Physico-chemical analysis of pekmez products made from grape varieties grown in the conditions of Uzbekistan

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Abstract. This article presents the results of a study on the physical and chemical properties of pekmez products made from technical grape varieties grown in soil and climate conditions of the Parkent district of the Tashkent region. In the study, physico-chemical properties including water-soluble dry matter content (°Bx), pH level, titratable acidity, density, ash content, 5 phenolic compounds and active antioxidant content of pekmez obtained from technical grape varieties “Saperavi” (black-colored), “Hindogi” (black-colored), “Soyaki” (white-colored), “Bayan Shirey” (white-colored), “Muskat Rozovy” (pink-colored), “Morastel” (black-colored) were determined. According to the results of the analysis, the amount of water-soluble dry matter in the pekmez samples obtained from different grape varieties was in the range of 69.33-74.40%, the pH level was between 4.34-5.70, and the titratable acidity was 0.65-0.75 (gr-100gr/l) was determined that the total ash content was in the range of 1.40-3.30 (g/cm³). The amount of phenolic compounds preserved after thermal processing, including caffeic acid, gallic acid, ferulic acid, p-coumarinic acid, ellagic acid and active antioxidant, have also been analyzed. Among the studied acids, caffeic acid was the most abundant (9.10-11.40 mg/kg⁻¹). Gallic acid (1.0-1.66), ferulic acid (0.70-2.10), p-coumarinic acid (0.68-2.67) and ellagic acid (0.20-0.40) tended to decrease during heat treatment. The highest antioxidant activity (66-68 µmol TE g/1) was recorded in black grape varieties, this indicator of pekmez made from white varieties was slightly lower (54-59 µmol TE g/1), the antioxidant activity of pink grape varieties had an intermediate expression (57.55 µmol TE g/1).

Keywords. Grapes, pekmez, phenol, antioxidant, dry matter, organic acid.

1 Introduction

In recent years, humanity has faced great challenges in terms of health, as a result of those the need for products with high biological and nutritional value has increased even more [1]. Today, it is an important task to expand the range of agricultural products by researching food products of good quality, free of various preservatives and useful for the human body, and at the same time ensuring food safety, which is one of the biggest problems [2, 3].

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role of grapes in the production of biologically active and nutrient-rich products is incomparable [4, 5]. Today, grapes are grown in Uzbekistan on an area of about 178.3 thousand hectares. Table grapes are grown on 40-43% of the area, raisin on 45-48%, and wine on 18-20%. A large part of the grapes grown are mainly table grapes and raisin varieties. The volume of industrial grape cultivation, processing, obtaining and packaging of various products is smaller, and it is necessary to radically expand and modernize this industry in accordance with the requirements of the times [6, 7].

For this reason, our state should establish clusters to create a full cycle of processing grapes and transformation of grapes into finished product, increase the total area of vineyards in our country to 321 thousand hectares by 2025, and establishing the production of new grape products that are competitive in export and foreign markets. Investment is set as one of the priorities of the national economy.

Grapes are known to play an important role in protecting human health due to the presence of valuable compounds such as phenolic compounds, minerals, vitamins and antioxidants. Grapes are a rich source of bioactive compounds [8-10]. Grapes contain phenolic substances with antioxidant properties. Phenolic compounds are secondary plant metabolites belonging to bioactive phytochemicals with characteristic hydroxyl (-OH) groups on aromatic rings [11].

They are based on the carbon skeleton of flavonoid and non-flavonoid compounds and are responsible for protecting plants from various microbiological infections and ultraviolet rays, regulating metabolic exchanges, and providing color and aromatic substances [12, 13]. The biochemical composition of grapes depends on many factors, including growing conditions, climate, soil composition, variety and degree of ripeness. Grapes ripen even within the same variety in different regions with different biological characteristics.

2 Materials and methods

Located in Uzbekistan on the western foothills of the Chotkal range of the Middle Tianshan and surrounded by mountains, Parkent District is 800 - 3627.8 (Kizilnura Peak) meters above sea level, in the most favorable region of the globe for viticulture, 41°north latitudes and It is located between 69°40′35 east longitudes (Figure 1).

Parkent has long been known for its unique viticultural experience. Here, vineyards are planted on hills with slopes of 15-60%. Good exposure of sunlight to these slopes and moderate air circulation strongly limit the occurrence of diseases such as mold in such vineyards. A large part of the vineyards erected in the district are characterized by raisin varieties. In addition, table and technical grape varieties are also planted in large areas.

Most of the grape varieties grown in Parkent district are used for the production of raisins and wine products. However, it is worth noting that not only wine and wine materials can be produced from the technical varieties of grapes, but also other highly nutritious, exportable food products such as pekmez, grape juice, drinks blended with grape juice, sauces and pastes, cream. The use of such opportunities is currently implemented in Uzbekistan on a very small scale.

Pekmez is a syrup prepared by boiling grape molasses and grape juice for a certain time without adding sugar or other additives. This traditional product has long been produced in large quantities in Eastern countries, especially in Uzbekistan. The biochemical composition of pekmez is distinguished by its richness in organic acids, minerals, and various vitamins. This product improves the functioning of the cardiovascular system and blood circulation, strengthens the capillaries.
Figure 1. Geographical location photo map of Parkent district, Uzbekistan

Pekmez increases the immune system of the human body, prevents the spread of viral diseases, increases tolerance to them. Useful in diseases of the gastrointestinal tract. It is recommended to use pekmez when suffering from high blood pressure. Also, pekmez is a high energy source, because almost 60-80% of pekmez consists of carbohydrates.

In the research, the yield of “Saperavi”, “Hindogni”, “Soyaki”, “Bayan Shirey”, “Muskat rozaviy” and “Morastel” varieties grown in the soil and climate conditions of Parkent district of Tashkent region was studied as an object. The harvest of the cultivars reached the period of physiological ripening, and when 24-26% of dry matter was formed in the juice on the °Bx scale, it was determined by a field refractometer (Pal-1 Atago, Japan) and then picked. After the grapes were crushed and juiced, they were boiled for 5-6 hours until it reached 65-70°Bx without using any coagulants.

A bubble was made from the foam that was released during boiling. After the pekmez was ready, it was put in glass containers and cooled. The composition of the experimental pekmez samples, including the amount of water-soluble solids, titratable acidity, pH, ash content, active antioxidants and total phenolic substances, were determined. Laboratory analyzes were carried out in cooperation with the experimental laboratory of the department of storage and processing of agricultural products of Tashkent State Agrarian University and the wine laboratory of MEHNAT GROUP agro-firm located in Tashkent region.

The amount of water-soluble dry matter in pekmez was measured at room temperature (18-20 °C) in a refractometer (Refractometer PAL BX ATAGO, Japan) and expressed in °Bx. The titratable acidity was determined using 0.1 NaOH or KOH as an indicator (a 10 ml sample of pekmez is heated with as much distilled water and 0.1 N NaOH is added and titrated with constant shaking until the color changes). The completion of the titration is determined by the color change of the indicator (phenolphthalein). Also, the pH indicator was determined using a pH meter (Benchtop pH 50 VioLab Basic, Made in Germany).

The amount of total phenolic compounds in the samples was determined by the Folin-Ciocalteu colorimetric method. To each 4 mL diluted sample, 0.1 mL of Folin-Ciocalteu solution was added, then 500 mL of 20% sodium carbonate (Na₂CO₃) solution was added and shaken for 4 minutes. After that, the samples were incubated at room temperature (20 °C) for 90 minutes. Finally, the samples were measured at a wavelength of 760 nm and gallic
acid was taken as a control. Results were expressed as milligram equivalents (Jenway 6705, Staffordshire, UK).

Experiments were carried out in full three times. The results were analyzed using Microsoft Excel and NCSS statistical models.

3 Results and discussion.

Analysis of physic-chemical properties of pekmez samples made from grape varieties of Parkent district showed that the amount of water-soluble dry matter in them differed according to the color of the cluster of grape varieties and ranged from 69.33 to 74.40% has changed. In this case, the content of water-soluble dry matter was the lowest in light-colored grapes, and varied between 69.33-71.38% according to varieties. The amount of water-soluble dry matter in the samples of pekmez products obtained from black grape varieties reached 74.40%. In grape bunches, water-soluble dry matter was mainly represented by fructose, glucose and sucrose formed from sugar, and acids - citric acid, malic acid (Table 1).

Table 1. Physic-chemical characteristics of grape pekmez samples from different grape varieties (2021).

<table>
<thead>
<tr>
<th>Grape varieties</th>
<th>Water-soluble dry matter content (%)</th>
<th>Titratable acidity (gr-100gr/l)</th>
<th>pH</th>
<th>Density (g/cm³)</th>
<th>Ashiness (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Bayan Shirey” (white)</td>
<td>71.38</td>
<td>0.66</td>
<td>4.34</td>
<td>1.200</td>
<td>1.40</td>
</tr>
<tr>
<td>“Soyaki” (white)</td>
<td>69.33</td>
<td>0.68</td>
<td>4.73</td>
<td>1.220</td>
<td>1.90</td>
</tr>
<tr>
<td>“Hindogni” (black)</td>
<td>71.14</td>
<td>0.75</td>
<td>5.20</td>
<td>1.350</td>
<td>3.30</td>
</tr>
<tr>
<td>“Morastel” (black)</td>
<td>74.40</td>
<td>0.65</td>
<td>4.65</td>
<td>1.450</td>
<td>2.69</td>
</tr>
<tr>
<td>“Muskat Rozoviy” (Pink)</td>
<td>71.13</td>
<td>0.74</td>
<td>5.70</td>
<td>1.250</td>
<td>2.80</td>
</tr>
<tr>
<td>“Sapereavi” (black)</td>
<td>73.30</td>
<td>0.78</td>
<td>5.30</td>
<td>1.400</td>
<td>3.10</td>
</tr>
</tbody>
</table>

The color intensity of the finished pekmez product also directly depended on the color of the bunch of grape varieties used. According to the rule, the product of pekmez with a dark-brown tint was obtained from such varieties as “Khindogni”, “Saperavi” and “Morastel”. The most light-skinned pekmez was recorded in the “Bayan Shirey” variety (Figure 2).

The data of the table above show that due to the fact that all the varieties studied belong to the technical varietal group, the titrable acidity of the pekmez product made from them also practically did not differ and changed in the range of 0.65-0.78 g/L. At this point, it is worth noting that in the traditional method, which has long been used by local residents, the titrating acidity of pekmez differs significantly when white soil is boiled. Also pekmez titrable acidity will depend on both the year of harvest and climatic conditions in which the grapes were grown.

The analysis of the pH level of pekmez obtained from the studied varieties also had the same tendency as the total acidity. Consequently, the pH indicator of pekmez did not depend on the color of the seed pods and had almost the same expression. This technological indicator was in the range of 4.34-5.70 according to varieties. The density of the prepared pekmez also differed depending on the varieties, in particular, their value and the amount of phenolic compounds. In this case, the highest density - 1350-1450 g/cm³ was recorded in such varieties such as black-grained “Morastel”, “Saperavi”, and “Hindogin” respectively. The lowest density - 1200-1220 g/cm³ was found in “Bayan Shirey” and “Soyaki” varieties. The density of the pekmez product made from the remaining varieties took an intermediate
place between these varieties and varied within the limits of 1250-1350 g/cm³. The total ash content of the samples was in the range of 1.40-3.30 (g/cm³), respectively, by varieties.


The analyzes showed that the organic acids and antioxidant activity of the pekmez product prepared from the studied varieties differed depending on the varieties. Among the studied acids, it was noted that caffeic acid had the largest amount and varied within the range of 9.10-11.40 mg/kg−1 according to varieties. Gallic acid (1.0-1.66), ferulic acid (0.70-2.10), p-coumarinic acid (0.68-2.67) and ellagic acid (0.20-0.40) tended to decrease during heat treatment. Ferulic acid and P-coumaric acid in pekmez samples prepared from all varieties, although in a much smaller value compared to caffeic acid, differed significantly by variety. Therefore, if the minimum amount of ferulic acid is equal to 0.70 mg/kg−1 in the “Bayan shirey” variety, then it was found that its amount reached 2.10 mg kg−1 in the pekmez obtained from the “Hindogi” variety. P-coumaric acid was 0.37 mg kg/l in pekmez obtained from “Soyaki” variety, while it was 2.10 mg kg/l in pekmez obtained from “Hindogi” variety. Ellagic acid was sometimes expressed in the form of traces in pekmez products made from grape varieties. In some varieties, it was not even recorded at all. Ellagic acid was detected only in pekmez prepared from Soyaki, Morastel and Saperavi varieties (Table 2).

The data of the following table 2nd allowed to note the fact that the amount of one or another organic acid in the finished pekmez product does not depend on the color of the grape bunch, on the contrary, it is a characteristic sign of each variety. After all, the highest values of caffeic acid were recorded both in the black-rumped variety (“Hindogni”; 11.33 mg/kg−1) and in the white-rumped variety (“Soyaki”; 11.40 mg/kg−1).
Table 2. Phenolic compounds (mg/kg−1) and active antioxidant content in grape pekmez samples from different grape varieties.

<table>
<thead>
<tr>
<th>Grape varieties</th>
<th>Caffeic acid</th>
<th>Gallic acid</th>
<th>Ferulic acid</th>
<th>p-Coumaric acid</th>
<th>Ellagic acid</th>
<th>Antioxidant activity (mmol TE g/1) DPPH</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Bayan Shirey”</td>
<td>9.10</td>
<td>1.12</td>
<td>0.70</td>
<td>1.31</td>
<td>not found</td>
<td>54.94</td>
</tr>
<tr>
<td>“Soyaki”</td>
<td>11.40</td>
<td>1.48</td>
<td>0.90</td>
<td>0.76</td>
<td>0.40</td>
<td>59.40</td>
</tr>
<tr>
<td>“Hindogni”</td>
<td>11.33</td>
<td>1.66</td>
<td>2.10</td>
<td>2.67</td>
<td>not found</td>
<td>60.84</td>
</tr>
<tr>
<td>“Morastel”</td>
<td>10.40</td>
<td>1.00</td>
<td>1.25</td>
<td>1.66</td>
<td>0.20</td>
<td>68.25</td>
</tr>
<tr>
<td>“Muskat rozoviy”</td>
<td>9.50</td>
<td>0.86</td>
<td>1.41</td>
<td>0.68</td>
<td>not found</td>
<td>57.55</td>
</tr>
<tr>
<td>“Sapereavi”</td>
<td>10.20</td>
<td>1.58</td>
<td>1.45</td>
<td>1.80</td>
<td>0.20</td>
<td>66.23</td>
</tr>
</tbody>
</table>

A number of scientific sources say that antioxidant activity is at slightly higher rates in the bunch of colorful grape varieties. In our experiments, the highest antioxidant activity (66-68 mmol TE g/1) was recorded in black cumin varieties. This indicator of pekmez made of white varieties was expressed by the smallest value (54-59 µmol TE g/1). The antioxidant activity of pink-colored grape varieties had an intermediate expression (57.55 µmol TE g/1).

4 Conclusions

Grape pekmez is a high nutritional and healing product that is not only produced for full-time consumption, but is also widely used in winemaking and confectionery. Grape juice prepared in a traditional way from grape varieties grown in Parkent district of Tashkent region was represented by the highest indicators of biochemical composition, phenolic substances and active antioxidant content. Among the studied varieties, “Soyaki” and “Bayan Shirey” grape varieties can be used for confectionery and coupage of high quality. Black grape varieties such as “Morastel”, “Saperavi”, and “Hindogni” can be used to produce products with higher nutritional value, rich in antioxidants, and higher phenol content than white grapes.

In order to maximally preserve the color intensity of the pekmez product made from various grape varieties, to ensure an excellent harmony of sugar and acidity in them, as well as to radically improve other technological quality indicators of the finished product, it is recommended to produce pekmez not in the traditional way, but in high-tech modernized industrial lines. Condensation of pekmez products in vacuum evaporator boilers allows to preserve the maximum of useful phenolic compounds, vitamins and other biologically active substances, in addition to their color intensity.

Reference

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