Preliminary Studies Regarding the Physicochemical Characteristics of Some Balsamic Vinegars

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Abstract: The aim of this work is to analyze the chemical and physical properties of balsamic vinegar, in order to improve the chemical information about this product, useful for its authentication and quality evaluation.

Using three balsamic vinegars purchased in local markets as samples, this study investigated the labeling and the physicochemical properties of commercial concentrated balsamic vinegar in order to understand their production method and quality. Two of the samples were balsamic vinegars from Modena (BVM) and the third was a balsamic vinegar from Kalamata (BVK). According to the labels, all the balsamic vinegars samples were made of grape must and had an acidity of 6%.

The appearance of the samples of vinegar differed significantly, but the acidity from the label was the same for all.

Since people are paying much more attention to health, the number of concentrated vinegar products is expected to increase in the future. Thus, appropriate rules and physicochemical properties are required to regulate vinegar production and quality.

Keywords: balsamic vinegar, physicochemical properties, chemical analyses.

INTRODUCTION

Human have used the vinegar as condiment and as food preservative for thousands of years. Vinegar was known by most ancient civilizations and its use as a seasoning or preserving agent, is as ancient as the use of wine. Although it is a spontaneous process which takes place in wines and musts in contact with air, vinegar is far from being a simple spoilage of wines (Rei-Chu Chang & all, 2005).

Apart from the antibacterial activity (Makino S. & all, 2000), the consumption of vinegar is associated with health benefits, including lowering blood pressure, reducing risk of cardiovascular disease (Kondo S. & all, 2001; Sugiyama A. & all, 2003), antioxidant activity (Sanchez-Moreno C. & all, 1999) and promoting nutrient metabolism (Wu M. L., 1999). Since consumption of vinegar can help in the maintenance of health, many vinegar products have been available in addition to the traditional vinegar.

By definition vinegar is „a liquid fit for human consumption, produced from a suitable raw material of agricultural origin, containing starch, sugars, or starch and sugars by the process of double fermentation, alcoholic and acetous, and contains a specified amount of acetic acid” (Joint FAO/WHO Food Standards Programme. 1987)

The term „balsamic” was used for the first time in ancient registers of Duchy of Modena and Reggio Emilia in 1747 and derives from a therapeutic use of the product. At the end of 1800, balsamic vinegar of Modena appears in the most important manifestations and becomes of international interest. The most important producer in that time was Giuseppe Giusti, whose productions are present in history since year 1605.
For the production of balsamic vinegar from Modena two acidification process can be used. The first method requires a grape must concentration until a reduction of 1/3 of its volume, as well as for the production of traditional balsamic vinegar, and acidification by adding wine vinegar. The second method regards the slow fermentation through wood shavings, inoculated with Acetobacter species with a continuous addition of concentrated must.

The medicinal use of vinegar was widespread during the Middle Ages and the Renaissance, for both internal and topical use. It was in fact used as a digestive, a prophylactic against liver disorders, an anthelmintic, for sore throats, and to rub on the wrists against fever, but also against hair loss and tinea.

The objectives of this study are part of a wider research who’s aims are to investigate the sensoryal profile of balsamic vinegar correlated with the presence of some aromatic compounds that could be used for the authentication of these products.

Thus, this study shows the preliminary researches concerning the determination of physicochemical characteristics of several types of balsamic vinegar that will be correlated with other sensory parameters, for establishing an intercorelation between these parameters for a particular brand of product.

The researches took place on the Testing Laboratory for Quality and Food Safety - LICSA- from UASVM Cluj and are wanted to be a start in the field of food authentication by using some correlations that could be established between the proprieties physico-chemical of foods and its flavor profile.

MATERIALS AND METHODS

Materials

Three different commercial vinegars were used in the present study: a Balsamic Vinegar “KALAMATA”, a Balsamic Vinegar from Modena „NIGRIS” and a Balsamic Vinegar from Modena “PONTI”.

All the samples were acquired from supermarkets and all of them have an individual label which contains the following information about the product (Tab. 1).

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Ingredients</th>
<th>Characteristics</th>
<th>Nutritional value</th>
</tr>
</thead>
</table>
| Aceto Balsamico KALAMATA (C.C. Papadimitriou S.A.) | • Acidity 6%.  
• The presents of some sediments is natural.  
• Without artificial coloring.  
• It has a high content of important antioxidants.  
• There are no added preservatives and any traces of natural sulphites occurring from the soil do not exceed 10 ppm. | • It is a natural product obtained only from sun-dry grapes.  
• The maturation takes place in oak wood barrels, giving a sweet-acid taste, that is specific Mediterranean.  
• It has a strong taste and fine aroma.  
• It does not carry any odors that do not belong in quality vinegar. | • Energetic value: 115.2 kj  
• Proteins: 0g  
• Lipids: 0g  
• Fat saturated acids: 0g  
• Glucides: 24g  
• From with sugar: 24g  
• Sodium: 0g |
| Balsamic Vinegar from Modena (De Nigris) | • Acidity 6%.  
• Density at 20°C: 1.08  
• Dry Extract: 170g/l.  
• It contains caramel colorant E150 d and a high content of antioxidants: (sulphites) E224. | • It is a natural product obtained from wine vinegar and concentrated grape must.  
• Taste: sweet-acid | • Energetic value: 17 kcal/ spoon |
| Balsamic Vinegar from | • Acidity 6%  
• It contains caramel colorant | • It is a natural product obtained from wine vinegar and concentrated |

The sample of balsamic vinegar KALAMATA was different from the ones from Modena by its maturation in wood barrels and it's obtain from dry grapes. The other two samples had a content of grape must and acetic wine.

Methods of analysis

- **Density**
  The density of the vinegar samples was calculated directly by the weigh and volume of each sample (Rei-Chu Chang & all, 2005). It is measured because it gives us information about the attitude of micro-organisms over the physical state of the environment.

- **The Ash**
  The total ash of the samples was determinate by evaporating to dryness the filter that was used for the sample filtration according to the Official Methods of Analysis of the Association of Official Agricultural Chemists.

- **pH**
  The determination of pH plays an important role in the control of the microbial fermentation. Its variation gives us information about the metabolic activity of the microflora.
  The samples were analyzed individually, with a WTW315 pH-meter, Wissenschaftlich-Technische Werkstatten GmbH, Germany, and with a pH-Electrode SenTix 81. The pH was measured directly, after a prior calibration of the pH-meter (M. D. Ould El Hadj & all, 2001).

- **The protein content**
  The quantity of total nitrogen of the samples was determinate with the method described by M. D. Ould El Hadj & all, (2001). The samples were analyzed in terms of repeatability and reproducibility, with a protein determination equipment for Kjeldhal method, that has a Selecta digest bloc for the mineralization and a Selecta Pro-nitro I for the distillation.

- **Total Acids**
  The total acidity is a very important parameter for the quality evaluation of the product. In fact, the total acidity is fixed by Low no 991 of 09.10.1964 (6 g 100 ml\(^{-1}\) minimum) and a decrease of these parameters is not acceptable for the commercialization of vinegar.
  We measured the total acidity by titration with 0.5N NaOH in accordance to the Official Methods of Analysis of the Association of Official Agricultural Chemists.
Total Solids Soluble

For most balsamic vinegars samples with high sugar content, the sample formed a sticky film making them difficult to weight to a constant weight during drying at 105°C. Therefore, the soluble solids method of CNS14384 N5239 was not used in this study. Soluble solids were measured with a refractometer, and the results were reported as Degrees Brix (M. D. Ould El Hadj & all, 2001).

Caramel

Caramel can be added to balsamic vinegar for colour correction, but for the Balsamic Vinegar of Modena the maximum amount of caramel that can be added is fixed by law at 2% in volume (Gazzetta Ufficiale dell’Unione Europea, 2007).

We have used the method described in STAS 157:2008, Vinegar. Methods of Analysis, (2008), 3.6, to determine the presence of caramel in our samples.

Synthetic colorants

The addition of any coloring substances to the vinegar is forbidden by law. So the determination of the synthetic colorants was made by using a solution of potassium sulphate and some wool (STAS 157:2008, Vinegar. Methods of Analysis, (2008), 3.5)

RESULTS AND DISCUSSION

All the results obtained were the average of duplicates analysis.

Physicochemical Analysis

<table>
<thead>
<tr>
<th>Samples Type</th>
<th>Kalamata</th>
<th>De Nigris</th>
<th>Ponti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extract (g/ml)</td>
<td>27.37</td>
<td>17.52</td>
<td>16.15</td>
</tr>
<tr>
<td>Total Ash (g/l)</td>
<td>16.89</td>
<td>10.57</td>
<td>9.84</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>23.4</td>
<td>23.2</td>
<td>23.4</td>
</tr>
<tr>
<td>pH</td>
<td>2.98</td>
<td>2.94</td>
<td>2.84</td>
</tr>
<tr>
<td>Acidity (%)</td>
<td>5.4</td>
<td>6</td>
<td>5.6</td>
</tr>
<tr>
<td>Protein Content (g/kg)</td>
<td>1.04</td>
<td>1.3</td>
<td>0.74</td>
</tr>
<tr>
<td>Total Acids (%)</td>
<td>5.4</td>
<td>6</td>
<td>5.6</td>
</tr>
<tr>
<td>Refractometric Index (%)</td>
<td>1.3765</td>
<td>1.3615</td>
<td>1.3605</td>
</tr>
<tr>
<td>Total Solids Soluble (°Brix)</td>
<td>27.3</td>
<td>18.65</td>
<td>17.85</td>
</tr>
</tbody>
</table>

1. Extract determination

2. Total Ash

After the cooling of the filters in the desiccators and individual weight on the analytical balance, we noticed a significant difference between the sample obtained from dry grapes (1.689 g/l) and the ones obtained from grape must (0.984-1.057 g/l). We also noticed that the differences between the two samples made from grape must were insignificant.
3. **pH**

The pH determination informs us on the evolution of the acidity of the medium, depending on the metabolism of acidophilic microorganisms.

The values obtained for our samples are above 2 but less then 3, (2.83-2.98), so that the environment of our samples is highly acidic. Knowing this we can say that they are supportive environments for the acidophilic germs.

4. **The protein content**

The quantity of nitrogen dosed in the vinegar samples is 1.04% for Kalamata sample, 1.3% for De Nigris sample and 0.74% for the Ponti sample. Because of the differences of dates, we noticed that the levels of these proteins in the vinegar samples, varies from one to almost double.

From all the samples the De Nigris sample with 1.3% proteins, contains the most nitrogenous matter. Also we can notice that a large proportion of nitrogen from the samples of vinegar is the result of the microbial metabolism.

5. **Total acids**

The total acidity represents one of the most important chemical parameters of the product for both marketing and biological safety.

The total acidity is due to the contemporary presence of acetic acid and other carboxylic acids. Acetic acid is the main product of acetic fermentation, but balsamic vinegar from Modena BVM, contains many other carboxylic acids which are either produced by microbial fermentation or originated directly from grapes.

6. **Total Solids Soluble**

The total soluble solids (TSS) for the three samples were in the range of 17.5 and 27.5 °Brix. In this case we noted a significant difference between the samples of balsamic vinegar from Modena and the KALAMATA sample, with had grater content in TSS.

7. **Caramel**

Although the Kalamata vinegar didn’t had mentioned in the label, the presence of caramel, we found it in all the analyzed samples.

8. **Synthetic colorants**

The color of the vinegar is an important factor related to the sensorial properties of the product.

The Italian legislation about vinegar, forbids the addition of any coloring substances to the vinegar. But, by analyzing the wool, used for this determination, we notice that all the samples had colorized the wool, and therefore we concluded that all the samples had a small content of synthetic colorants.

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REFERENCES