EFFECTS OF SOME PRODUCTION FACTORS ON CHEMICAL COMPOSITION AND SENSORY QUALITIES OF WILLIAMS PEAR BRANDY

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Abstract: Pear is one of the most widely grown fruit species across the world, but of all varieties, the best and most appreciated is for sure Williams pear or Bartlett pear as better known in the West. Those choosy worldwide have been enchanted over decades and centuries by its generous, exuberant and extraordinarily pleasing aroma. Bartlett pear’s qualities are probably best expressed through its far and wide famous, delicious, of the same name, pear brandy. For many people it is a queen of all fruit brandies, while for others it is, in general, the best strong alcoholic drink. However, Williams pear brandy is scarcely present in foreign, particularly domestic, professional and scientific literature. This is the reason why the present paper’s author wants to pay due respect to Williams pear brandy for sensory pleasure it affords. Production of top quality Williams pear brandy (top quality only because it is what this pear deserves) is neither simple nor easy. The present paper deals with the most important stages of pear brandy production, therefore it is a pioneering attempt to acquaint scientific, professional and broader consumer audience with this top quality brandy.

Key words: Williams pear brandy, fruit brandy, production, aroma, quality.

Introduction

As a fruit species, pear is the most widespread in the world and for its production of approx. 16 million tons (FAO, 1998/99) it is ranked the sixth (following citrus fruits, banana, apple, mango and olive) and the second among deciduous fruit trees (following apple tree). It is considered to be one of the oldest grown species. The earliest written documents on its growing date back to the
New Stone Age i.e. over 20,000 years. It is thought that 6000 varieties have been developed to date. Asia is its homeland, while Europe is its place of domestication. It is mainly grown in the north hemisphere. The greatest producers are Asia (approx. 50% of world production) and Europe (approx. 21%), and of the countries it is China, Italy, USA, Japan, Spain, France etc. The unofficial title of the queen of all pear varieties goes to Williams pear variety or Bartlett pear variety as better known in the West. Thanks to its pomological-technological properties, it is one of the leading and most widespread pear varieties in many countries. Also, due to its subtle and very pleasing aroma it is highly appreciated raw material for the production of a famous, delicious brandy.

**Bartlett pear**

Williams pear is a very old and appreciated English variety that Williams Bartlett discovered as a spontaneous seedling in 1796. In the West it is better known as Bartlett pear. It is the most widespread pear variety of all. In France, of all areas under pear 20% accounts for Bartlett pear, and in the USA even over 30%. In this country it is also a leading pear variety, highly appreciated and widely grown. Its tree is medium prolific and the crown is of a pyramidal shape. Its flowering season is mid-late; it is frost tolerant to likely late spring frosts and is an excellent pollinator for varieties flowering at the same time. It sets a crop very early and cropping is regular and abundant. Fruit is ripe in the second half of August. It is medium large to large, elongated and regular-pear-shaped, most often weighing 150-200 g. It stands shipping and handling conditions very well and can be kept in adequate atmosphere-controlled chambers as long as 5 months. In its lower part, the fruit has marked irregularities, where tiny and numerous brownish lenticels are noticeable. The skin is thin, smooth and shiny; at the outset of ripening it is green and later it becomes green-yellowish, while at the full technological phase it is straw-like yellow. Sometimes, a very delicate blush can be brought to fruits exposed to longer hours of sunshine. Mesocarp (the fleshy part of the fruit) is white, tender and juicy, of fine gritty structure, with extremely pleasant and pleasing Muscat flavor. It is the best quality pear variety of all, and some authors find it, in general, the best quality fruit variety.

**Production of quality Williams pear brandy**

Technologically, the right time of picking is very important. Today, aside from organoleptic evaluation of maturity, there are modern instrument-analytical methods (tenderometry, penetrometry, standard chemical analysis) for examining specific properties and chemical composition of pear. For objective evaluation of technological maturity stage, the most reliable parameters are fruit size and its
technical characteristics, mesocarp firmness, and the most significant parameters of chemical composition. The best time to pick Bartlett pear is as early as in its biological i.e. physiological maturity (5-10 days prior to technological maturity) when it is still firm and contains approx. 50-60% maximum starch content (like bananas). Thereafter, pear fruits are left in a suitable storage to gradually ripen. During this period, sugar content is increasing, primarily due to hydrolysis of starch but also of cellulose, hemi-cellulose and pectins. Fruits become softer, receive characteristic color, while flavor reaches its top quality.

Not fully ripe fruits are unsuitable for processing because later on insufficiently fermented crushed fruit produces distillates of unpleasant and repulsive herbal and grassy flavor. This phenomenon is caused by hexanal and hexanol compounds deriving from linoleic acid present in higher amounts in unripe fruits. One should know that mentioned compounds develop to a greater extent at higher fruit pomace aeration but to a lower extent in CO₂ presence. Therefore, it is advisable to immediately transfer just crushed Bartlett pear fruit into a container saturated with CO₂ or into a fermentor where fermentation has already started. The highest amount of Bartlett pear’s aromatic potential is concentrated in that part of mesocarp around core. When fruits are disintegrated in a suitable mill for pome fruits, core should be damaged as little as possible because a certain amount of CN unions is concentrated in seeds, which is a precursor of developing harmful ethyl-carbamate, and can later impart stale and rancid flavor to distillates.

Alcoholic fermentation of fruits should be conducted slowly at low temperature, most suitably at 18°C, so that valuable aromatics of Bartlett pear are preserved as much as possible. To make fermentation as genuine and uniform as possible, pH of crushed fruit should be reduced by medium acidification with 50 ml H₂SO₄ per 100kg crushed fruit or even better with 1:10 H₂SO₄. To make fermentation faster and thorough, it is advisable to add some mineral salts for yeasts, e.g. (NH₄)₂SO₄ or (NH₄)₃PO₄ at the rate of 10-25g/100kg crushed fruit. To model the chemical composition of produced brandies (higher alcohols selection), it is desirable to carry out fermentation with some selected yeast strains at the rate of 20-25g/100kg crushed fruit.

Distillation of fermented crushed fruit should be done immediately or within 48h after fermentation is finished, so that harmful components do not increase (methanol, acids, esters, aldehydes, HCN etc.) and accumulated secondary aroma (emerging due to yeast activity) does not become lost. Distillation is performed in a simply designed device i.e. copper pot still of Charant type, where first-made brandy fraction is not separated (aromatics are preserved!). Middle fraction or distillation core should be separated from weak brandy fraction when ethanol concentration in the contents (average!) is not 15-20% vol. It is obligatory for a still to be equipped with a mixer or at least copper grid to prevent burning of distilling contents.
Redistillation of raw weak brandy is performed using the same device, when first-made brandy fraction must be separated in the amount of 0.5 – 1.5% of the starting weak brandy amount put for distilling (the rule that applies is as follows: lower amount of first-made brandy should be separated when pomace is of very good quality and vice versa). Middle fraction (distillation core) should be separated from weak brandy fraction when average concentration in the contents is 55-60%vol. Collection of weak brandy fraction should be done until ethanol is completely exhausted. Thereafter, collected weak brandy fractions can be redistilled at 1% first-made brandy separation, when second-rate quality core is obtained.

Newly obtained Bartlett pear distillate is sharp, burning, raw and non-harmonious. That is why it goes for gradual maturing and physical stabilization takes place mainly in glass or chromium-steel containers for at least 60 days. Bartlett pear distillate (sweet cherry, sour cherry and peach too) never matures (ages) in a cask because primary distillate components are incompatible with secondary components extracted from a wooden container. After it has been processed (and distillate is diluted to its ultimate strength from 40-45%vol.), Williams pear brandy is consumed colorless and cooled at 12-15°C.

**Goal of investigations**

The discrepancy between scarce data in both foreign and domestic research and professional literature about this highly appreciated and delicious brandy and its growing demand by not only men but also women over past years has been the cause and motivation for the present work. The quality of Williams pear brandy is primarily dependent on the quality of starting raw material i.e. pear fruit and method of its processing. Investigations focus on alcoholic fermentation and distillation as the most important stages of the technological process of this brandy production. Monitoring was done of effects of various methods for performing alcoholic fermentation (addition of yeast and mineral salts, pH value reduction i.e. boiling medium acidification) and various methods for conducting distillation (separation of middle fraction from weak brandy fraction i.e. cutting) on chemical composition and sensory qualities of produced brandies. Investigations also comprised extraction of aromatic components from experimental variants as well as their GH-MS analysis in order to identify distinguishing bearers of this by far known and appreciated aroma.

**Material and Methods**

To set up the experiment, we used technologically mature Bartlett pear fruits delivered from the PKB fruit plantations from Grocka. The experiment set-up, alcoholic fermentation, distillation of fermented pomaces, redistillation of raw weak brandies, quantitative chemical analysis and sensory evaluation of the
quality of produced brandies per experimental variant was all carried out at the Faculty of Agriculture in Zemun, while GH-MS analysis of aromatic components in brandies was performed at the Faculty of Chemistry in Belgrade. Disintegration of Bartlett pear fruits was done to obtain mashed uniform contents and the experiment was set up according to the variants as follows:

1. Bartlett pear + fermentation + distillation to 20% vol without fractions separation + redistillation with separation of 1% first-made brandy and cutting at 45% vol

2. Bartlett pear + fermentation + distillation to 20% vol without fractions separation + redistillation with separation of 1% first-made brandy and cutting at 50% vol – control

3. Bartlett pear + fermentation + distillation to 20% vol without fractions separation + redistillation with separation of 1% first-made brandy and cutting at 55% vol

4. Bartlett pear + fermentation with addition of pectolitic enzyme 1 Pectinase endozym (1g/10kg) + distillation to 20% vol without fractions separation + redistillation with separation of 1% first-made brandy and cutting at 50% vol

5. Bartlett pear + fermentation with addition of pectolitic enzyme 2 Pectinex R 300 (2g/10kg) + distillation to 20% vol without fractions separation + redistillation with separation of 1% first-made brandy and cutting at 50% vol

6. Bartlett pear + fermentation with addition of pectolitic enzyme 3 Pectinex R 700 (2g/10kg) + distillation to 20% vol without fractions separation + redistillation with separation of 1% first-made brandy and cutting at 50% vol

7. Bartlett pear + fermentation at reduced pH (pH=3.0, addition of 5 ml conc H2SO4/10kg crushed fruit) + distillation to 20% vol without fractions separation + redistillation with separation of 1% first-made brandy and cutting at 50% vol

8. Bartlett pear + fermentation with addition of yeast 1 (Uvaferm, 2g/7kg) + addition of mineral salts ((NH4)2HPO4, 1g/10kg crushed fruit) + distillation to 20% vol without fractions separation + redistillation with separation of 1% first-made brandy and cutting at 50% vol

9. Bartlett pear + fermentation with addition of yeast 2 (Oenophilic, 2g/7kg) + addition of mineral salts ((NH4)2HPO4, 1g/10kg crushed fruit) + distillation to 20% vol without fractions separation + redistillation with separation of 1% first-made brandy and cutting at 50% vol

10. Bartlett pear + fermentation with addition of yeast 3 (Oenophilic, 2g/7kg) + addition of mineral salts ((NH4)2HPO4, 1g/10kg crushed fruit) + addition of pectolitic enzyme Pectinex R 700 + distillation to 20% vol without fractions separation + redistillation with separation of 1% first-made brandy and cutting at 50% vol

Chemical composition of raw Bartlett pear fruits was as follows: dry matter 15%, total sugars 13% and total acids 0.37%. All experimental variants (fruits without stalk) were fermented in identical laboratory conditions at the Institute for Food Technology and Biochemistry, Faculty of Agriculture, Zemun. During
alcoholic fermentation, dry matter dynamics (table refractometer) and temperature (mercury thermometer) were monitored. Fermentation proceeded in a uniform manner at 17°C. On fermentation accomplishment, distillation of fermented pomaces was immediately done for experimental variant each, using a laboratory copper pot still of Charant type, 20 l vol. The first distillation proceeded without first-made brandy separation, in order that as much as primary and secondary aromas concentrate in weak brandy. Cutting i.e. separation of middle from weak brandy fraction was done at distillate average strength of 20% vol in the contents. Weak brandy fraction was then collected until ethanol was completely exhausted. Redistillation of raw weak brandies was also done in a pot still of Charant type, 10 l vol. First-made brandy was separated in all variants in the ratio of 1% to the volume of raw weak brandy. Thereafter, middle fraction (distillation core), except in variants 1 and 3, was collected to average strength of 50%vol, and, finally, weak brandy until ethanol was fully exhausted.

The aim of the first three experimental variants (1, 2 and 3), control (2) being among them, was to examine effects of separation (cutting) of middle from weak brandy fraction on distillate quality of Williams pear brandy. Variants 4, 5 and 6 were to demonstrate effects of pectolitic enzymes addition on aromatic components release from Williams pear brandy pomace and their intensifying in end-distillate as well as their effects on methanol content in the produced brandy. Also, examinations comprised effects of active yeast strains addition on fresh crushed fruit and mineral salts addition (variants 8 and 9) to yeasts to accelerate and model alcoholic fermentation (effects on higher alcohols composition) and allow for its timely finish. Variant 7 was to show effects of reduced pH (acidification of boiling medium) on chemical composition of end-distillate (effects on methanol, ester, aldehyde, furfural contents..."cleaner" alcoholic fermentation without bacterial influence etc). In variant 10 the aim was to examine effects of enzymes, yeast and mineral salts on chemical composition and sensory qualities of the produced brandy.

Lastly, the quality of all experimental brandies has undergone sensory evaluation by a five-member expert panel. Evaluation of basic quality parameters, on a points-system basis, (color, clearness, typicality, aroma and flavor) was also done at the Faculty of Agriculture.

Results and Discussion

The results of quantitative chemical analysis of Williams pear brandies for experimental variants are presented in Tab. 1. It is evident that all results comply with quality standards as prescribed by Regulations for quality of alcoholic drinks, Official Gazette of SFRY, Nos 16/88 and 63/88.

Separation of middle from weak brandy fraction at different ethanol concentrations did not have any significant influence on chemical composition of
brandies in the present paper. Yet, in distilling and separating middle from weak brandy fraction in Williams pear brandy (and most other fruit brandies), the achieved ethanol concentrations should not be lower than 45%vol because of the brandy’s genuine and pleasing aroma and flavor (effects produced by higher alcohols). Middle fraction should be separated within the 50-55%vol range, and sometimes 60%vol is desirable.

In all experimental variants, where pectolitic enzyme was added to crushed Bartlett pear fruit (variants 4, 5 and 6), methanol content was increased in brandies under all other identical conditions, which indicates that co-action of naturally present pectolitic enzymes in Bartlett pear and added enzymatic preparations produce effects on de-esterification of pectins during alcoholic fermentation. Effects of enzymes adding are markedly noticeable in improving and intensifying brandy’s finishing aroma and flavor, as confirmed by scores given in Tab. 2. Results for sensory evaluation indicate that variants 4 and 5 produced the best evaluated samples, while variant 6 yielded lower results probably due to the character of the preparation itself and its incompatibility with Bartlett pear fruit pomace. On the other hand, intensifying aroma in produced Williams pear brandies is clearly confirmed by extinction values for finishing brandies on the spectrum UV band.

This was the reason why clear Williams pear brandies were diluted with 40% ethanol 100 times (0.1ml + 9.9 ml 40%vol ethanol). Diluted Williams pear brandy was placed in a quartz cuvette (10mm) and the reading of absorption (extinction) value on lambda = 260 millimicrons along with using 40%vol ethanol for a blind test.

Computations: \( a \times 100 = A \), where \( a \) is the reading of absorption on a spectrophotometer

Computations go on as follows: \( 22,000 : A = 100 : N \) where

\( N = % \) of characteristic esters in 40%vol Williams pear brandy or

\( N \times 2.5 = % \) of characteristic esters in relation to \( aa \)

Absorption values for experimental variants amounted to:

<table>
<thead>
<tr>
<th>Variant</th>
<th>( A )</th>
<th>% of characteristic esters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variant 1</td>
<td>A=0.279</td>
<td>0.30% characteristic esters</td>
</tr>
<tr>
<td>Variant 2</td>
<td>A=0.223</td>
<td>0.25%</td>
</tr>
<tr>
<td>Variant 3</td>
<td>A=0.338</td>
<td>0.37%</td>
</tr>
<tr>
<td>Variant 4</td>
<td>A=0.447</td>
<td>0.50%</td>
</tr>
<tr>
<td>Variant 5</td>
<td>A=0.374</td>
<td>0.42%</td>
</tr>
<tr>
<td>Variant 6</td>
<td>A=0.338</td>
<td>0.37%</td>
</tr>
<tr>
<td>Variant 7</td>
<td>A=0.253</td>
<td>0.27%</td>
</tr>
<tr>
<td>Variant 8</td>
<td>A=0.261</td>
<td>0.27%</td>
</tr>
<tr>
<td>Variant 9</td>
<td>A=0.312</td>
<td>0.35%</td>
</tr>
<tr>
<td>Variant 10</td>
<td>A=0.407</td>
<td>0.45%</td>
</tr>
</tbody>
</table>
It is evident that Variant 4 had the highest content of characteristic esters. Variant 7 produced the lowest methanol content, which is normal considering the fact that it was fermenting at reduced pH value (3.0), and consequently there resulted partial inhibition of activity and adverse conditions for the activity of enzyme of pectin-methyl esterase. Acidified medium also affected cleaner fermentation, without any deterioration caused by bacteria or inhibition of yeast activity. Also, slightly higher contents of esters, aldehydes and furfurals are noticeable compared to control, which is normal. The amount of 5 ml cone H₂SO₄/10 kg crushed fruit can be considered optimum.

Adding of selected yeast strains and mineral salts in the form of diaminiumphosphate to crushed fruit in Variants 8 and 9 contributed to faster and more thorough fermentation. Future investigations should employ H₃PO₄ to reduce pH value and partially replace mineral salts, instead of H₂SO₄ used in the present work. Higher share of nitrogen substances in a boiling medium (adding of yeasts and mineral salts) resulted in significantly higher contents of higher alcohols. This phenomenon was even more markedly expressed in Variant 10, where yeasts, mineral salts and pectolitic enzyme were added together.

### Table 1 - Chemical composition of Williams pear brandy

<table>
<thead>
<tr>
<th>Variants</th>
<th>Ethanol (vol%)</th>
<th>Total acids (g/l)</th>
<th>Esters (mg/laa)</th>
<th>Aldehydes (mg/laa)</th>
<th>Furfural (mg/laa)</th>
<th>Higher alcohols (mg/laa)</th>
<th>Methanol (vol%/aa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>44.9</td>
<td>0.43</td>
<td>2117</td>
<td>100.52</td>
<td>6.75</td>
<td>1960</td>
<td>0.93</td>
</tr>
<tr>
<td>2</td>
<td>50.3</td>
<td>0.24</td>
<td>2304</td>
<td>97.09</td>
<td>5.75</td>
<td>2140</td>
<td>0.82</td>
</tr>
<tr>
<td>3</td>
<td>55.8</td>
<td>0.34</td>
<td>2167</td>
<td>86.99</td>
<td>5.50</td>
<td>2060</td>
<td>0.76</td>
</tr>
<tr>
<td>4</td>
<td>50.0</td>
<td>0.48</td>
<td>1949</td>
<td>98.28</td>
<td>7.50</td>
<td>2440</td>
<td>0.96</td>
</tr>
<tr>
<td>5</td>
<td>50.8</td>
<td>0.42</td>
<td>2205</td>
<td>86.87</td>
<td>6.25</td>
<td>2240</td>
<td>0.93</td>
</tr>
<tr>
<td>6</td>
<td>50.8</td>
<td>0.22</td>
<td>2274</td>
<td>88.19</td>
<td>6.75</td>
<td>3060</td>
<td>0.86</td>
</tr>
<tr>
<td>7</td>
<td>50.9</td>
<td>0.48</td>
<td>2513</td>
<td>104.04</td>
<td>7.70</td>
<td>2900</td>
<td>0.61</td>
</tr>
<tr>
<td>8</td>
<td>50.0</td>
<td>0.18</td>
<td>1508</td>
<td>97.09</td>
<td>6.50</td>
<td>4240</td>
<td>0.70</td>
</tr>
<tr>
<td>9</td>
<td>49.3</td>
<td>0.18</td>
<td>1743</td>
<td>80.56</td>
<td>5.75</td>
<td>4460</td>
<td>0.72</td>
</tr>
<tr>
<td>10</td>
<td>51.0</td>
<td>0.16</td>
<td>1273</td>
<td>69.22</td>
<td>7.75</td>
<td>4640</td>
<td>0.93</td>
</tr>
</tbody>
</table>

After a 2-month stabilization and gradual reducing of strength to 43%vol, sensory evaluation of produced Williams pear brandies was done by a sensory panel. The results for evaluation are given in Tab. 2. Very good quality of Williams pear brandies is evident. Samples 4 (18.40) and 5 (18.20) were awarded Great Gold Medals, sample 3 (18.02) was awarded Gold Medal, and samples 1, 2, 6, 7, 8, 9 and 10 were awarded Silver Medals, although sample 1 nearly got a Gold Medal. Sample 4 gained the highest number of points (18.40) and sample 10 gained the lowest number (16.76). Average score of all assessed brandies was 17.56. Such high score was certainly the result of healthy and technologically mature fruits,
method of conducting fermentation process, timely distillation of fermented pomace into weak brandies and redistillates, distillation method to some extent, proper and gradual final processing of end-distillates.

### Table 2. Sensory scores for Williams pear brandies

<table>
<thead>
<tr>
<th>Assessor</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
<th>8.</th>
<th>9.</th>
<th>10.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>17.8</td>
<td>18.2</td>
<td>18.5</td>
<td>18.3</td>
<td>18.2</td>
<td>17.2</td>
<td>18.1</td>
<td>18.0</td>
<td>17.5</td>
<td>17.4</td>
</tr>
<tr>
<td>2.</td>
<td>17.9</td>
<td>18.0</td>
<td>18.1</td>
<td>18.8</td>
<td>18.1</td>
<td>16.9</td>
<td>17.0</td>
<td>17.3</td>
<td>17.5</td>
<td>17.0</td>
</tr>
<tr>
<td>3.</td>
<td>17.8</td>
<td>18.0</td>
<td>18.1</td>
<td>18.6</td>
<td>18.2</td>
<td>17.0</td>
<td>17.5</td>
<td>17.0</td>
<td>17.4</td>
<td>16.4</td>
</tr>
<tr>
<td>4.</td>
<td>18.3</td>
<td>17.2</td>
<td>17.4</td>
<td>18.2</td>
<td>18.5</td>
<td>16.0</td>
<td>16.4</td>
<td>16.3</td>
<td>16.2</td>
<td>15.9</td>
</tr>
<tr>
<td>5.</td>
<td>17.8</td>
<td>17.7</td>
<td>18.0</td>
<td>18.1</td>
<td>18.0</td>
<td>17.4</td>
<td>17.6</td>
<td>17.1</td>
<td>17.0</td>
<td>17.1</td>
</tr>
<tr>
<td>Average</td>
<td>17.92</td>
<td>17.82</td>
<td>18.02</td>
<td>18.40</td>
<td>18.20</td>
<td>16.90</td>
<td>17.32</td>
<td>17.14</td>
<td>17.12</td>
<td>16.76</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medal</th>
<th>Silver Medal</th>
<th>Silver Medal</th>
<th>Gold Medal</th>
<th>Gold Medal</th>
<th>Silver Medal</th>
<th>Silver Medal</th>
<th>Silver Medal</th>
<th>Silver Medal</th>
<th>Silver Medal</th>
<th>Silver Medal</th>
</tr>
</thead>
</table>

Sample 4 scored very high (18.40). It was probably the quality of pectolitic enzyme with its full activity that added to high score. Distillation was slow and cutting at optimum strength. The same refers to sample 5 too. Samples 6 and 10 scored lowest. Unlike samples 4 and 5, in sample 6 the activity of added enzyme produced adverse effects on brandy quality (aroma in particular), which supports the statement that one should always be careful and meticulous in the choice of enzyme. Variant 10 was set up to confirm what had been claimed, where the same enzyme was used again together with appropriate yeasts and mineral salts. This sample scored lowest, which confirmed previously made statements. Addition of enzyme, yeast and mineral salts resulted in lack of full genuine aroma, flavor and retronasal flavor of brandy (as if something had disguised aromatics), which caused considerably lower organoleptic score.

Sensory qualities of produced brandies were as follows:

**Variant 1:** Sample is clear and colorless. Aroma is characteristic of Bartlett pear, medium intensive to intensive, pure and without foreign and additional aromas following ethanol in larger amounts. Flavor is harmonious, full and pleasing. Retronasal flavor is proper and prolonged.

Score: 17.92

**Variant 2:** Sample is clear and colorless. Aroma is characteristic of Williams pear brandy, fresh, pure and without foreign aromas. Flavor is harmonious, medium full to full, slightly astringent but pleasing and drinkable. After swallowing it goes away more quickly than preceding sample. In retronasal flavor it is slightly sweet and insipid.

Score: 17.82

**Variant 3:** Sample is clear and colorless. Aroma is typical of brandy produced from Bartlett pear, pure and intensive, without foreign aroma, typical of fresh
fruity nature. Flavor is harmonious, full and drinkable. Retronasal flavor is pure and prolonged. In its quality it matches high quality Williams pear brandy.
Score: 18.02

Variant 4: Sample is clear and colorless. Aroma is typical, complex and intensive of Bartlett pear, pure, lavish, fresh, fluttering, of ester nature, very pleasing. Flavor is full, harmonious, rounded off, sweetness-acid balanced, very drinkable and pleasing. Retronasal flavor is very impressive, with very pleasant prolonged action. It matches Williams pear brandy of top quality.
Score: 18.40

Variant 5: Sample is clear and colorless. Aroma is specific but characteristic of Williams pear brandy, pure and slightly less intensive than preceding sample. Flavor is harmonious, full, rounded off and drinkable. It is pleasing and its retronasal flavor has specific fruity-ester luxurious additional flavor. It matches top quality Williams pear brandy.
Score: 18.20

Variant 6: Sample is clear and colorless. Aroma is not fully typical of this kind of Williams pear brandy, somehow disguised, heavy and incomplete, medium intensity of Bartlett pear. Flavor is incomplete, medium harmonious, discretely bitterish and astringent, moderately drinkable. Retronasal flavor is heavy and moderately pleasing.
Score: 16.90

Variant 7: Sample is clear and colorless. Aroma is characteristic, medium intensive to intensive of Bartlett pear, pretty pure but not so pleasing, of fresh fruity nature. Flavor is slightly incomplete, but balanced and pleasing. Retronasal flavor is adequate, though it could last longer.
Score: 17.32

Variant 8: Sample is clear and colorless. Aroma is characteristic of Bartlett pear but not pure enough, of weak brandy nature, medium pleasing. Flavor is medium harmonious, astringent, blunt, moderately drinkable with mediocre retronasal flavor lasting long but pleasing a little.
Score: 17.14

Variant 9: Sample is clear and colorless. Aroma is characteristic, medium intensive of Bartlett pear, heavy, distinctively stale, of weak brandy nature. Flavor is oily, discretely astringent, medium full and harmonious, moderately drinkable. Retronasal flavor is heavy, sweetish, remains long in the mouth but is not pleasing.
Score: 17.12

Variant 10: Sample is clear and colorless. Aroma is specific, impure, heavy, not fully typical of brandy produced from Bartlett pear, of weak brandy character. Flavor is incomplete, heavy, burning, aldehyde-type, not exactly pleasing. Retronasal flavor has long lasting weak brandy nuances.
Score: 16.76
Aromatic components of Williams pear brandy

To write about Williams pear brandy and not to mention its subtle and worldwide appreciated aroma would be unfair, to say the least. Therefore, GH-MS analysis was carried out of aromatic components in brandies per experimental variant. The results of these investigations will be presented in one of future works, while the most important ones will be shown herein.

Aromatic components of Williams pear brandies per experimental variant were extracted and concentrated in the apparatus for continuous liquid-liquid extraction by using methylene-chloride (CH$_2$Cl$_2$) as an extracting solvent. Extraction was performed in the following manner: 100 ml brandy was extracted using 50 ml methylene-chloride in the apparatus for continuous liquid-liquid extraction during 2 hours as long as water layer did not become clear. After cooling and layer formation, lower phase (organic layer) was separated and dried with unhydrated Na$_2$SO$_4$ during night. Thereafter the extract was steamed without heating (room temperature) in a vacuum steamer until volume of 1 ml was reached. The apparatus used was the one for continuous extraction for the case when eluens has higher specific weight. The GH-MS scanning and analysis was carried out using gas chromatograph manufactured by “Varian”, model 3400 of smelted quartz with capillary column, 60 cm long, 0.32 mm in inner diameter and a bearing gas He 1-2 ml/min. Mass spectrums were scanned on mass spectrometer manufactured by Finigan-Mat, model 8230. Spectrums were digitalized and processed on a DEC computer, model micro PDP 1/73. To search and make comparisons, the program used spectrum libraries, such as Wiley/NBS libraries containing 6724 compounds and 80,680 spectrums (Cornell University, USA). Typical chromatogram (aromagram) of Williams pear brandy is presented in Fig. 1 and the most important compounds (the total of 33 compounds was detected and identified) in Tab. 3.
The most important aromatic components of Williams pear brandy were esters, such as: methyl 2-trans, 4-cis decadienoate accounting for 18.79% and ethyl 2-trans, 4-cis decadienoate accounting for even 56.23%, the latter being a bearer and the most prominent aromatic component of Williams pear brandy. Also, ethyl ester of octanoic acid was present in a considerable per cent (14.65%) as well as ethyl ester of decanoic acid (10.06%), whereas per cent of ethyl ester of dodecanoic acid was only 0.26%. Apart from the mentioned, the following volatile compounds were detected and identified: ethyl lactate, n-hexanol, phenyl ethyl alcohol, ethyl octanoate, ethyl,cis-4 decanoate, ethylpentadecanoate, undecanoic acid, ethyl caprate etc.

<table>
<thead>
<tr>
<th>No</th>
<th>Compound</th>
<th>R.T. min.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Octanoic acid ethyl ester</td>
<td>15.50</td>
<td>14.65</td>
</tr>
<tr>
<td>2</td>
<td>Decanoic acid ethyl ester</td>
<td>22.12</td>
<td>10.06</td>
</tr>
<tr>
<td>3</td>
<td>Methyl (E,Z)-2,4-decadienoate</td>
<td>22.56</td>
<td>18.79</td>
</tr>
<tr>
<td>4</td>
<td>Ethyl 2.4-trans, cis-decadienoate</td>
<td>24.78</td>
<td>56.23</td>
</tr>
<tr>
<td>5</td>
<td>Dodecanoic acid, ethyl ester</td>
<td>28.17</td>
<td>0.26</td>
</tr>
</tbody>
</table>

**Conclusion**

Williams pear (known as Bartlett pear too) is the best quality pear in the world, while Williams pear brandy is one of the most appreciable strong alcoholic drinks, in general.

Only healthy and technologically mature fruits (without stalk) should undergo alcoholic fermentation.

Throughout fermentation, it is advisable to add suitable pectolitic enzyme and appropriate yeast strain to disintegrated Bartlett pear fruits and to reduce boiling medium pH to the value of 3.0.

During distillation of fermented pomace to obtain raw weak brandy, first-made brandy fraction should not be separated, while middle fraction (distillation core) should be separated (cut) from that of weak brandy fraction at 20% vol.

During redistillation of raw weak brandies to obtain redistillates, it is obligatory to separate first-made brandy fraction in the amount of 1% minimum and to cut core from weak brandy at average strength from 55-60% vol.

Fresh distillate stabilization should last for at least 60 days, while dilution to final strength should be gradually done, in 2-3 cycles.
Sensory qualities of williams pear brandy

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Williams pear brandy ageing should never be done in a wooden container but exclusively in a glass or inox one.

Williams pear brandy is consumed at concentration of 42-43%vol and cooled at 12-15°C.

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UTICAJ NEKIH PROIZVODNIH FAKTORA NA HEMIJSKI SASTAV I SENZORSKE KARAKTERISTIKE RAKIJE VILIJAMOVKE

N. Nikićević

R e z i m e

Medju voćnim vrstama, kruška je jedna od najviše gajenih u svetu, a Vilijamovka je zasigurno najcenjenija sorta kruške svuda u svetu. Pored potrošnje u svežem stanju i proizvodnje soka, njeni kvaliteti se najbolje iskazuju u proizvodnji nadaleko poznate delikatesne rakije.

U radu su razmatrani uticaji nekih proizvodnih faktora na hemijski sastav i senzorske karakteristike rakije vilijamovke a težiše istraživanja dati su načinima izvodjenja alkoholne fermentacije i destilacije. Na alkoholnu fermentaciju stavljeni su isključivo zdravi i tehnološki zreli plodovi vilijamovke, bez peteljki. Tokom vrenja određenim eksperimentalnim varijantama dodati su odgovarajući pektolitički enzimi u cilju izvlačenja dela mirisa iz tvrzo vezanog nemirisnog dela. Snižavanje vrednosti pH vrionog medijuma kao i dodatak određenih selekcionisanih sojeva kvasaca uticali su na modeliranje hemijskog sastava finalnih destilata kao i kvalitet njihovih senzorskih karakteristika.

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Pri destilaciji prevrelog kljuka u cilju dobijanja sirove meke rakije, nije odvajana frakciju prvenca, a srednja frakcija (srce) odvajana je od patoke pri prosečnoj koncentraciji etanola (u masi) od 20%vol. Pri redestilaciji (prepicanju) sirove meke rakije u cilju dobijanja prepeka, odvajana je frakcija prvenca u količini od 1%, a srednja frakcija je sečena pri koncentraciji 55-60%vol (prosek u masi).

Stabilizacija svežih destilata trajala je 60 dana a razblaživanje etanola na finalnu jačinu obavljeno je postupno, u nekoliko turnusa. Odležavanje destilata vilijamovke obavljeno je u staklenim sudovima.