

PRODUCTION AND CHARACTERIZATION OF PLUM JAMS WITH DIFFERENT SWEETENERS

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Abstract

Jam production is one of the oldest food conserving methods, where the properties of the raw material are transferred to the finished product. The most frequently used sweetener in jam production is sucrose, however, other sweeteners may also be used.

In order to determine and compare the characteristics of jams produced by using different sweeteners, different types of plum jams were produced and their chemical properties were determined. Jams were produced by boiling down previously prepared fruits, in open stainless steel vats on direct flame, temperature of ≈ 100 °C, for a period of 15 minutes. The sweeteners used include: sucrose (reduced amount), fructose, sorbitol, and agave syrup. The research was repeated three times, in a period of three years. Analysis was conducted on the fresh plum fruits of the Stanley variety and on the obtained jams of the following chemical parameters: total dry matter (by oven drying, 105 °C), soluble solids (with the refractometer), sugars (HPLC method), total acids (titration with a 0,1 M solution of NaOH), pH (pH meter), pectin's (Carre and Haynes method), vitamin C (iodometric titrimetric method), anthocyanins (spectrophotometric), proteins (Kjeldahl method), fats (Soxhlet method) and ash (gravimetric determination). Microbiological tests of the obtained jams were also conducted. The samples were tested for *Salmonella* spp., *Listeria monocytogenes*, *Enterobacteriaceae*, *Clostridium perfringens*, yeasts and moulds using tested ISO microbial determination methods.

The resulting values for the average content of total dry matter in the jams (43.29 - 44.36%) are correlated with the average values obtained for the soluble solids (42.04 - 42.89%). Lower values were obtained for the content of vitamin C (11.35 - 11.73 mg/100 g), as well as for the content of anthocyanins (5.56 - 28.19 mg CGE / 100 g FW) in jams compared with the established values in the fresh fruits (13.93 mg/100 g and 34.81 mg CGE/100 g FW, respectively).

From the results it can be concluded that the obtained jams possess the necessary quality in compliance with the standards. All jams are according the regulations for microbiological food safety.

Key words: Plum, Sweeteners, Jam, Characteristics.

1. Introduction

The wealth of nutrients, which can be found in different types of fruits, is the reason that a great advantage in the healthy diet is given to fruit and its products. Different ways of fruit processing allow the fruit to get processed with preserved nutritional and physiological values, such as: dried fruit, compote, jam, juices, marmalades, jellies, candied fruits etc.

The jam is in the group of jellied products. It features with jelly consistency, which is created during the process of boiling fresh, frozen or semi processed fruit or

fruit pieces, with a corresponding amount of sugar, pectin and acid [1, 2, and 3]. The boiling can be performed in open vessels (duplicators) at atmospheric pressure, with vigorous stirring at a temperature around 100 °C or vacuum apparatus under reduced pressure and lower temperature (60 - 75 °C). Processing methods that differ in the number of steps and techniques, heating, temperature and processing time can significantly influence the changes that occur in processed products and their quality [3, 4].

Traditional jams are produced with an extra amount of sucrose, which does not allow their consumption by people with overweight or obese, people with diabetes, hyperglycemia and others. According to Parsayee *et al.*, [5] traditional jams (65% dry matter) due to high sugar content contributes to obesity and other health problems.

For customers who want to control the level of sugar in the blood or regulate their weight, of great interest is the production of jams in which sucrose is contained in a smaller percentage, or it is replaced with another sweetener. In the world there is a tendency of constant increase in the use of various sweeteners to replace sucrose [6]. The interest is mostly focused on natural sweeteners (fructose, sorbitol, honey, maple syrup, agave-syrup, stevia), which represent an adequate substitute for sucrose [7, 8, and 9].

In this context, this research has been done, for obtaining quality plum jam, where the addition of various sweeteners (natural) would result with processed products that will become part of everyday healthy diet of man. This study indicates the quality of the products obtained by thermal processing of fruit, at atmospheric pressure and a temperature of ≈ 100 °C. Considering the knowledge that the quality of raw materials is important for obtaining a quality product, the quality of the fruit plum is set.

2. Materials and Methods

As basic raw material for jam production, fresh fruit from the plum variety Stanley from the Polog Region have been used. Fruits have been picked at their full technological maturity. Before the process of processing, studies of the chemical composition of the fruits have been made.

Technological process of fruits processing are performed at the factory "Vitalia Nikola" - LLC, where the traditional way for manufacturing jams with low energy value is used. During the processing, as sweeteners have been used: sucrose (reduced amount), fructose, sorbitol, and agave syrup. To achieve the desired degree of jelling during the manufacturing process is added low - esterified pectin GENU pectin type LM 115AS from the company CPKelco, and calcium ions in the form of calcium citrate, and to provide the necessary acidity is used citric acid.

The technological process includes the following steps: receiving and storage, preparation of fruits (washing, cutting, and inspection), measurement, heat treatment (boiling by adding suitable sweetener with constant stirring, adding pectin, calcium citrate and acid boiling with stirring), packing in jars, closing, cooling and storage. The boiling of the mixture is performed in open inox vats on direct fire, with manual mixing of the mixture. The heat treatment time was 15 min., and the dry matter content in the final product is 42 - 44%. During production the temperature is maintained at ≈ 100 °C, and the content of dry matter is controlled (refractometry).

Fresh fruit of plum variety Stanley and the produced jams are analyzed in terms of the following chemical parameters: total dry matter (drying of the homogenized material in a dryer of 105 °C to constant weight [10]), soluble solids (refractometry, using a handheld refractometer ATAGO, HSR-500) content of total sugars, sucrose, fructose and glucose (by HPLC-RI detector), total acid (by titration with a standard solution of NaOH with concentration of 0.1 mol/L, in the presence of 1% phenolphthalein as indicator [10]), pH value (digital pH meter Santorios Basic meter-PB-11) soluble pectic substances (the method of Carre and Haynes [10]), the content of vitamin C (iodometrically titration method) content of anthocyanins (spectrophotometrically at pH differential method with UV-Vis spectrophotometer Helios omega [11]), protein content (according to the standard method of Kjeldahl), fat content (based on the standard method of Soxhlet) and content of minerals (ash) (gravimetric, putting the material in an oven at 550 °C [10]).

Microbiological tests have also been made in order to determine the microbiological correctness of the jams. The samples were tested for the presence of: *Salmonella* spp. (ISO 6579), *Listeria monocytogenes* (ISO 11290-1:1996), *Enterobacteriaceae* (ISO 21528-2:2004), *Clostridium perfringens* (ISO 7937), yeasts (ISO 7954) and molds (ISO 7954).

The tests are made in three iterations, for a period of three years (2011, 2012, and 2013). They were performed at: laboratory for fruits and vegetables processing at the Faculty for Agricultural Sciences and Food in Skopje, the USO „Dimirija Cupovski“- Veles chemical laboratory, the laboratories of the Institute of Public Health - Skopje, the laboratory of the Institute of Food at the Faculty of Veterinary medicine - Skopje, laboratories at the Bulgarian Academy of Science in Plovdiv, Bulgaria (BAS), and the laboratories of the Faculty of Technology in Plovdiv, Bulgaria (University of Food Technologies).

3. Results and Discussion

As a basic raw material, the fruit during processing must meet the conditions of the technological aspect, including chemical properties, because the quality of the fruit used, greatly affects the quality of the final product [12].

According Salunkhe *et al.*, cited by Voicu *et al.*, [13], fruits intended for industrial processing are considered in the terms of quality, or more precisely, despite the sensory properties they should have a high content of soluble dry matters, pectin matters, and retain their color and flavor during processing into compotes, jellies, jams, juices etc.

The results of the analysis of the chemical composition of the plums from the variety of Stanley in the three years of testing are shown in Figures 1 - 5.

Analyzing the data obtained and comparing them with the reference, it was determined that the values of the parameters tested were partially identical with reference data of the plums from the Stanly variety chemical composition. The difference in the values obtained is expected, taking into account that the chemical composition of fruits is specific and depends on the climatic conditions, technical measures, degree of maturity etc. [2, 14].

Namely, Miletić *et al.*, [15], examining the same variety of plum from the vicinity of Zaječar in Serbia, found that the content of total dry matter was from 15.00%, 15.50% and 16.40%, which is less than the content of total dry matter of our research (18.92% - 2011, 19.07% - 2012 and 18.89% - 2013, Figure 1). Earlier Veličković *et al.*, [16] performed research on fruit from the variety Stanley from four different regions of Serbia and established higher values for the content of total dry matter: 24.11% (Kragujevac), 22.47% (Belgrade), 22.51% (Valjevo), and 21.11% (Aleksandrovac).

From the results shown in Figure 1, it can be concluded that the fruits of the plum from the variety Stanley researched in 2012 were characterized by higher content of soluble solids (18.14%) compared with the fruits in

2011 and 2013 (17.92% and 17.99%). Reference data related to the content of soluble solids of fruits from the variety Stanley plum are different. According to tests carried out by Veličković *et al.*, [16], the content of dry soluble matters in the same variety ranges from 18.97% up to 22.23%. In these limits are the values presented by Mitrović *et al.*, [17], Božović and Jaćimović [14], and Minev and Stoyanova [18]. Lower content of soluble solids is determined by Nenadović-Mratinić *et al.*, [19] and Moghaddam *et al.*, [20], who established the content of soluble solids of 16.80% and 15.94%. Approximate values with ours is ascertained by Milošević and Milošević [21], which for three years examining the fruits of plum from the variety Stanley found the average soluble solids content of $17.95 \pm 1.34\%$.

Figure 2 presents the results obtained for the content of sugars in the plums from the variety Stanley in the three years of testing.

Plums from the variety Stanley in the first and third year of the survey are characterized by lower content of total sugars (16.93% and 16.99%) compared to the fruit in the second year (17.22%). Comparing our results for total sugars content with the results of other authors can be observed that there are certain exceptions. According to tests carried out by Veličković *et al.*, [16], the content of total sugars in the same variety ranges from 14.44 to 16.02%. In these limits are the values presented by Mitrović *et al.*, [17] and Božović and Jaćimović [14]. Lower content of total sugars of 12.49% is determined by Minev and Stoyanova [18]. Dragoyski *et al.*, [22], concluded much lower values for the content of total sugars (9.48 - 11.23%) and approximate to theirs are presented by Nenadović-Mratinić *et al.*, [19] and Milošević and Milošević [21].

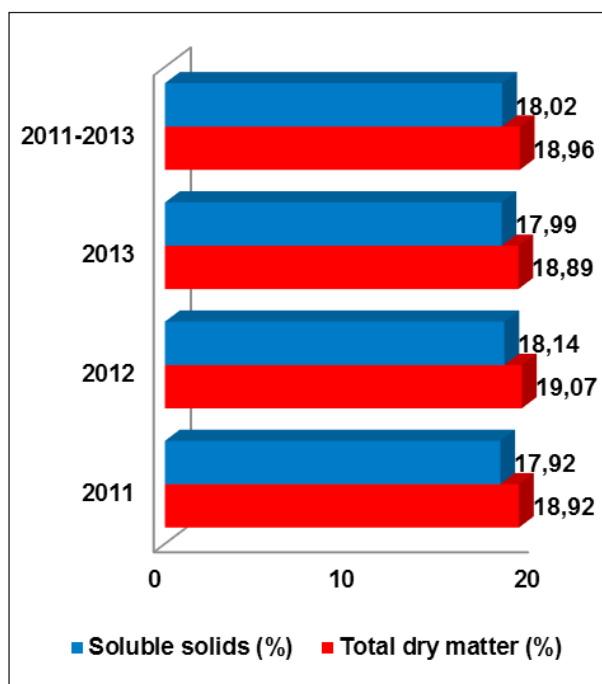


Figure 1. The results obtained for total dry matter and soluble solids in the fresh plum fruits

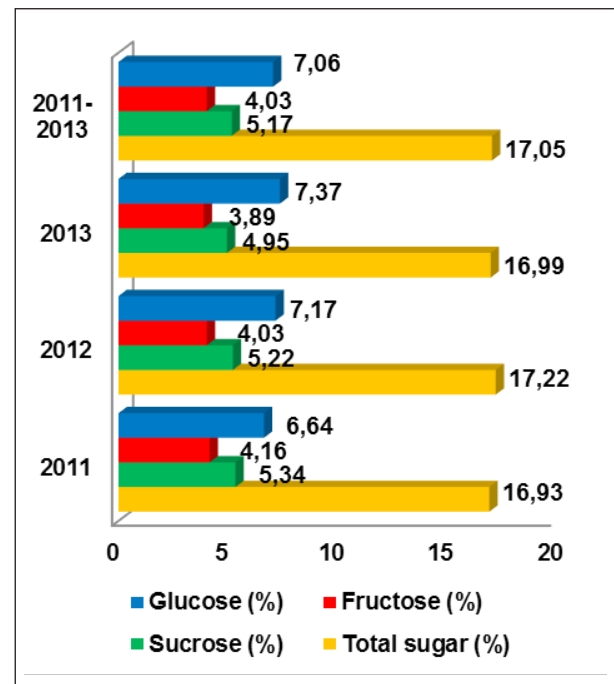


Figure 2. The content of total sugar, sucrose, glucose and fructose in the fresh plum fruits

Based on the values for the content of sucrose in the fruits of plum from the variety Stanley, it can be concluded that the fruits from 2011 and 2012 are characterized by higher content of sucrose (5.34% and 5.22%) compared to the fruits of 2013 (4.95%). Lower values for sucrose content in the plum from the variety Stanley in terms of our ($5.17 \pm 0.02\%$ average for three years) is found by Milošević and Milošević [21], in which after the three-year examination of the plums from the variety Stanley found percentage of sucrose representation of $3.99 \pm 0.05\%$. These results coincide with the results presented Dragoyski *et al.*, [22], in which the sucrose content in the fruits of the variety Stanley blends ranges from 1.31 to 3.89%. Higher values for the content of sucrose (6.15% and 6.75%) are determined by Mitrović *et al.*, [17].

Based on the results for the presence of fructose and glucose, in plums from the variety Stanley can be found in the first year of studies more fructose (4.16%) compared to fruits in the second and third year (4.03% and 3.89% appropriately), while in terms of glucose fruits in second and third year of studies are characterized by greater content of glucose (7.17% and 7.37%) compared to fruit of the first year (6.64%). Lower values for the content of fructose (2.83%) and glucose (4.17%) compared to ours, of this variety is detected by Milošević and Milošević [21].

Figure 3 presents the values obtained for the content of: total acids, soluble pectin's and pH of the fruits of plum from the variety Stanley in the three-year research.

From Figure 3 it can be concluded that the fruits of the plum from the variety Stanley contain approximately

equal quantity of acids (2011 - 0.65%; 2012 - 0.67%; 2013 - 0.66%). The obtained results are consistent with the results determined by Nenadović-Mratinić *et al.*, [19], Mitrović *et al.*, [17], and Dragoyski *et al.*, [22]. Higher values (0.74%) are ascertained by Minev and Stoyanova [18], and lower (0.43%) by Šić Žlabur *et al.*, [23].

Regarding the pH value, it can be concluded that the fruits in 2011 and 2013 are characterized by the same pH (3.63%). Higher pH of 3.67 is determined at fruit in 2012. Approximate pH-value as observed in our researches, is that one made by Milošević and Milošević [21], who at the fruits of plum from the variety Stanley found the average pH of 3.66 ± 0.04 . Higher pH values from 3.8 to 4.11 and 3.84 are determined by Mitrović *et al.*, [17] and Šić Žlabur *et al.*, [23].

From the calculated values for the content of soluble pectin's can be concluded that fruits examined in 2011 contain 0.79% soluble pectin's, in 2012 - 0.80%, and in 2013 - 0.78%. Lower content of pectin's from 0.714% is determined by Ogašanović quoted by Marković [24].

The obtained results for the content of vitamin C and anthocyanins are shown in Figure 4. The fruits of plum from the variety Stanley researched in 2011 were characterized by higher content of vitamin C (14.50 mg/100 g) compared with fruits in 2012 and 2013 (13.20 mg/100 g and 14.10 mg/100 g). Obtained values for the content of vitamin C in fruits are higher than those shown by Walkowiak-Tomczak [25], (4-11 mg/100 g).

Based on the values for the content of anthocyanins it can be concluded that the fruits in 2013 are characterized by the lowest content of anthocyanins (33.20 mg)

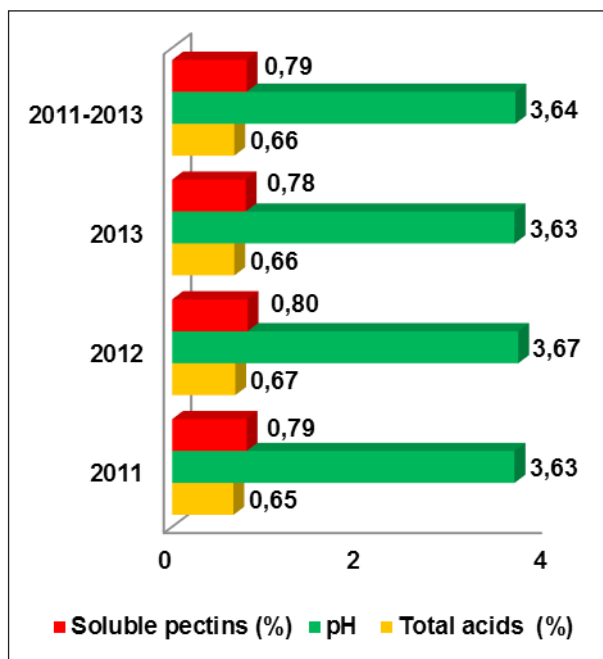


Figure 3. The values obtained for soluble pectin's, total acids and pH in the fresh plum fruits

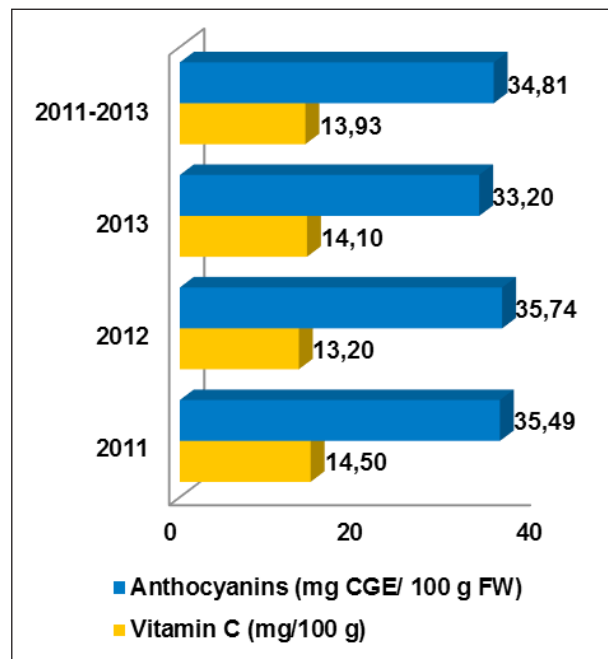


Figure 4. Amount of vitamin C and anthocyanins in the fresh plum fruits

gallic acid equivalents/100 g fresh weight (mg CGE/100 g FW)). More anthocyanins content of the fruits are featured in 2011 (35.49 mg CGE/100 g FW) and 2012 (35.74 mg CGE/100 g FW). Miletić *et al.*, [26], performed tests on fruits plums from the variety Stanley designating total anthocyanins, total phenols and anti-oxidative capacity over three consecutive years. The total content of anthocyanins ranged from 5.01 ± 0.42 to 54.72 ± 3.21 mg CGE/100 g FW.

Figure 5 shows the results obtained for the content of proteins, fats and minerals (ash) the fruits of the plum variety Stanley.

The fruits examined in 2012 are characterized by a lower protein content (0.50%) compared with the fruits in 2011 and 2013 (0.68% and 0.65%). The values obtained are within the limits provided by Walkowiak-Tomczak [25], on the protein content of the fruit of plum (from 0.4 to 0.9%).

In terms of fat content, the fruits in 2011 and 2012 were characterized with greater content (0.15%) than fruits in 2013 (0.10%). The results coincide with the results presented by several authors who point out that the fat content in the fruits of plums is 0.1 - 0.3% [10, 25].

The content of minerals in the fruits of plum variety Stanley ranges from 0.30 to 0.33%, which is within the limits (from 0.3 to 0.4%) presented by Walkowiak-Tomczak [25]. Higher values for the content of mineral substances from 0.54% have been found by Božović and Jaćimović [14].

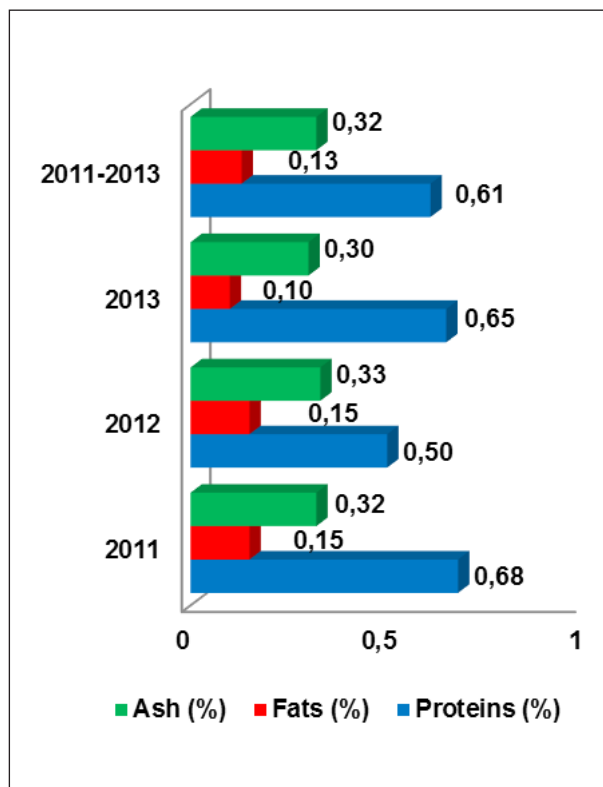


Figure 5. The content of proteins, fats and ash in the fresh plum fruits

According to the values of the parameters tested for the fruit of plum variety Stanley in the three years, we can freely say that they fulfilled the conditions laid down in the Regulation for quality of fruit, vegetables and mushrooms [27].

For the consumer, despite the visual appearance of the product that buys, it is important to know what the product contains. For processed fruit, and this includes jam, it is good to know its composition and how many of the components of the basic raw material - the fruit, is preserved after processing. The results of the analysis of the chemical characteristics of the plum jam, obtained from the variety Stanley with different sweeteners (reduced amount of sucrose, fructose, sorbitol and agave syrup) in the three years of testing are given in Figures 6 - 14. For better visibility, interpretation and discussion of the results from the analyzes carried out, the produced jams are marked with Arabic numbers from 1 to 4, as follows:

- Jam plum from the variety Stanley with sucrose - 1.
- Jam plum from the variety Stanley with fructose - 2.
- Jam plum from the variety Stanley with sorbitol - 3.
- Jam plum from the variety Stanley with agave syrup - 4.

The content of total dry matter, soluble solids and total sugars in the jam made from variety Stanley plums (1, 2, 3, 4) according years of production are shown in Figure 6 and Figure 7.

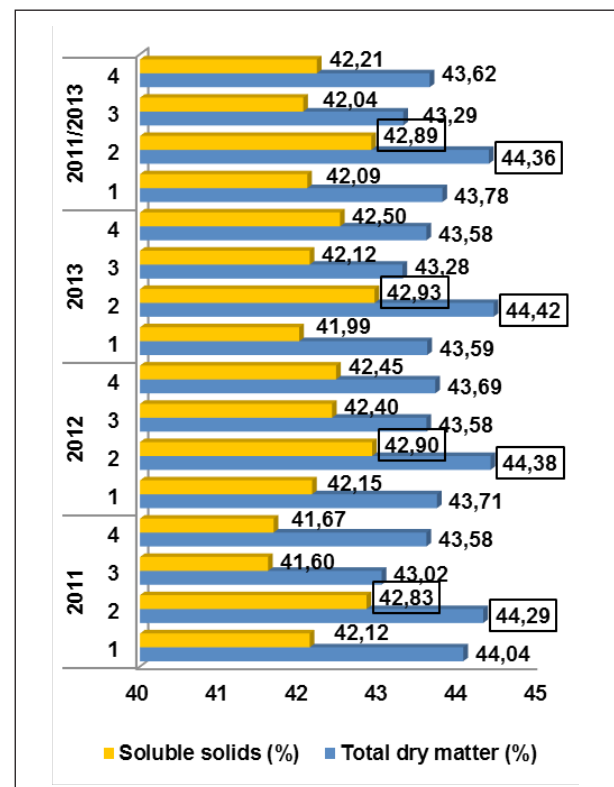


Figure 6. The results obtained for total dry matter and soluble solids in produced jams

According to the data shown in Figure 6 and Figure 7, it can be concluded that in the three years of testing, the jams with fructose are featured with the highest content of total dry matter, soluble solids and total sugars (jams 2), and the lowest the jams with sorbitol (jams 3). The difference in the content of total dry matter that occurs between the jams with different sweeteners in the year of testing, depends on the sweetener applied during production. The resulting values for the average content of total dry matter in the jams (43.29 - 44.36%) correlate with average values obtained for soluble solids (42.04 - 42.89%). The content of total dry matter, soluble solids and total sugars in the produced jams is dependent on the sweetener that is applied during production, but the amount of total dry matter, soluble solids and total sugars contained the fruits and the influence of heat treatment should not be neglected.

For obtaining jams with reduced energy value, sucrose is added in a reduced amount or it is completely replaced with another sweetener. It should also be noted that when sucrose is completely replaced with another sweetener, the production process shall use only the sucrose contained in the processed fruits. During the fruit heat processing, in slightly acidic environment, sucrose hydrolyzes to fructose and glucose [28].

Data on the content of sucrose and glucose in the jams (1, 2, 3, and 4) are shown in Figure 8.

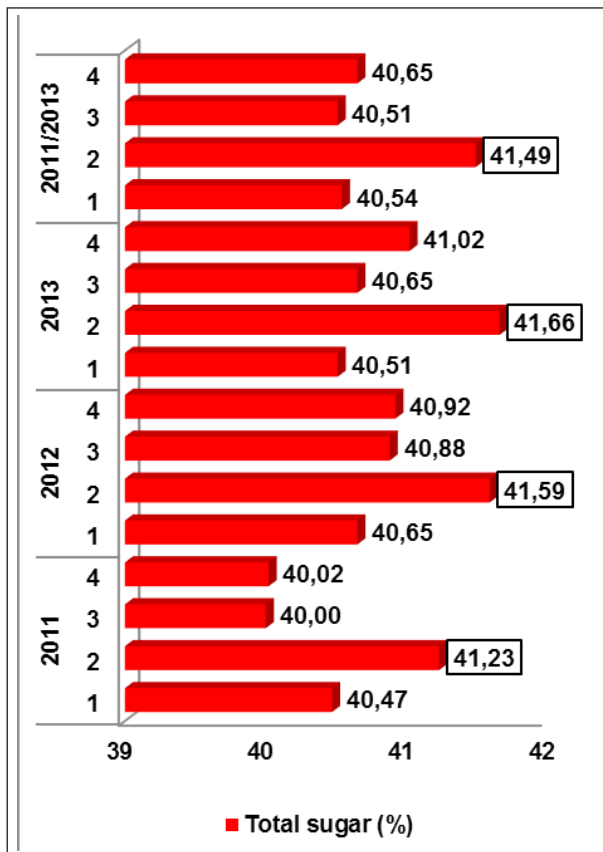


Figure 7. The results obtained for total sugar in produced jams

In the three years with the highest values of sucrose content, are featured the jams where is used reduced amounts of sucrose, which is expected due to the use of sucrose as a sweetener. In the jams where sucrose is completely replaced with another sweetener (fructose, sorbitol, and agave syrup) the values for the content of sucrose are lower as a result of inversion performed during the heat treatment to fructose and glucose [6, 28]. It should be mentioned the possible caramelization, which can also occur during the heat treatment [9].

Based on the determined values for the content of glucose in the jams (jams 8), can be concluded that jams with reduced amounts of sucrose (jams 1) in the three years, are characterized by the highest content of glucose (16.19%, 16.20%, 16.40%), due to using sucrose as a sweetener and its inversion during processing.

Figure 9 presents the results obtained for the content of fructose and sorbitol in jams (1, 2, 3, and 4).

Of the reported values for the content of fructose in the jams it can be concluded that jams with fructose (jams 2) in the three years are characterized by higher content of fructose (31.92%, 31.86%, 31.76%), compared to jams with other sweeteners, owing to the use of fructose as a sweetener.

The content of glucose and fructose in jams is correlated with the content of glucose and fructose in

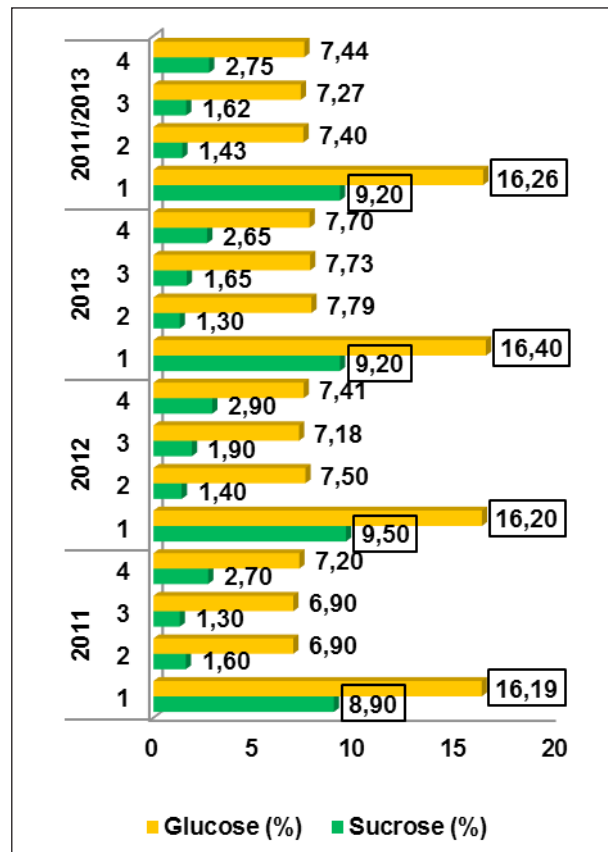


Figure 8. The content of sucrose and glucose in produced jams

fruit which is processed, the content of sucrose that inverts, as well as sweetener used in their production. We should not overlook the impact of thermal processing of fruit, which can cause certain chemical reactions, degradation and creating new compounds and thereby to cause a reduction in sugars represented [29, and 30]. As a reducing sugar, fructose can undergo non-enzymatic browning reactions such as the Maillard reaction and caramelization [31].

According to the announced results in Figure 9, it can be concluded that in the three years sorbitol is present only in the jams where is used sorbitol (jams 3) (26.41%, 26.10% and 26.17%), due to the replacement of sorbitol as the sweetener.

With regard to the values of total acids is found that the jams 1, 2 and 3 are characterized by an average content of total acid of 0.99% and the jams 4 by the average content of total acids of 1.00% (Figure 10). The content of total acids in the produced jams is in accordance with the determined content of total acids in fruits used, as well with the added quantity of citric acid.

In the jams there have been detected a pH of 3.07 to 3.17 (Figure 10). Determined pH values of the produced jams enabled proper jelling in accordance with the conditions set forth in their production (use of various sweeteners and low esterified pectin as a gelling

agent), and within the limits of the permitted [4, 32].

Data on the percentage of soluble pectin's and proteins in the plum jams of variety Stanley (1, 2, 3, and 4) are shown in Figure 11.

The jams are featured with average content of soluble pectin's from 0.81 - 0.82%. The content of soluble pectin's in the produced jams is in the accordance with established content of soluble pectin's in raw materials and with the added quantity of pectin.

The average proteins content in the fruit jams for three years ranges from 0.67 to 0.72%. The resulting values for the content of protein in jams deviate from the specified values of raw materials due to the degradation of proteins and possible interactions with the components present in the fruit jams [33, 34].

The resulting values for the content of vitamin C and anthocyanins in the fruit jams (1, 2, 3, 4) according years of production are shown in Figure 12.

Lower average values for the content of vitamin C (11.35 - 11.73 mg/100 g) and of anthocyanins (5.56 - 28.19 mg CGE/100 g FW) in the fruit jams has been detected, compared with the established values in the fresh plums (13.93 mg/100 g and 34.81 mg CGE/100 g FW, respectively). Part of vitamin C and anthocyanins is lost during processing.

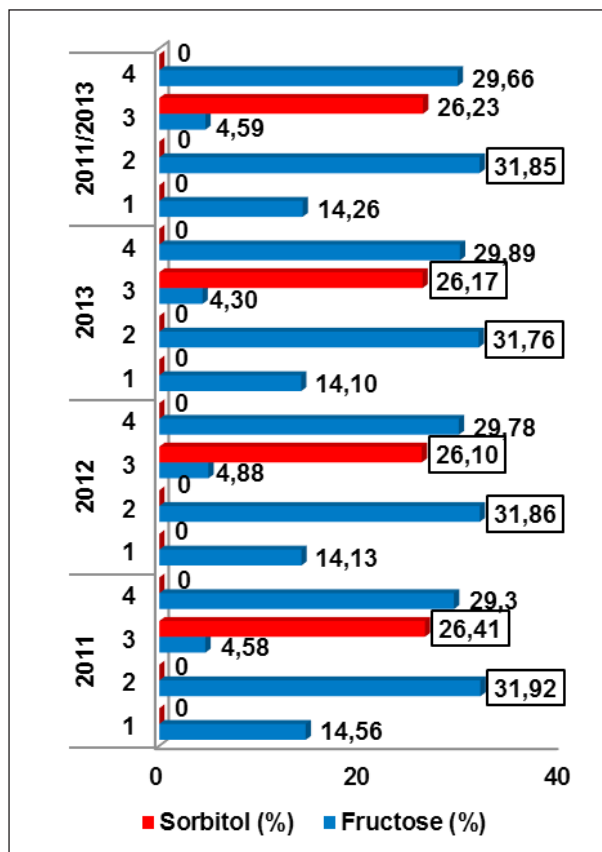


Figure 9. The content of fructose and sorbitol in produced jams

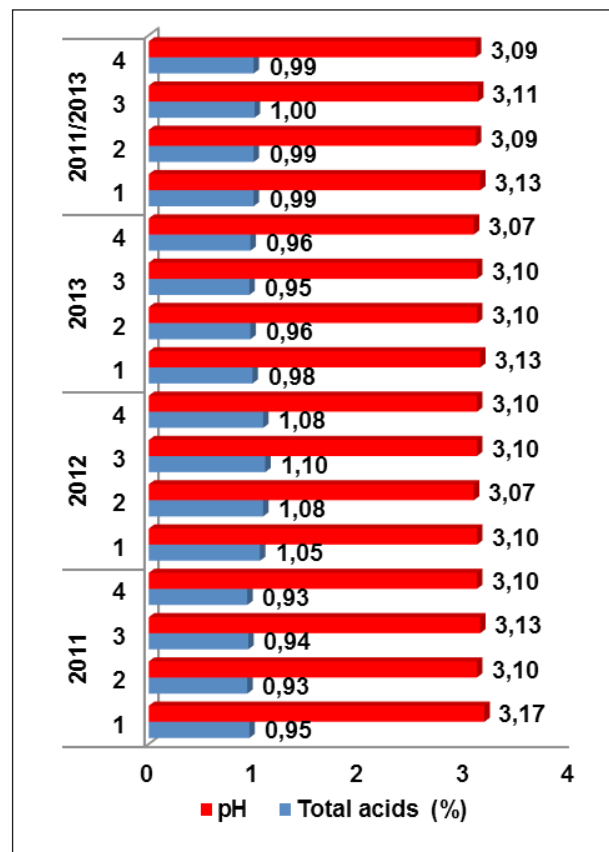


Figure 10. The values obtained for total acids and pH in produced jams

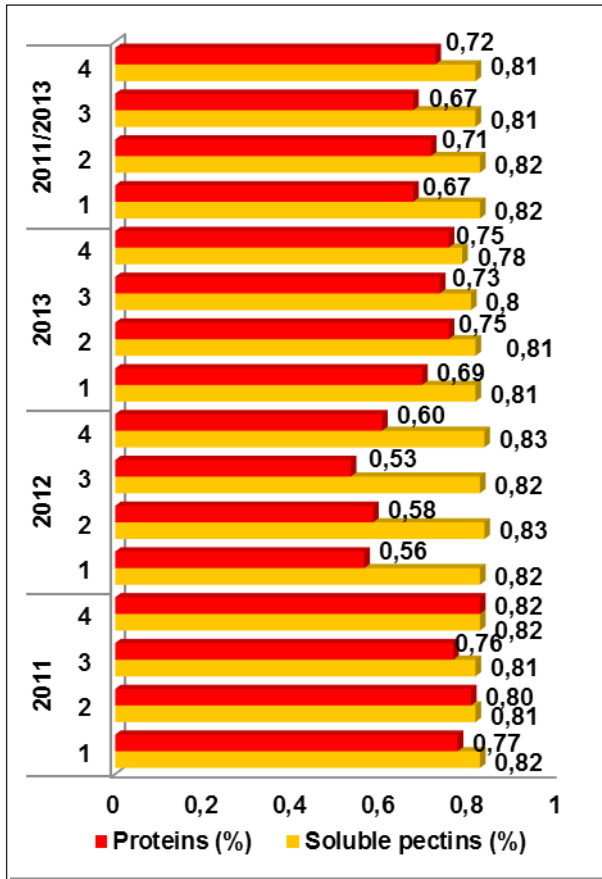


Figure 11. The values obtained for proteins and soluble pectin's in produced jams

The data indicate great instability of vitamin C, especially when in presence of oxygen the fruit has been treated at higher temperatures, so in very short time, the greatest part of the vitamin C in the product is oxidizing [35, 36]. Issuing the loss of vitamin C during the process of jam production and the lower percentage of vitamin C in jams obtained from the initial raw materials, many other authors have come to the same conclusion [37, 38, 39, 40, and 41].

In the references, as factors which affect the stability of anthocyanins, are mentioned the following: pH value, temperature, presence of: enzymes, ascorbic acid, sugars, metals and others. When the fruit is thermally treated at higher temperatures in presence of oxygen, the present anthocyanins can degrade. Sugars in higher concentrations increase the stability of anthocyanins. At low concentrations, fructose, arabinose, lactose, and sorbose has a greater impact on anthocyanins degradation than glucose, sucrose and maltose. Disaccharides protect the anthocyanins until they break down into sugars. The speed of degradation of anthocyanins follows the speed of degradation of sugars to furfural and hydroxymethylfurfural (HMF) [42, 43].

Ścibisz and Mitek [44], explain the effect of sugars on the stability of anthocyanins in the production of jam. This is in agreement with earlier reports showing that a high

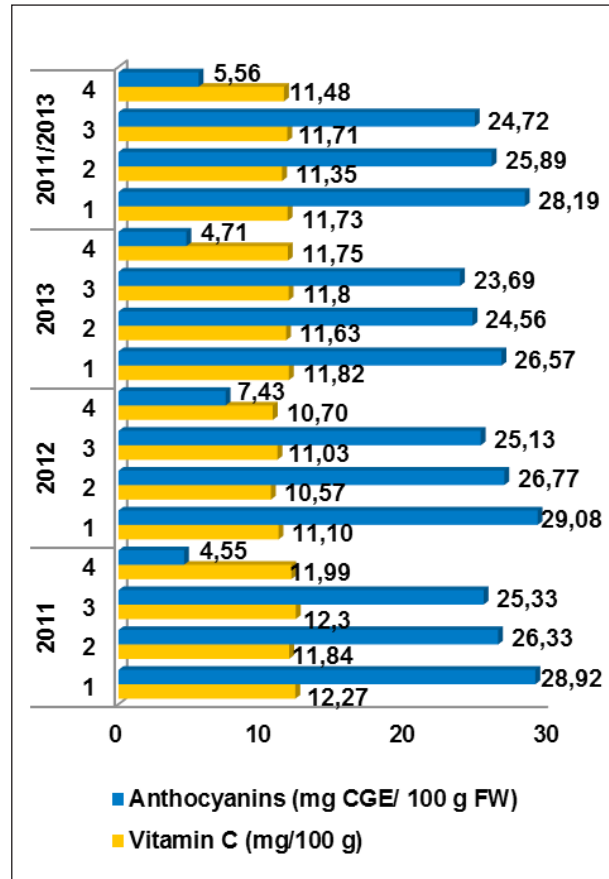


Figure 12. Amount of vitamin C and anthocyanins in produced jams

dose of sucrose (40 - 50%) stabilizes anthocyanins during heating, while fructose can perform degradation of anthocyanins during the heating process. To the same conclusion, that anthocyanins are lost during the process of jam production and the jams produced are characterized by lower content than the starting raw materials, have come many other authors [3, 37, 38]. The reason for this phenomenon are probably the previously mentioned factors which affect the stability of anthocyanins.

It should be noted that in the jams with agave syrup, the lower content of anthocyanins (4.55 mg CGE/100 g FW, 7.43 mg CGE/100 g FW, 4.71 mg CGE/100 g FW, 5.5 mg CGE/100 g FW) may be due to the reaction of the minerals present in agave syrup with anthocyanins from the raw materials. Then, new compounds will be formed, that can affect the chemical composition and sensory characteristics of the final product [43, 45].

The content of fats and minerals (ash) in the jams (1, 2, 3, and 4) by years of production is shown in Figure 13. The jams are characterized by low content of fats, according to the determined fats content of the fresh fruits used as material for the jams. This is underlined by Tepić *et al.*, [43] and Pavlović [46]. The results have shown stability of fats, despite the use of high temperature during the production process. The content of mineral substances is within the established content

of mineral substances in the plums from which they are produced. Differences in the content of mineral substances is due to the degree of purity of the applied sweeteners.

The energy values of the jams produced (1, 2, 3, and 4) have been calculated and are presented in Figure 14.

In the calculation, for conversion of basic macronutrients that release energy (proteins, fats and carbohydrates) the factor At_{water} has been used [47]. The average energy value in the jams for three years ranged from 166.08 kcal/100 g to 170,10 kcal/100 g, which is in accordance with the obtained energy values for this group of products (low-energy jams) presented by other authors [45, 48].

According to the values of the examined parameters, the jams meet the conditions prescribed in the Regulation on specific requirements for the safety of fruit jams, jellies, marmalades and sweetened chestnut puree [49].

According to the results of the microbiological tests, we can conclude that the presence of *Salmonella* spp., *Listeria monocytogenes*, *Enterobacteriaceae*, *Clostridium perfringens*, yeasts, and molds is within the limits specified by the regulations for microbiological food safety [50, 51].

4. Conclusions

- The examinations and the results confirmed that if the plums are thermally processed for a short time at high temperature and under atmospheric pressure, they can be processed into jam successfully, and besides sucrose, other sweeteners can be used (fructose, sorbitol and agave syrup).

- According to the obtained results of the chemical analysis of the used fresh plums of the variety Stanley, we can conclude that the tested fruits are characterized by good quality features that meet the prescribed standards as quality raw material for further processing.

- According to the results of the chemical analysis of the processed jams, we can conclude that heat treatment affects the increase or decrease of represented components (sugars, vitamin C, anthocyanins), but jams do not lose the quality features and meet the prescribed quality requirements. According to the results obtained by microbiological analysis of the processed jams, it can be concluded that the microbiological parameters were within the framework of the standards established by the national legislation.

- This results are expected to find applications and help primary producers, processors and direct consumers. Production of such processed fruit will help people in their need of limited amount of sugar intake.

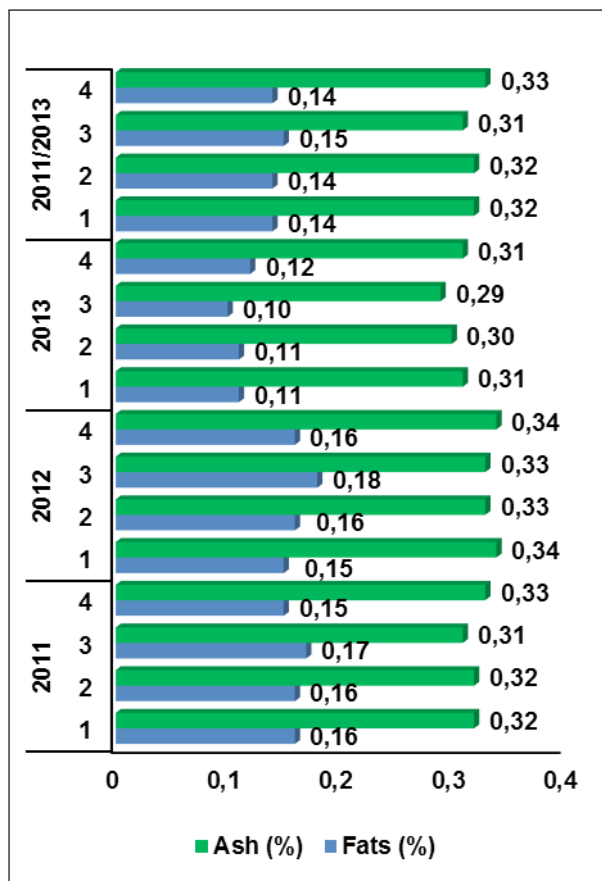


Figure 13. The content of ash and fats in produced jams

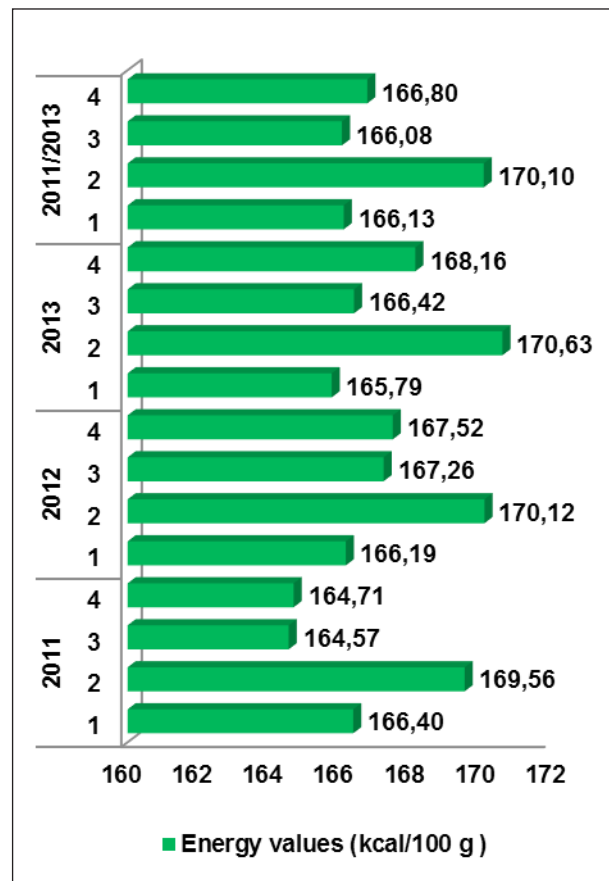


Figure 14. The energy values of produced jams

5. References

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