fruit content, citric acid is only slightly contributed to a better rating, while in those with 60 % of fruit content, malic acid has contributed to a better overall sensory impression rating.

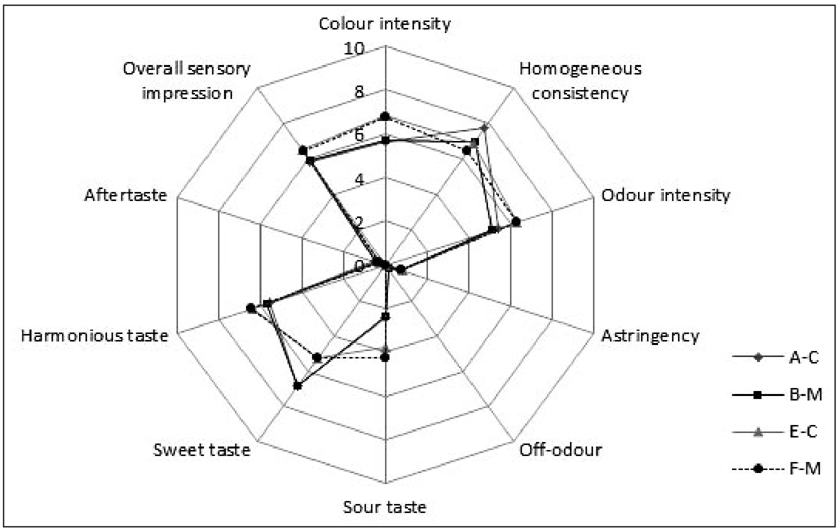

Figure 1. *Spider's web plot for plum nectars with added sucrose (A and B – 30 % of fruit content; E and F – 60 % of fruit content; C – citric acid; M – malic acid)*

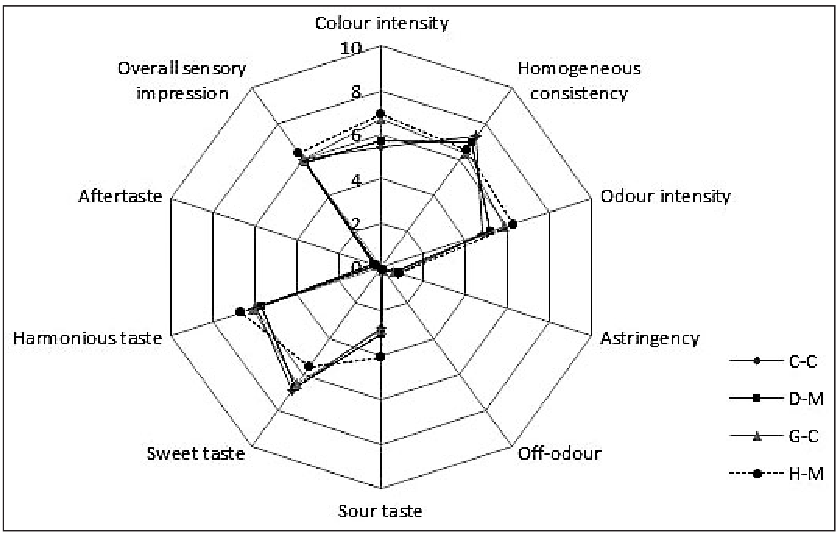

Figure 2. *Spider's web plot for plum nectars with added fructose (C and D – 30 % of fruit content; G and H – 60 % of fruit content; C – citric acid; M – malic acid)*

PCA was performed on all samples and variables to determine whether the different kinds of samples (plum nectars with different fruit content, sugar and acid type) had an influence on different sensory attributes which were characteristic in describing the sensory profile of the samples investigated. In this context, ten sensory attributes were the investigated variables, while plum nectars were the cases under investigation.

The PCA results were two graphs (projections of variables, loading plots and cases-score plots), but the interpretation also mentioned eigenvalues of the correlation matrix, factor variable correlation (factor loadings) and case contributions, which are not discussed here (Figures 3 and 4).

In Figures 3 and 4, the first two factors (PC1 and PC2) represented 82.15 % of the initial variability of the data. Figure 4 gives a visual representation of the differences between the plum nectars with different fruit content. Plum nectars with 60 % of fruit content were positioned on the right and plum nectars with 30 % of fruit content on the left side of the PC1. Regardless of sugar and acid type, plum nectars with 60 % of fruit content, were characterized by sensory variables such as colour and odour intensity, sour, sweet and harmonious taste as well as overall sensory impression. These sensory attributes strongly correlated with the PC1.

Results obtained in this study can be considered of particular interest to better define sensory attributes of various plum nectars.

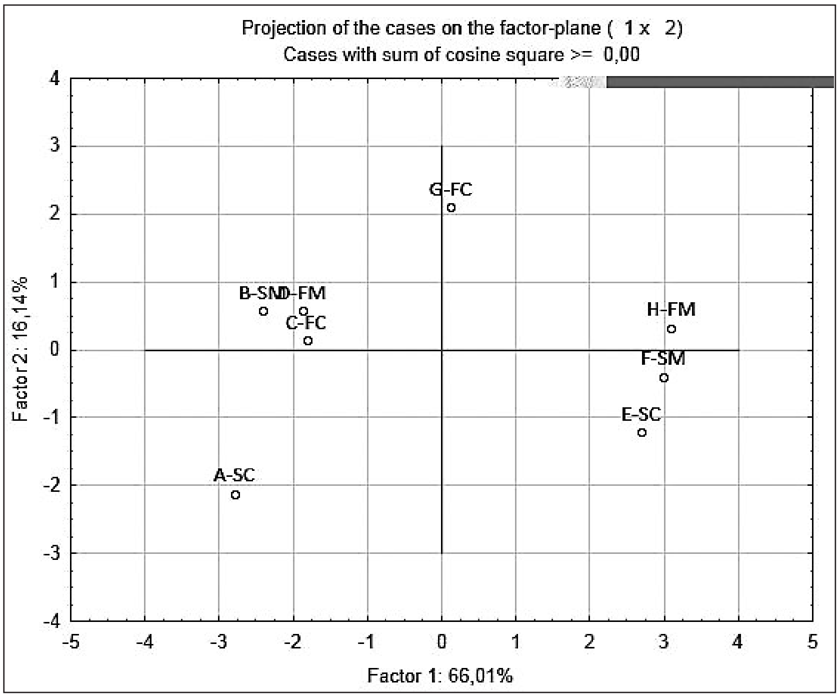

***Figure 3**. Loading plot (PC1 vs. PC2)*

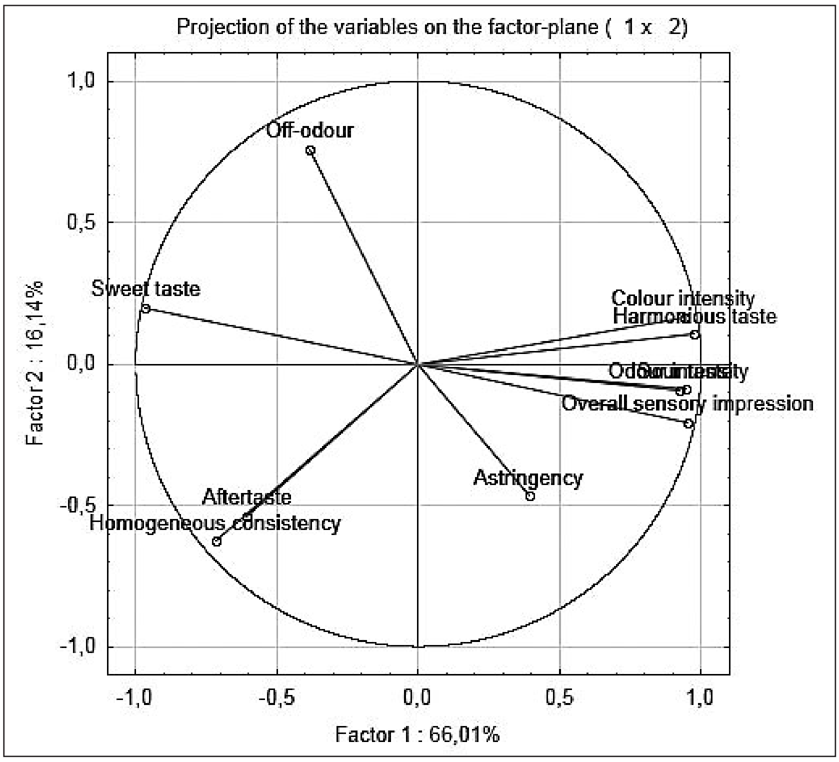

***Figure 4**. Principal component analysis (PC1 vs. PC2) of the plum nectars (Sample labels for the score plot: A, B, C, D (30 % of fruit content); E, F, G, H (60 % of fruit content); sugars: S (sucrose) and F (fructose); acids: citric (C) and malic acid (M))*

Conclusions

Type of added acid or sugar did not have significant impact on the sensory acceptance of nectars ($p<0.05$). A larger fruit content in nectars significantly contributes to a better sensory evaluation in terms of colour intensity, homogeneous consistency, odour intensity, sour and sweet taste as well as overall sensory impression ($p<0.05$). Thus, nectar with 60 % of fruit content, added sucrose and citric acid showed excellent sensory acceptance suggesting commercial potential. Also PCA might itself prove to be a valuable tool which can be successfully used to distinguish the influence of fruit content on sensory profiles in plum nectars.

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