RESEARCHES ON THE EVOLUTION OF CONCENTRATED FRUIT JUICES QUALITY AT STORAGE

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Abstract. *The purpose of the study was to compare some concentration methods of clear fruit juices without added chemicals, foaming agents, clarification.*
For this study we chose three apples varieties (Idared, Golden Delicious and Red Delicious) and they were processed into clear juice using a robot type fruit squeezer. Apple juices were concentrated in a Rotavapor type concentrator at 40°C temperature and 175 mbar pressure from almost 12% dry matter to almost 25%. The samples were examined over a period of 30 days shelf life at refrigeration temperature. The physical and chemical determinations were: acidity, pH and dry matter variation.
We also made for juice the following microbiological determinations: total number of yeasts and moulds, mesophilic aerobic bacteria and osmofile yeasts.
The three types of apple juice concentrates have shown stability all over the storage period at refrigeration temperatures (6-8°C), their aspect being determined by the acidity variation of the products.
We also noticed that the dry matter variations in the three types of concentrated juices are constant during the storage period. The difference between the values of the dry matter is made by the apple varieties, as follows: for Golden Delicious is higher (26.3%) than the one for Idared which is the lowest (25%).
After the microbiological analyses have been made we reached the conclusion that the concentrated apple juice of Idared variety has the greater loading number of microorganisms (mesophilic aerobic bacteria - 13 x10^6).

Keywords: *Idared, Golden Delicious, Red Delicious, concentration, clear juice*

1. Introduction

Apple juice is a fruit juice manufactured by the maceration and pressing of apples. The resulting expelled juice may be further treated by enzymatic and centrifugal clarification to remove the starch and pectin, which holds fine particulate in suspension, and then pasteurised for packaging in glass, metal or aseptic processing system containers, or further treated by dehydration processes to a concentrate. Apple juice may also be sold in an untreated state.

Due to the complex and costly equipment required to extract and clarify juice from apples in large volume, apple juice is normally commercially produced. In the United States, unfiltered fresh apple juice is produced by smaller operations in areas of high apple production, in the form of non-clarified apple cider. Apple juice is one of the most common fruit juices in the world; the world production is led by China, followed by Poland, Germany and the United States. (USDA Foreign Agricultural Service, 2004-2005).

100% Apple Juice Concentrate is produced from mature apples to retain the characteristic flavour, colour, and freshness of the whole fruit. The product

contains no added sugars, acid, colour, preservatives, or other foreign material. The predominant varieties processed are: Red Delicious, Golden Delicious, Fuji, Gala and Granny Smith. Single variety concentrates and custom blends are available upon request. Each lot is guaranteed to be manufactured in accordance with USDA, FDA, and other generally recognized regulatory agencies.(C. Huffman, 2007)

Fumaric acid is not considered as the natural constituent of freshly prepared apple juice without heat treatment. However, fumaric acid content slightly increases due to malic acid dehydration during processing when heat treatment such as evaporation and/or pasteurization is applied (Lee and Wrolstad 1988). It has been reported that the level of fumaric acid in well-prepared apple juice usually does not exceed 3,0 mg (Junge and Spadinger 1982). Therefore, higher contents of fumaric acid in apple juices may be due to adulteration by the addition of synthetic malic acid which contains fumaric acid as a minor contaminant, excessive heating, microbial spoilage of juice or an intermediate or processing of decayed fruits (Evans et al. 1983, Zyren and Elkins 1985, Kvasnicka and Voldrich 2000).

Several comprehensive reviews were published that discussed the chemical composition of authentic single strength apple juice (Mattick and Moyer, 1983; Withy et al., 1978; Lee and Wrolstad, 1988) and commercially produced apple juice concentrate (Elkins et al., 1996). Various factors such as cultivar, growing region, climate, cultivar practices, harvest maturity (Drake and Eisele, 1997), storage atmosphere (Drake and Eisele, 1994), storage condition and processing (Spanos et al., 1990; Wrolstad et al., 1989) are known to affect the chemical composition of apple juice and apple juice concentrate. Also, many of the juice compositional studies were limited to common or commercial varieties of apples which were developed to meet various marketing schemes and customer acceptance for sweetness, acidity, colour, and texture (Way and McLellan, 1989).

The compositional data on apple juice reported in this study are unique in that the fresh fruit was obtained from a local plot in Selah, WA that contained over 400 varieties on 85 semi-dwarf orchard trees (Prater, 1996). Scion wood for grafting was collected from major growing regions of the world over a 15-year period. This included new and ‘‘antique’’, old, varieties—many of which are not easily available. There was sufficient fruit formed in the fall of 1997 to investigate the compositional characteristics of 175 varieties. Care was taken to maximize cooling and minimize treatment times to maintain the quality integrity of the samples. The compositional information can be used in conjunction with existing databases to better describe acceptable attribute ranges for authentic apple juice and in the development of commercial apple varieties that would target specific consumer requirements.

The purpose of the study was the comparison between some concentration methods of clear fruit juices without added chemicals, foaming agents, clarification.

For this study we chose three apples varieties: Idared, Golden Delicious and Red Delicious.

Idared apple is medium/large, has a round - flat shape. The ratio of 1/4 - 3/4 some red stripes on a yellow inaccurate, it is soft, rather than hard and smooth and has glossy appearance. The colour inside is white. When the fruit is ripe,it is crispy, juicy and very sweet, but it can be gummed and tasteless. To be very colourful, it should stay for a long time to be collected. It remains very good in the tree until late autumn.

Golden Delicious flavour is outstanding and Golden Delicious apples are kept long.

It is characterized by fine texture, green-yellow skin hiding inside a crispy, sweet and juicy fruit.
Some people think that Golden Delicious variety is "lime yellow", Red Delicious variety of popular, but there is only similarity between the two in terms of their name. The Golden Delicious is an independent variety as sweet as honey. The apples of this variety are perfect for snacks or picnics and ideal for salads, pies, jams and other dishes that requires cut slices.
The Red Delicious is one of the most popular types of apples, and one of the most cultivated species of apples.
Although similar in name Red Delicious and Golden Delicious are two totally different species. There are many similarities between them: both species have been discovered in America in the late 19th century, both in need of warm climates and both are species of fresh apples.

Table 1.
Physico-chemical composition of apples

Nutritional qualities	For 100 g product
Proteins	0.4 g
Carbohydrates	0.1 g
Fats	11.8 g
Fibers	1.8 g
Calories	4.7 kcal

Vacuum concentration operation

Evaporation by using a rotary evaporator is the most commonly used method to separate solvents. Vacuum evaporators are considered class function because by lowering the pressure above a bulk liquid lowers the boiling points of the component liquids in it. Generally, the component liquids of interest in applications of rotary evaporation are research solvents that one desires to remove from a sample after an extraction, for instance, following natural product isolation or a step in an organic synthesis. The use of a "rotavap" therefore allows liquid solvents to be removed without excessive heating of what are often complex and sensitive solvent-solute combinations.

Rotary evaporation is the most often and conveniently applied to separate "low boiling" solvents such as n-hexane or ethyl acetate from compounds which are solid at room temperature and pressure. However, careful application also allows removal of a solvent from a sample containing a liquid compound if there is minimal co-evaporation (azeotropic behaviour), and a sufficient difference in boiling points at the chosen temperature and reduced pressure.
The characteristics of the concentrated apple juice are presented in Table 2.

Table 2
The characteristics of the concentrated apple juice

Characteristics	Values
Acidity	0.16 – 1.27 (g malic acid)
pH	3.3 – 4.5
Dry weight	20 – 40%

In sensorial terms the concentrated apple juice must have characteristic flavour of apple, to be palatable and to have the characteristic odour of the apples.
The microbiological determinations may characterize the concentrated apple juice regarding the free microorganisms in product. In this order it we determined the total number of yeasts and moulds, mesophilic aerobic bacteria and osmofile yeasts.
The concentrated apple juice must not contain any other microorganisms than mesophilic aerobic bacteria.
The purpose of the study was the comparison between concentration methods of clear fruit juices without added chemicals, foaming agents, clarification.

2. Materials and methods

2.1 Materials

2.1.1. Raw materials: apples Idared, Golden Delicious, Red Delicious.

2.1.2. Auxiliary materials: knife, fruit squeezer, Erlenmeyer and Berzelius glasses, cylinders, NaOH 0.1 N, burettes, rod, dropper, Petri plates, tube, culture medium (MMA for yeasts and moulds and BCA for bacteria).

2.1.3. Instalation/Equipment: evaporator (Rotavapor type concentrator), ph-meter, refractometer, incubator.

2.2. Methods

2.2.1. The method of obtaining concentrated apple juice

Apples were washed and squeezed to obtain apple juice. The juice was filtered to obtain a clear juice and it was stored for 24 h at refrigeration temperature to allow the natural enzymatic clearing. The clear juice was concentrated using a Rotavapor type concentrator at a temperature of 40°C and a pressure of 175 mbar. The concentration had the purpose to increase the value of the dry matter from 12% to 25%. The samples were examined over a period of 30 days shelf life at refrigeration temperature with a 5 days periodicity. The physical and chemical determinations were: acidity, pH and dry matter variation. We also made microbiological determinations on juice such as: the total number of yeasts and moulds, mesophilic aerobic bacteria and osmofile yeasts.

2.2.2. The physical and chemical determinations

The titratable acidity: we used the standard method for titratable acidity determination according to STAS 5952-71**.**

pH determination: we used a pH-meter called pH-meter IQ Scientific.

Dry matter: we used the refractometer method according to STAS 5956-71 for soluble substances determination.

2.2.3. Microbiological determinations

The total number of yeasts and moulds: The sample was distributed in Petri plates. We used a MMA specific medium incubated at 37 °C. The colonies formed were counted.

Mesophilic aerobic bacteria: the sample was distributed in Petri plates. We added a specific medium PCA (Plate count agar) and they were incubated at 25°C. The colonies formed were counted.

Osmofile yeasts: are microorganisms which can live and develop in sugar/salt rich medium, being the principal responsible for food alteration. The determinations are based on the growth study of the osmofile yeasts on a specific medium PCA (Plate count agar) or hyperglucidic, incubated at 37°C. The colonies formed were counted.

3. Results and discussion

The concentrated apple juices from the three apple varieties (Idared, Golden Delicious and Red Delicious) were stored at refrigeration temperature (6-8°C) for 30 days. The determination had been made with a 5 day frequency.

The results obtained for the titratable acidity variation for the three apple varieties were presented in Figure 1.

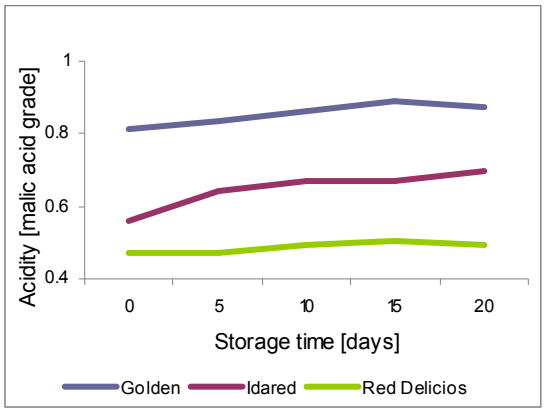

Figure 1. The titrable acidity variation for the three apple varieties

All three varieties of apples had an acidity expressed in g malic acid /100 ml concentrated juice situated in normal limits (0.15-1.27 g malic acid). The acidity depends on the apple varieties, so that a greater amount of malic acid had the Golden apple juice (0.871 g malic acid/100 ml product). Malic acid was lower in the concentrated apple juice Red Delicious (0.494 g malic acid/100 ml product).
In the next graphic (figure 2) the pH variation during storage for Idared, Golden Delicious and Red Delicious is presented.

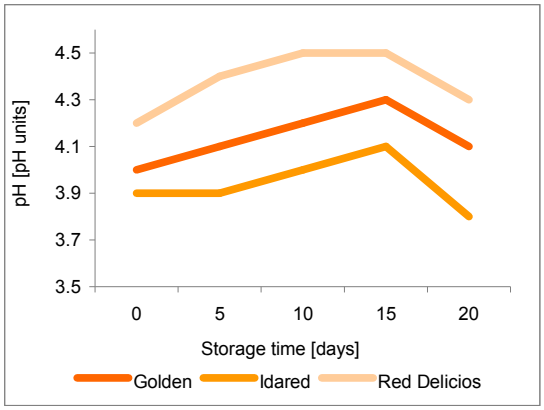

Figure 2. The pH for the three varieties of apples

The pH varied inversely proportional in comparison with the malic acid. So, a high pH (4.5) is corresponding to the concentrated apple juice of Red Delicious apple and the concentrated apple juice from Idared had a lower pH (4.3). The concentrated apple juice Golden had values between the other two varieties of juices (3.9).
In the following graphic (figure 3) the dry matter evolution of the concentrated apple juices is shown.
By concentration we doubled dry matters of the concentrated apples juices. From a value of 12% we got 24 - 26%. The concentrated apples juice which has high dry matter was Golden (26.3%) and that obtained from Idared presented lower values of dry matter throughout determinations (25%).

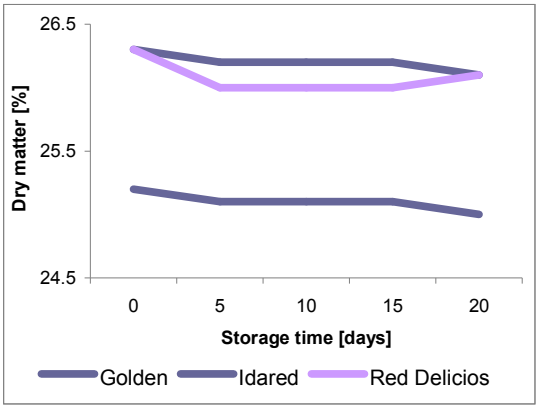

Figure 3. The dry matter for the three varieties of concentrated apple juices

4. Conclusions

Juice is the liquid that is naturally contained in fruit or vegetable tissue. Juice is prepared by mechanically squeezing or macerating of fresh fruits or vegetables flesh without the application of heat or solvents.
The concentrated apple juice obtained from the three apple varieties introduced and performed within normal limits throughout refrigerated storage for all the physical and chemical specific characteristics.
During the 30 days of refrigeration (6-8°C) the concentrated apple juice had good storage stability.
The malic acid content was in the proper limits (0,15-1,27 g malic acid), but it was varying depending on apples varieties. The Golden apple juice had greater amount of malic acid, whereas the Red Delicious one presented a lower content of malic acid. The pH varied inversely proportional in comparison with the evolution of the malic acid.
The difference between the values of the dry matter is also an important agent depending on the apple varieties, as for Golden Delicious is higher (26.3%) than the one for Idared which is the lowest (25%).

After the microbiological analyses have been made we can draw the conclusion that the concentrated apple juice from Idared variety has the greater loading number of microorganisms (mesophilic aerobic bacteria – 13 cfu/ml). Both other studied types did not show any microorganism loading.

5. References

1. USDA Foreign Agricultural Service. World Apple Juice Situation. 2004-2005.

2. S.R., DRAKE, T.A., EISELE, Influence of harvest date and controlled atmosphere storage delay on the colour and quality of 'delicious' apples stored in a purge-type controlled-atmosphere environment, Horticultural Techniques 4 (3) 1994, 260–263

3. S.R., DRAKE, T.A., EISELE, Carbohydrate and acid contents of gala apples and bartlett pears from regular and controlled atmosphere storage. Journal of Agricultural and Food Chemistry 47, 1999, 3181–3184

4. H.J., BIELIG, H.J., HOFSOMMER, The importance of the amino acid spectrum in apple juices. Flussiges Obst 49, 1982, 50–56

5. S.R., DRAKE, T.A., EISELE, Quality of 'gala' apples as influenced by harvest maturity, storage atmosphere and concomitant storage with 'bartlett' pears. Journal of Food Quality 20, 1997, 41–51

6. E.R., ELKINS, A., MATTHYS, R., LYON, C.J., Huang, Characterization of commercially produced apple juice concentrate. Journal of Food Composition and Analysis 9, 1996, 43–56

7. R.H., EVANS, A.W., VAN SOESTBERGEN, K.A., RISTOW, Evaluation of apple juice authenticity by organic acid analysis. Journal of the Association of Official Analytical Chemists 66, 1983, 1517–1519

8. L.R., MATTICK, J.C., MOYER, Composition of apple juice. Journal of the Association of Official Analytical Chemists 66, 1983, 1251–1255

9. R.E., WROLSTAD, D.A., HEATHERBELL, G.A., SPANOS, R.W., DURST, J., HSU, B.M., YORGEY, Processing and storage influences on the chemical composition and quality of apple, pear, and grape juice concentrates, 1989

10. G.A., SPANOS, R.E., WROLSTAD, D.A., HEATHERBELL, Influence of processing and storage on the phenolic composition of apple juice. Journal of Agricultural and Food Chemistry 38, 1990, 1572–1579

11. G.A., SPANOS, R.E., WROLSTAD, Phenolics of apple, pear, and white grape juices and their changes with processing and storage—a review. Journal of Agricultural and Food Chemistry 40, 1992