CHEMICAL COMPOSITION OF JAM FROM TRADITIONAL APPLE CULTIVARS FROM BOSNIA AND HERZEGOVINA

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Summary

Jam (traditionally called pekmez) is a product produced by concentrating of fresh thick apple juice. In this study, 20 jam samples, from different apple cultivars, were analyzed, including: 'Samoniklica', 'Paradija', 'Habikusa', 'Zuja', 'Srebrenicka' and mixed cultivars. The aim of this study was to determine physicochemical properties of jam from different apple cultivars and mixed jam. The analyses have shown that the average value of the dry matter was 77.38%, the ash 1.26%, pH value 4.25, electrical conductivity 2.90 mS/cm. The nitrogen content was 685.10 mg/100 g. The relative density was 1.36 g/mL. The potassium content (K) was 430.70 mg/100 g, sodium (Na) 99.31 mg/100 g, calcium (Ca) 43.65 mg/100 g, magnesium (Mg) 30.80 mg/100 g, iron (Fe) 5.61 mg/100 g, zinc (Zn) 1.07 mg/100 g, copper (Cu) 0.41 mg/100 g, manganese (Mn) 0.26 mg/100 g. The total polyphenols were 0.78 g/kg. Hydroxymethylfurfural (HMF) was 162.02 mg/kg. Apple jam is recommended in recovery from many diseases because of its special nutritional value, especially for people who suffer from *anaemia sidropenica* and similar diseases, and for the athletes as well.

Keywords: jam, apple, chemical composition

Introduction

Apples represent very important part of human nutrition as they are source of sugar, acids and many other biological active compounds such as phenolic compounds which are responsible for antioxidant activity (Wu et al., 2007). Besides sugar and organic acids, phenols also determine apple quality (Nogueira et al., 2006).

According to the some authors (Drake and Eisele, 1997), there is a significant difference between chemical composition among different cultivars of apples. The factors which are affecting chemical composition of apples, as well as the content of some components, are: cultivar, climate, harvesting period, soil, storage and others. Bosnia and Herzegovina is known for its valuable domestic fruit cultivars. Simultaneously, there is a trend of inscreasing demand for fruit which has been organically farmed and has not been or is in a small degree chemically treated.

The apple jam (traditionally called pekmez) can be defined as a concentrated and shelf-life extended form of apple juice produced by boiling without adding sugar or any other food additives (Yogurtcu and Kamisli, 2006). The production of jam from traditional apple cultivars has a long tradition in Bosnia and Herzegovina. There is 46 accounted and recognised traditional apple cultivars so far. The jam is produced from numerous traditional apple cultivars: '*Paradija*', '*Samoniklica*', '*Žuja*', '*Šarenika*', '*Srebrenička*', '*Sladica*', '*Tankokora*' and others (Beširović, 2009). Jam consumption in Bosnia and Herzegovina has not been systematically monitored, but more and more importance is given to the jam as a traditional product. For centuries, the jam has been used as the unique permanent product from apples and also for preparing many Bosnian delicacies (Lakešić, 1999).

In folk medicine of Bosnia and Herzegovina this product has been used as a medicine for anemia, cough, inanition and boosting immunities. The nutrition rich in fruits and vegetables is directly connected with lower risk of chronic, non-communicable diseases. A concept of functional foods is based upon these findings. Characteristics of traditional products are being discovered but the new functional foods are being designed also (Miletić et al., 2008).

Nutritional properties of food products are including energy value, compounds composition, nutrient utilization, antioxidant capacity, the influence of bioactive compounds on human health etc. Nutritional attributes are measurable parameters. Based on nutritional properties it can be concluded whether the specific product fills the conditions of functional food. Many definitions show that functional food is a food which contains components with beneficial effects on one or more functions of the human organism and in that way it affects improvement of general organism condition and health or significantly reducing the risk of diseases (FAO, 2007).

The jam is produced from royal apple juice and it can be classified as functional food due to the components such as polyphenols, flavonoids, dietetic fibres,

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minerals, as well as other active ingredients present in traces: alkaloids, glycosides, phytosterols, polyunsaturated fatty acids and other phytochemicals.
Functional properties of jam can also be determined by nutritional attributes such as glycemic index (GI) of food. Besides positive parameters which affect nutritional and functional properties of the jam, there are also parameters which affect negatively such as Maillard reaction and caramelisation products, present microorganisms and their toxins, different ecological contaminants and others.
Hydroxymethylfurfural (HMF) represents Maillard reaction product. HMF is a product of simple sugars degradation (most often fructose) in the presence of acids and it occurs in the moment when the proportions of acids and simple sugars are favourable for the reaction. HMF can generate during the food storage, but it is usually formed at higher temperatures during the processes such as baking, cooking and drying. Although epidemiological studies have not showed adverse effects on health, laboratory studies showed that HMF has cytotoxic and genotoxic effects.
The aim of this study was to determine chemical composition of the jam from traditional apple cultivars in Bosnia and Herzegovina.

Materials and methods

Production of traditional jam

The traditional jams was produced by concentrating of fresh thick apple juice. Traditional way of production is carried out by boiling a juice until a concentration reaches values between 67% and 75%. The concentrating on the temperature up to 70 °C is more modern way of a jam production.
20 jam samples were used as follows: 10 jam samples from ‘Samoniklica’ cultivar and 10 samples from mixed apple cultivars which are: ‘Paradija’, ‘Šarenika’, ‘Žuja’, ‘Sladica’ and ‘Tankokora’ (Table 1).

Table 1. Materials used in this study

The jam samples	The jam from apple cultivar	Jam production method	The year of production
1	‘Samoniklice’	On the temperature up to 70 °C	2011
2	‘Samoniklice’	On the temperature up to 70 °C	2011
3	‘Samoniklice’	On the temperature up to 70 °C	2011
4	‘Samoniklice’	On the temperature up to 70 °C	2011
5	‘Samoniklice’	On the temperature up to 70 °C	2011
6	‘Samoniklice’	Traditional	2011
7	‘Samoniklice’	Traditional	2011
8	‘Samoniklice’	Traditional	2011
9	‘Samoniklice’	Traditional	2011
10	‘Samoniklice’	Traditional	2011
11	Mixed cultivars	Traditional	2011
12	Mixed cultivars	Traditional	2011
13	Mixed cultivars	Traditional	2011
14	Mixed cultivars	Traditional	2011
15	Mixed cultivars	Traditional	2011
16	Mixed cultivars	Traditional	Before the year 2006
17	Mixed cultivars	Traditional	Before the year 2006
18	Mixed cultivars	Traditional	Before the year 2006
19	Mixed cultivars	Traditional	Before the year 2006
20	Mixed cultivars	Traditional	Before the year 2006

Determination of the content of soluble dry matter

For this measurement refractometry method was used (measuring the light refraction index of different liquid materials with Abbe refractometer by Metller Toledo - USA).

Determination of pH value

This determination is based on the measuring of potential differences between two electrodes that are immersed in a solution. Reference electrode has a permanent potential, while the glass electrode has the potential, which is function of activity of H+ ions in the solution. pH value of samples is determined by using a digital pH-meter MP 225 manufactured by Metller Toledo (USA), with combined glass electrode.

Determination of the total and reduced sugars in the jam

Reduction of Fehlings solution by a solution of reduced sugars in the jam, using methylene blue as an indicator were used. The content of reducing sugars is determined by volumetric method upon Luff-Schoorl (Trajković et al., 1983).

Determination of the total ash

Burning on 600 C in burning furnace (Instrumentaria, Zagreb) was used. The total ash includes an inorganic leftover that remains after the burning and represents the total mineral content of the sample. During the burning, all the cations, beside ammonia cations, turn into carbonates or into others anhydrous inorganic salts. The total ash content was determined by standard gravimetric method (Trajković et al., 1983).

Determination of the concentration of total nitrogen

Kjeldahl method on the Kjeltec TM 2300 device (Foss Tecator, Sweden) was used. Determination of the concentration of total nitrogen was conducted in three fases: wet burning of the sample, distillation and titration. In a cuvette the jam sample was pipetted and two catalyst tablets were placed and the sample was burned on the unit for burning. After the total burning, cuvette was transfered to the unit for a distillation. The strong base was added which caused a release of NH_3. NH_3 was transfered through the cooling system and treated with 1% boric acid which caused an increase of pH value in a solution. This solution was titrated with 0,1 N HCl. Bromine cresol and methil red were used as indicators. The concentration of ammonium ion was determined based on a volume of HCl that was needed for a titration.

Mineral analysis

The following minerals have been analyzed: iron (Fe), manganese (Mn), copper (Cu), potassium (K), magnesium (Mg), zinc (Zn), sodium (Na) and calcium (Ca), using methods of atomic spectometry on instruments A Analist 100 and HGA-800 (Perkin Elmer, Waltham, MA, SAD). 2 g of a sample were weighed into a ceramic vessel for annealing. The vessel was put into a cold annealing furnace by Instrumentaria (Croatia). The temperature was adjusted to 550 °C and maintained for 4 hours. After 4 hours vessel was cooled down and the sample inside was treated with 5 mL of 3N HCl. Then, the vessel was covered with a watch glass and the content was cooked for 10 minutes. After 10 minutes, the content was cooled down and filtered to a volumetric flask. Volumetric flask was made up to the mark with distilled water. From the prepared solution were determined contents of Fe, Mn, Cu, K, Mg, Zn, Na and Ca. The blank was also prepared with the same method, only without the sample.

Determination of the total polyphenols

Folin-Ciocolteu method was used for total phenols determinatiom using spectrophotometer by ThermoFisher Scientific (USA) at wavelength of 756 nm. Gallic acid was used to prepare the standard curve. 0,1 mL of diluted jam solution was pipetted to the test tubes after which 1.9 mL of a distilled water, 10 mL of Follin-Ciocolteu reagent and 8 mL of sodium carbonate solution were added. Apsorbance was measured after 2 hours. The blank was prepared with distilled water instead of the sample.

Determination of hydroxymethylfurfural (HMF)

Hydroxymethylfurfural reaction with barbituric acid and p-Toluic acid were applyed, where the pink color is produced which is measured on the wavelenght of 550 nm. 10 g of the sample was dissolved in 20 mL of distilled water. This solution was transfered to the measuring flask of 50 mL and was made up to the mark with distilled water. 2 mL of this solution was pippeted into each of two tubes. Into one tube was added 1 mL of distilled water and into other 1 mL of barbituric acid. The tube with distilled water was used as a blank. Apsorbances in these samples were measured. Content of HMF is expressed in mg/kg.

Results and discussion

As shown in Fig. 1, the content of dry matter of jam samples was from 64.27% to 77.33%. The average value was (72.38 ± 3.62 %). As the process of concentration of juice is the main factor which determine the content of dry matter, that means that the cultivar of apple does not have an impact on the dry matter content of the jam. Apple jam samples had the similar content of dry matter as the commercial apple jam (65.7%) (Mendoza et al., 2002). Fig. 2 shows a coefficient of correlation between dry matter content and relative density.

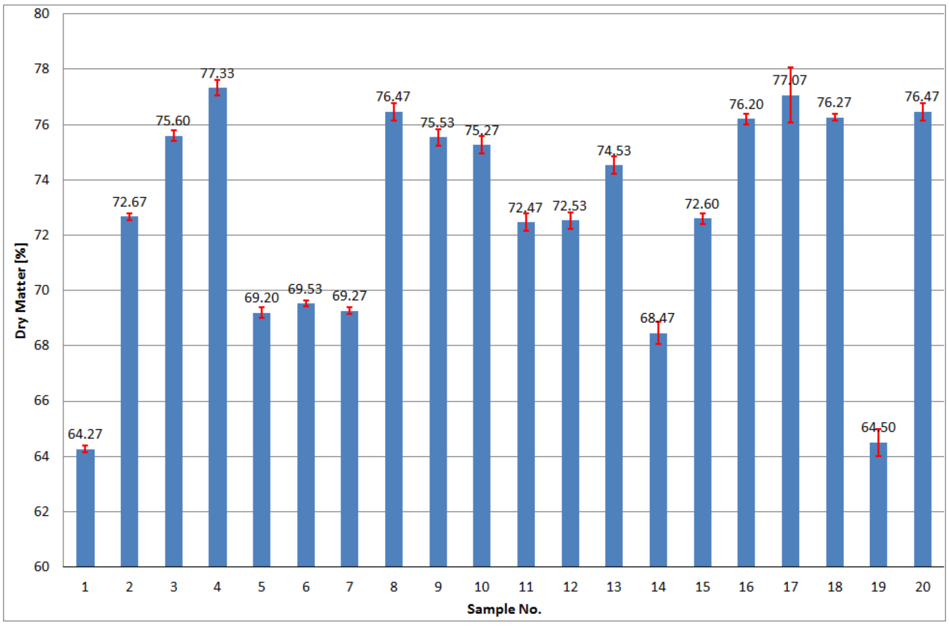


Fig. 1. The content of dry matter in the jam

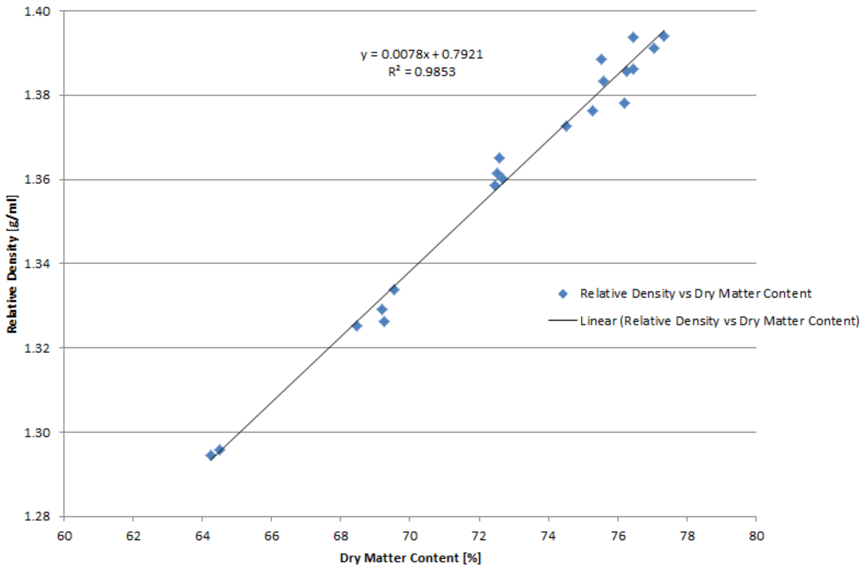


Fig. 2. Coefficient of correlation between dry matter and relative density

The presence of acids in apples affect the pH value of the jam. Research results of the eight apple cultivars have showed that the pH value is 3.87, while the pH value of the jam was from 4.05 to 4.70, as shown in Fig. 3, and the average value was (4.25±0.15). Apple jam samples had the similar pH value as the commercial apple jam (3.54) (Mendoza et al., 2002).
As shown in Fig. 4, the total sugars in jam samples were between 53.49 g/100 g and 67.32 g/100 g, while the reducing sugars were between 51.50 g/100 g and 65.55 g/100 g. Apple jam samples had the similar total sugars values as the grape, apricot, strawberry and blueberry jams (65.99 - 67.65 g/100 g) (Mohd Naeem et al., 2015). The content of sucrose was from 0.72 g/100 g to 1.99 g/100g. The reducing sugars make 97.42% compared to the total sugars.

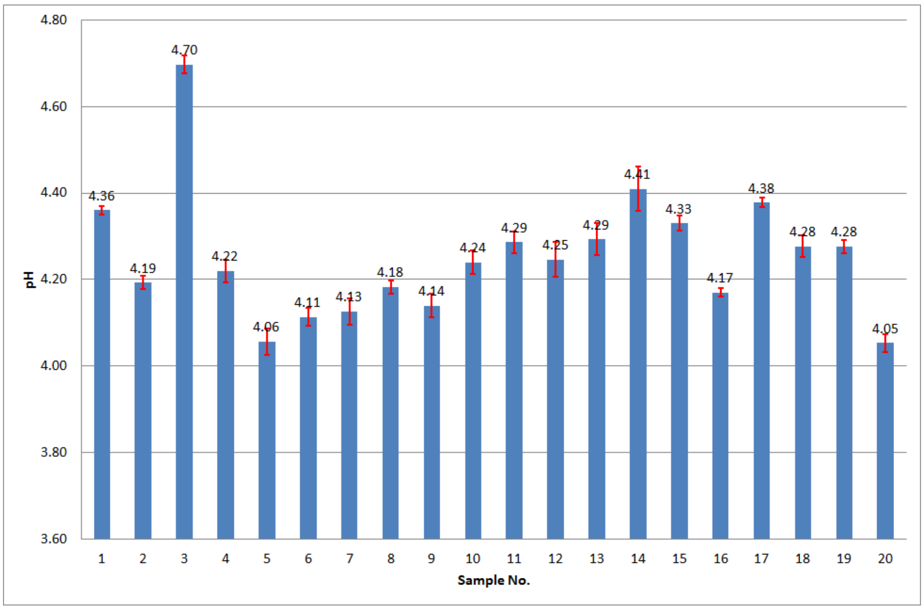


Fig. 3. pH values of the jam samples

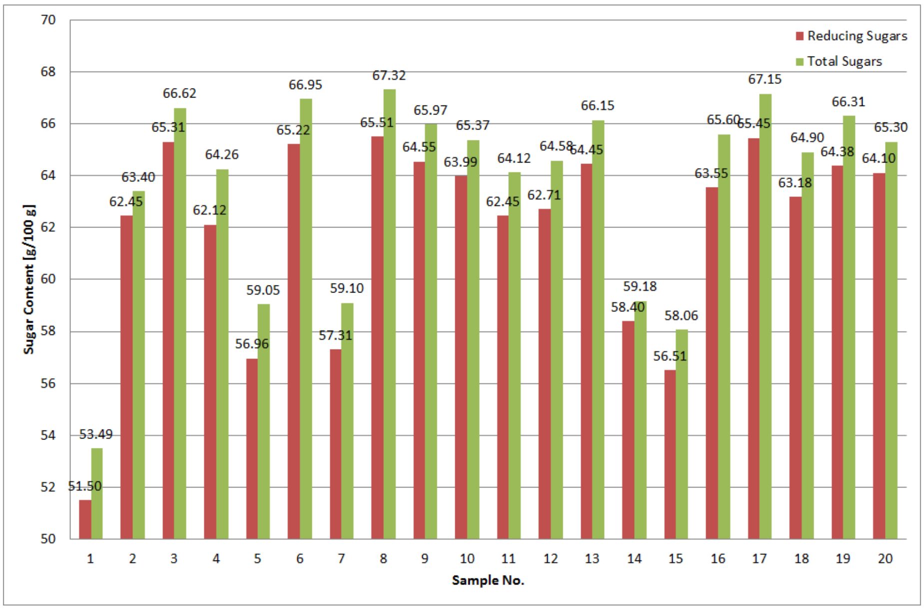


Fig. 4. Sugar content in the jam samples

As shown in Fig. 5, the ash content in the jam samples was between 0.93% and 1.60%. The average value was (1.26 ± 0.21 %). Ash in the jam does not represent just valuable substances. Ash content of the apple jams was significantly higher to the one reported for the grape, apricot, blueberry and strawberry jams (0.12 - 0.25 %) (Mohd Naeem et al., 2015). However, the presence of some metals in the concentrations above allowed values can cause toxicity of the jam.

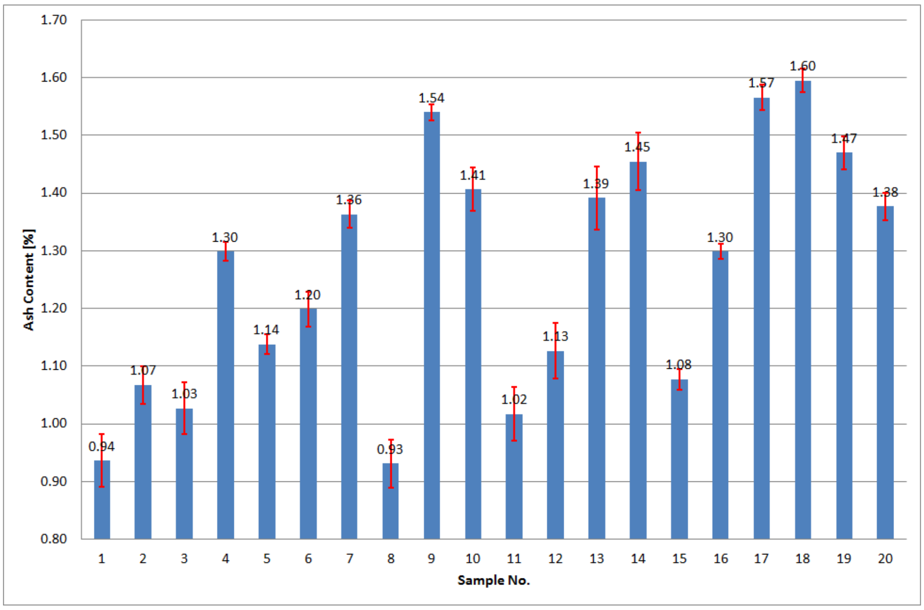


Fig. 5. The ash content in jam

As shown in Fig. 6, the total nitrogen in the jam samples was from 301.80 mg/kg to 1472.60 mg/kg. The average value was 685.10 ± 300.80 mg/kg. The sample No. 2 had significantly bigger nitrogen content compared with the sample No. 18.

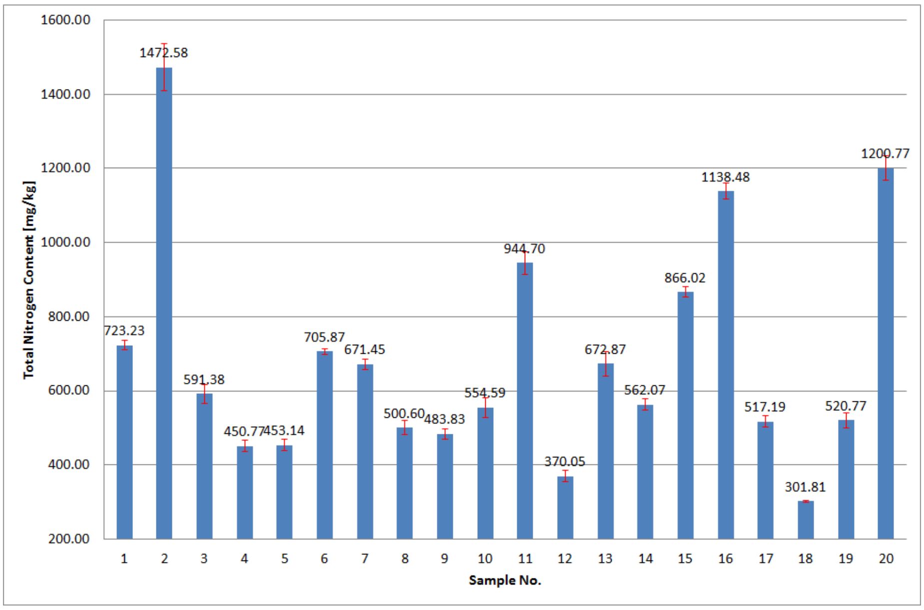


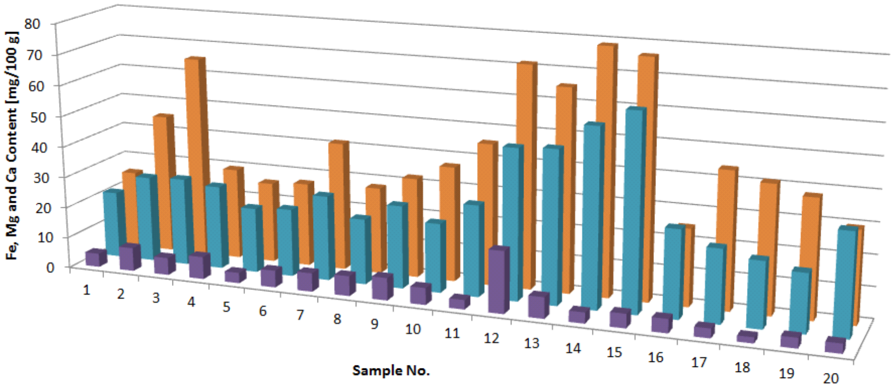
Fig. 6. Total nitrogen content of the jam samples

For the determination of nutritional grade of jam, 20 jam samples have been analysed and the content of: iron (Fe), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), zinc (Zn), copper (Cu) and manganese (Mn) have been determined.

As shown in Fig. 7, the content of iron in apple jam samples was from 1.88 mg/100 g to 19.82 mg/100 g. The average value was 5.61 ± 3.74 mg/100 g. In the jam sample No. 12 the content of iron was 19.82 mg/100 g. Fe content of the apple jams was significantly higher to the one reported for the grape, apricot, blueberry and strawberry jams (0.200-0.267 mg/100 g) (Mohd Naeem et al., 2015). The reason for this high content of iron is the equipment used during grinding, percolating and concentrating. The jam from ‘Samoniklica’ cultivar had the iron content 5.88 mg/100 g, while the jam from mixed apple cultivars had the iron content 5.34 mg/100 g. When the results of the sample No. 12 were excluded, the average value for the jam from mixed apple cultivars was 3.82 mg/100 g. Based on the results it can be concluded that the jam from ‘Samoniklica’ had bigger content of iron compared with jam from mixed cultivars.

The content of magnesium (Mg) in the jam was present in much less amount compared with the other products of plant. The content of magnesium in jam, which can be seen in Fig. 7, was from 18.79 mg/100 g to 62.86 mg/100 g. The average value was (30.80 ± 12.91) mg/100 g. Mg content of the apple jams was significantly higher to the one reported for the grape, apricot, blueberry and strawberry jams (2.717- 6.783 mg/100 g) (Mohd Naeem et al., 2015). Unlike iron which has to be taken by food, the organism effectively process Mg and stored it in the kidneys, as well as excrete all of the excesses Mg. This is the reason why magnesium deficiency is rare. The results of magnesium content indicate that analysed samples from 1 to 10 had approximate content and those were the samples of the jam from ‘Samoniklica’cultivar. The magnesium content was slightly higher for other ten samples (samples 11-20) and the differences between the samples were significant.

Calcium (Ca) has an important role as a macro-element in the organism, where the lack of calcium can lead to diseases such as osteoporosis. The content of calcium in jam samples, which can be seen in Fig. 7, was from 24.80 mg/100 g to 78.82 mg/100 g. The average value was 43.64 ± 18.03 mg/100 g. Ca content of the apple jams was significantly higher to the one reported for the grape, apricot, blueberry and strawberry jams (6.517- 18.100 mg/100 g) (Mohd Naeem et al., 2015). The present amount of Ca in the jam can not satisfy minimum daily intake nor 10% of organism needs. The low content of Ca in the jam is a reflection of insufficient amount of Ca in the soil which confirms that the soil on this territory is acidic. Often for intensive fruit-growing, the whitewash is added for the neutralisation of the acidic soil. The low calcium content in the jam is a good base for absorption of iron in the human organism, because high values of calcium prevent absorption of iron.

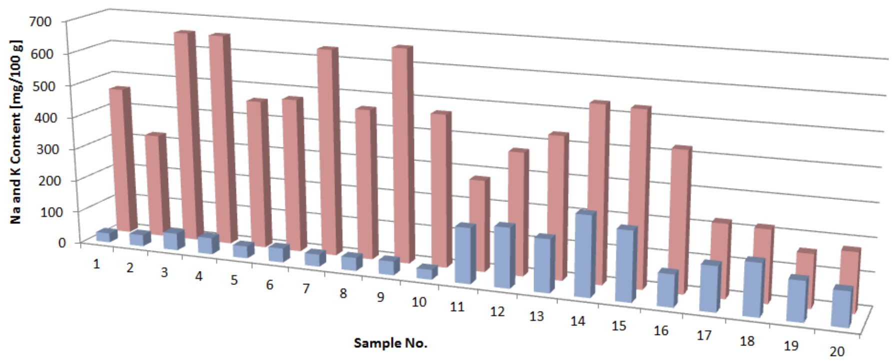


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Fe	4.42	7.6	5.6	7.28	3.39	5.46	6	6.43	7.24	5.43	3.03	19.82	6.81	3.5	4.56	4.46	3.04	1.88	3.27	3.09
Mg	21.51	27.77	28.35	27.02	20.99	21.86	27.4	21.14	26.67	22.23	29.35	48.43	49.15	57.23	62.86	28.13	23.48	21.09	18.79	32.63
Ca	25.2	45.29	65.38	29.56	26.1	27.06	41.5	27.98	32.24	37.11	45.63	71.52	65.41	78.82	76.45	24.83	44.04	41.07	38.05	29.58

Fig. 7. The content of iron, magnesium and calcium in the jam

Fig. 8 shows that sodium content (Na) in the jam samples was from 29.10 mg/100 g to 244.19 mg/100 g. The average value of sodium in 20 analyzed samples was 99.31 ± 68.89 mg/100 g. Na content of the apple jams was significantly higher to the one reported for the grape, apricot, blueberry and strawberry jams (1.367 - 9.233 mg/100 g) (Mohd Naeem et al., 2015). From the results of the Na content in the jam from Samoniklica it can be seen that it can satisfy up to 10% of organism needs, regarding the fact that the recommended minimum daily intake of Na is 500 mg. The content of sodium in the ‘Samoniklica’ jam was approximately equal and it was not bigger than 50 mg/100 g, while the content of sodium in the jam from mixed cultivars was much higher.

Potassium (K) belongs to the group of macro-elements and it has a significant effect on the balance of liquids in the organism. Regarding the obtained results, it is in considerable amount represented in the jam. As shown in Fig. 8, the content of potassium was from 160.10 mg/100 g to 656.00 mg/100 g. The average value was 430.70 ± 159.70 mg/100 g. It can be seen from the results that the jam had a high content of potassium because of the high content of potassium in the soil. The content of K was determined on the territory of Gradačac by Faculty of Agriculture in Sarajevo in collaboration with „Proizvodno marketinška grupa voće i povrće poljoprivredna zadruga Gradačac“ (PZ „PMG“ Gradačac) and results showed that the content of K in the soil was from 30.00 mg/100 g to 100.00 mg/100 g. Recommended minimum daily intake of potassium is 2000.00 mg, and it can be concluded that 100 g of jam can satisfy 25% of total needs for the human organism. The jam from ‘Samoniklica’ contains more potassium in comparison with the jam from mixed apple cultivars.



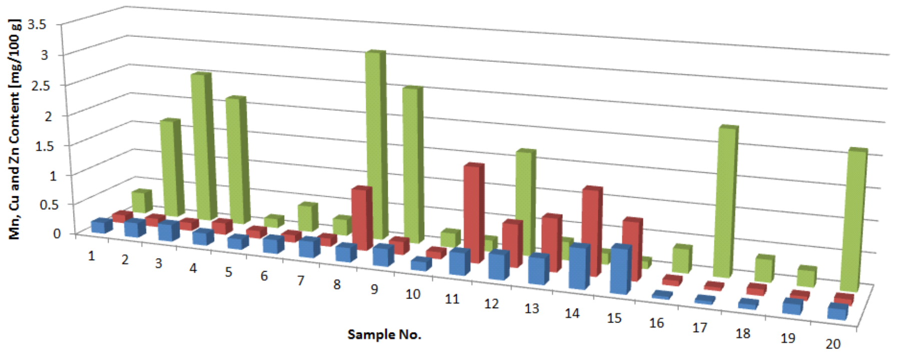
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Na	29.2	35.79	52.8	51.09	37.62	43.88	37.76	40.33	42.35	30.45	169.6	182.9	161.4	244.2	211.9	97.7	135.2	157.5	120	104.5
K	463.1	323.8	656	654.9	460.6	475.4	636.6	462.9	656	468.2	279.7	374.7	433.9	535.6	530.4	424.2	221.9	217.8	160.1	178.1

Fig. 8. The content of sodium and potassium in the jam

Manganese content (Mn) in the jam samples was between 0.05 mg/100 g and 0.70 mg/100 g, which can be seen in Fig. 9. The average value was (0.26 ± 0.17) mg/100 g. The jam samples from ‘Samoniklica’ had similar manganese content, while that was not a case with mixed cultivars. The highest manganese content was observed in the sample No. 15. Recommended minimum daily intake for manganese is 2.50-5.0 mg. It has the important role in the formation and maintenance of bones, cartilage and connective tissue. Also, it contributes to the protein synthesis and genetic material, helps generating energy from food, works as antioxidant and helps normal blood coagulation. The nutrient composition of foods can satisfy recommended intake of manganese.

Copper content (Cu) in the jam samples was between the values 0.05 mg/100 g and 1.55 mg/100 g, as shown in Fig. 9. The average value was 0.41 ± 0.48 mg/100 g. The highest content of Cu was recorded in the sample No. 11. Copper is important for human health because it helps creating haemoglobin in blood, facilitates iron absorption so that the red blood cells can transfer oxygen to the tissue. It affects the blood pressure and heart beats, helps strengthening blood vessels, bones, tissues and nerves, improves fertility and provides healthy skin and hair pigmentation. Also, it protects the tissue from free radical damages, strengthens immune system and has a part in cancer suppression. Cu content of the apple jams was significantly higher to the one reported for the grape, apricot, blueberry and strawberry jams (0.003 - 0.023 mg/100 g) (Mohd Naeem et al., 2015). It was determined that jam samples 8, 11, 12, 13, 14 and 15 had higher copper content compared with all the other samples. The reasons for high copper content in samples number 8, 11, 12, 13, 14 and 15 can be the: presence of large amount of copper in the soil, as well as the production method of jam. Traditionally, the jam was produced by concentrating the juice done in cupric kettles or tavulji which are not appropriate for the production of jam.

Zinc content (Zn) in the jam samples was between values 0.12 mg/100 g and 3.09 mg/100 g. The results showed in Fig. 9 were pointing out that there were no significant differences between the jams produced from 'Samoniklica' and from mixed apple cultivars. The average value was 1.07 ± 1.05 mg/100 g. Zn content of the apple jams was significantly higher to the one reported for the grape, apricot, blueberry and strawberry jams (0.010 - 0.070 mg/100 g) (Mohd Naeem et al., 2015). Zinc is significant element but its lack in the organism is very common due to insufficiently food intake. Compared with 15.00 mg of recommended daily dose, 100.00 g of the jam can satisfy 10 - 20 % of daily needs of the organism, and it can be significant for kids, vegans and elders.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Mn	0.187	0.246	0.282	0.205	0.174	0.23	0.27	0.235	0.288	0.145	0.361	0.403	0.419	0.644	0.7	0.045	0.051	0.074	0.156	0.16
Cu	0.139	0.143	0.137	0.194	0.13	0.124	0.136	1.001	0.216	0.115	1.554	0.701	0.86	1.36	0.931	0.087	0.054	0.102	0.067	0.1
Zn	0.357	1.668	2.512	2.154	0.152	0.434	0.27	3.092	2.555	0.236	0.189	1.682	0.298	0.18	0.121	0.386	2.324	0.36	0.256	2.139

Fig. 9. The content of manganese, copper and zinc in the jam

The highest difference in the content of Ca, Mg, Na, Mn and Cu was observed between the samples 11, 12, 13, 14 and 15. Many factors can influence the minerals content, for instance: the soil, precipitation, technological processes and the equipment.

Beside minerals which are present in the jam, biological active compounds like polyphenols are also present. As shown in Fig. 10, the content of total polyphenols in jam samples was in range from 0.36 g/L to 1.00 g/L. The average value of polyphenols in the jam was 0.75 g/L. Samples 10, 13 and 14 had highest polyphenol content which was not influenced with apple cultivar. Some of the jam samples, such as sample No. 20, had low polyphenols content which can be result of low exposure to sunlight which leads to unripe apples.

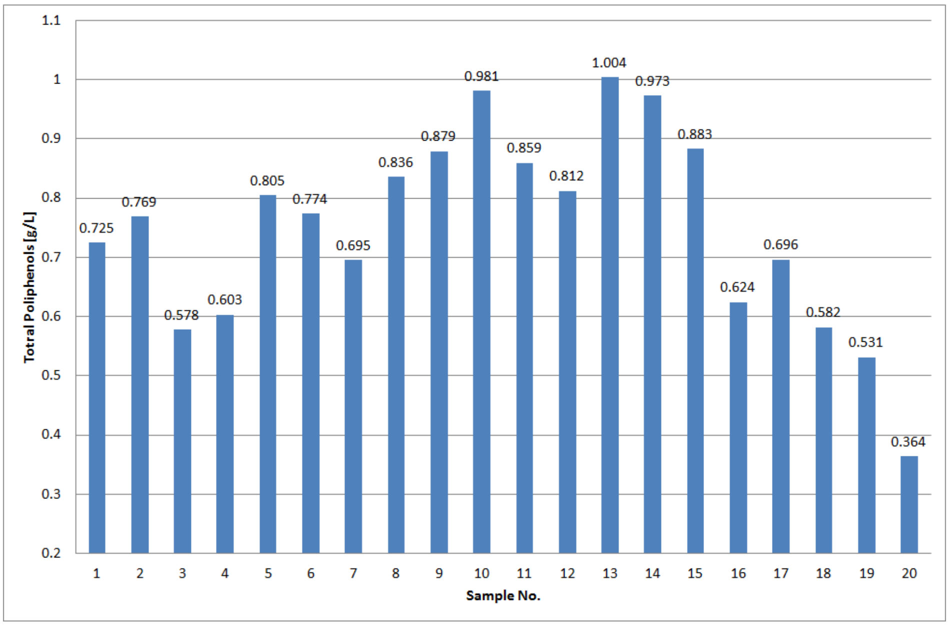


Fig. 10. The content of polyphenols in jam

The results of HMF content analysis in the jam were divided in three groups. The first group represented results of jam sample which were produced at lower temperatures up to 70 °C. The second group included the samples which were produced in traditional way, while the third group included the samples which were produced before the year 2006.

As shown in Fig. 11, the HMF content in jam samples produced at lower temperatures was between values 0.63 mg/kg and 4.4 mg/kg, while the average value was

2.86 mg/kg. Besides temperature as the main influence factor on the high HMF content, the significant effect can have the juice amount which needs to be concentrated, as well as the evaporable surfaces.

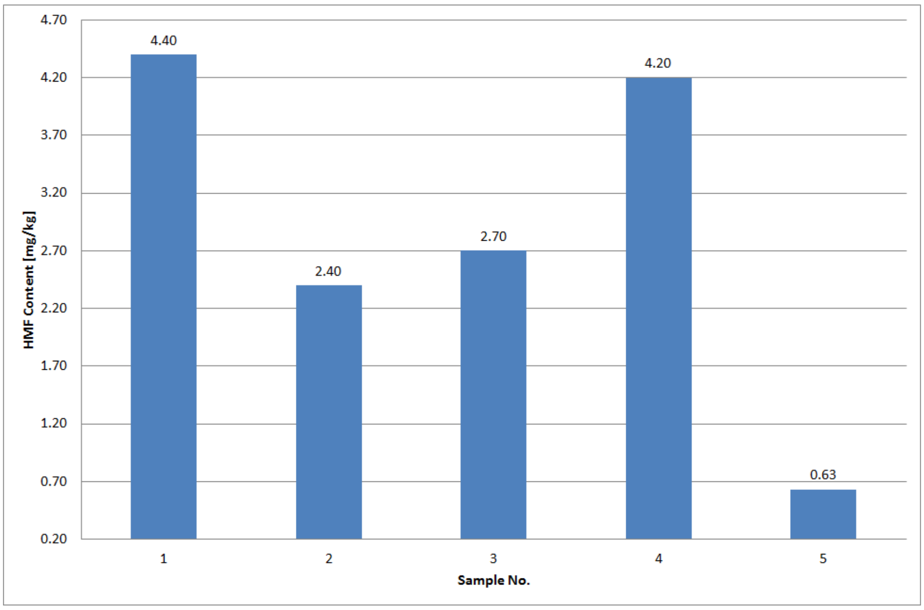


Fig. 11. The HMF content of jam produced at temperature up to 70 °C

The second group included the results of samples analyses which were produced in traditional way, which can be seen in Fig. 12.

Their HMF content was from 3.40 mg/kg to 30.90 mg/kg, while the average value was 24.79 mg/kg. The jam samples of the second group were produced in the year 2011 and the process of concentrating of juice was carried at controlled temperature. The sample No. 14 had significantly lower HMF content compared with other samples. This result indicates that the sample No. 9 is concentrated at lower temperature compared with the traditional process of concentration, as well as the evaporable surface was bigger. The sample No. 9, according to the HMF content can be classified within the first group of samples which were concentrated at the temperatures up to 70 °C which leads to the conclusion that the jam produced in traditional way can have low HMF content.

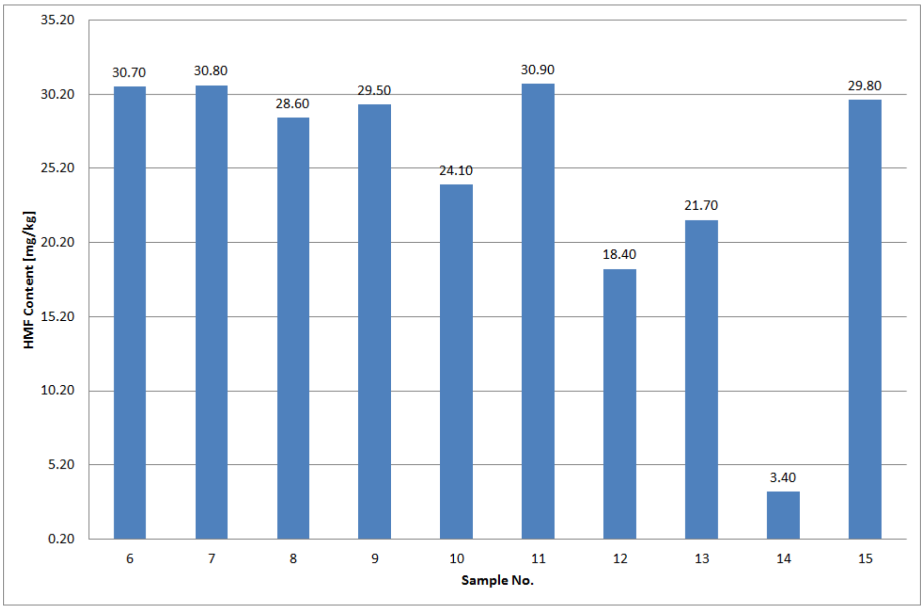


Fig. 12. HMF content of jam produced in traditional way

The third group included samples which were also produced in traditional way but the jam was produced before the year 2006. HMF content in the jam produced before the year 2006, which can be seen in Fig. 13, was between 67.67 mg/kg and 1646.03 mg/kg, while the average value was 595.66 mg/kg. The big differences ocurred among the results of samples belonging to the third group. The high HMF content in the samples of third group can be caused by the year of production of the jam and bad juice percolation (presence of fruit parts) which lead to increase of the HMF content at high temperatures. The findings were not comparable to the HMF content of apple commercial jam (0.98 mg/199 g), which had a significantly lower HMF content (Mendoza et al., 2002).

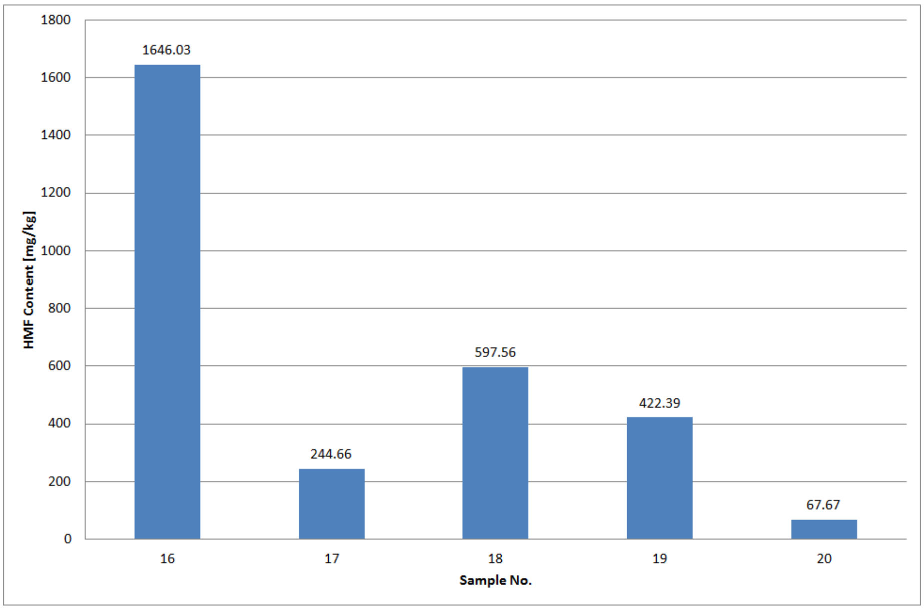


Fig. 13. HMF content in jam produced before the year 2006

The apple cultivar does not have the effect on the HMF content. The results showed that the traditional way of the jam production can satisfy standards when it comes to the HMF content, along with quality production control. The dry matter content in the jam had a low coefficient correlation with the HMF content.

Conclusions

According to the obtained results it can be concluded that the jam from traditional apple cultivars can be used as functional food. Carbohydrates make 85% of the entire dry matter of the jam which indicates that the jam can be classified as high energy food and as such can be recommended to the sport players. The recommended daily intake of potassium is 2000 mg, which means that 100 g of jam can satisfy 25% of daily organism requirements. The content of zinc in 100 g of jam compared to the recommended daily intake of 15 mg, can satisfy 10 - 20 % of daily organism requirements, which can be significant for little children, vegans and elderly. 100 g of the jam can satisfy 35% of daily organism requirements for iron. The high HMF content can be caused by the higher temperatures, so it leads to a conclusion that jam needs to be prepared in controlled temperature.

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