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Examination of fruit juices produced with aseptic technology

Nagy-Fodor I.

Corvinus University of Budapest, Faculty of Food Science, Department of Oenology, H-1118 Budapest, Ménesi út 45, Phone: (06 1) 482-63-47, Fax: (06 1) 482-63-46, ilona.fodor@uni-corvinus.hu

Summary: The quality of finished products with a 100% fruit content is influenced to the greatest extent by the fruit-base (fruit pulp and fruit juice concentrate) used. In terms of the production of the fruit juice, the minimization of the quantity of the dissolved oxygen, which can cause detrimental oxidation processes to start, is a very important aspect. Scientific experiments specify de-aeration before pasteurization as the solution to the problem. The choice of the packaging material and the manner of packaging also contribute to the preservation of the alimentation-biological and pleasure value of fruit juice. On the basis of the results of the experiments, regarding the parameters which are important in terms of quality, i.e. dissolved oxygen content, C-vitamin concentration, deepening in the colour and sensory features, Tetra Bric Aseptic packaging proved to be better in the examined cases. Storage circumstances also influence the quality of fruit juice.

Key words: fruit juice, aseptic packaging, quality preservation

Introduction

Fruit- and vegetable juices are valuable components of our alimentation, primarily because of their vitamin content and mineral substances, further because of their favourable dietary effects. Their nutritional value is primarily provided by their hydrocarbon content (mainly glucose and fructose), their biological effect by their vitamin content and their pleasure value by the fruit acids (malic acid, citric acid and tartaric acid), which have a pleasantly refreshing effect. Further, its natural aroma components give the product a unique character, which can be recognized both in its taste and its flavour.

Producers make every effort to meet increasing consumer demands for fruit-based, preservative-free and packaged products.

Finished products put on the food industry market as fruit juice or fruit nectar are produced according to the compulsory provision no. 1-3-2001/112 on Fruit Juice and Certain Similar Products of the Hungarian Book of Food Products. Pursuant to this, only fresh fruit juice gained from fruit with a mechanical procedure and products made from concentrate in a manner, which is allowed can be denominated as fruit juice. Further, this provision states that in the course of the preparation and conservation of the fruit-base as well as during the preparation of the finished product made from fruit-concentrate, only the usage of physical canning procedures is allowed.

Factors determining the quality of packaged fruit juice

The quality of the packaged fruit juice is influenced by the fruit-base, the production technology and the packaging material used, and by the manner of packaging and the circumstances of its storage.

The quality of the fruit-base

The features of the fruit juice to be produced are determined to the largest extent by the quality of the fruit-base. For the production of a finished product (fruit juice) with a 100% fruit content, the choice of the suitable raw materials (pulp, fruit juice concentrate) deserves utmost attention (*Pescoroni*, 1996). The production of a fruit juice-base requires fully ripe, intact and healthy fruit. Both the optimal values of the parameters determining the quality of the fruit juice and its characteristic sensory features, which jointly shape the desired result, need to be established (*Löffler*, 1996).

According to the provision of the Hungarian Book of Food Products, only the replacement of the water evaporated and the fruit's own, natural aroma separated during the thickening of the fruit is allowed. There is no other possibility to improve its quality.

The production technology of the fruit juice

In terms of the technology of the production of fruit juice, the factor influencing the quality is the procedure for the preparation and treatment of the juice, which can differ depending on whether or not de-aeration is used, in the manner, temperature and duration of pasteurization and in the quality of the softened water. *Figure 1* shows the (possible) technological process of the production of fruit juice with a 100% fruit content.

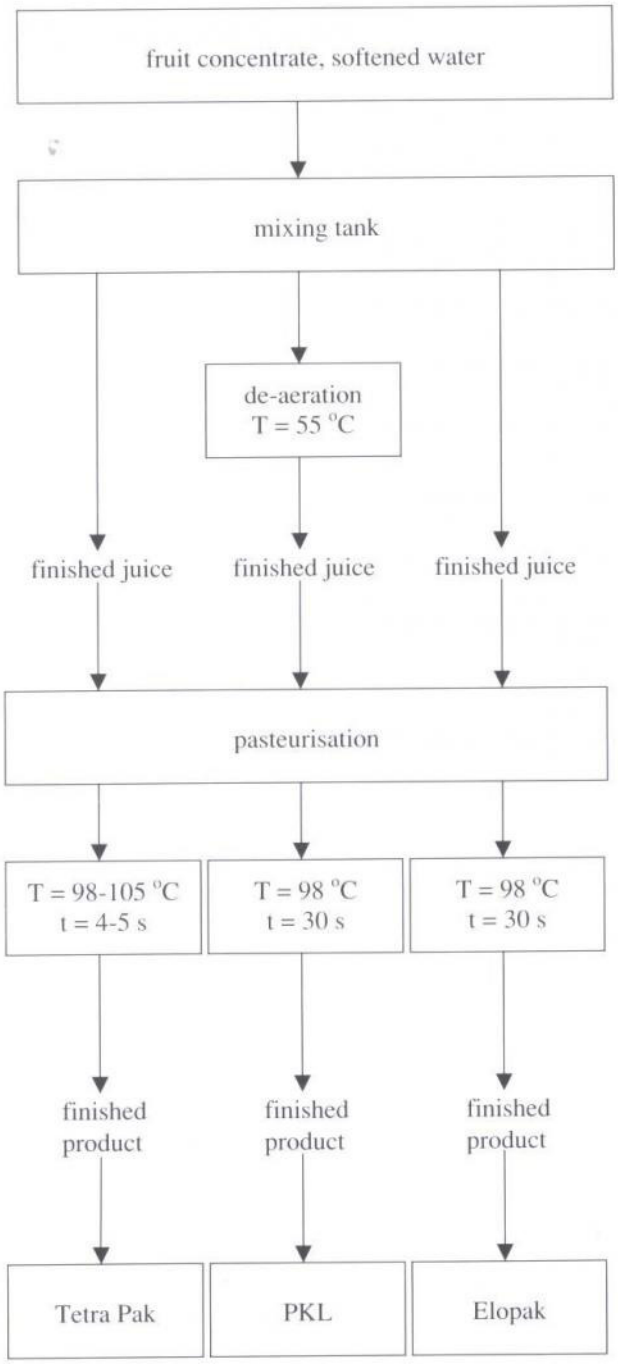


Figure 1: The technological process of the production of fruit juice with a 100% fruit content

During the production (e.g. putting together the juice, mixing) the juice comes in contact with air. Therefore the amount of dissolved oxygen increases, which can cause detrimental oxidation processes to start (*Schobinger*, 1987) that decrease the quality and, accordingly, the value of the product. The changes can be shown both by instrumental analysis and by analysis through the sensory organs. Accordingly, producers strive to develop such technologies by which the dissolved oxygen content of the fruit juice can be decreased significantly.

Scientific experiments specify de-aeration before pasteurization as the solution to the problem. Also the results of *Ostermann & Lorenz* (1988) verified that the dissolved oxygen content of a de-aerated product is significantly lower than that of a non-de-aerated product.

Further, the dissolved oxygen content of a product depends greatly on the packaging material and the manner of packaging used.

Packaging material

The aim of the packaging of fruit juice is to preserve the quality, as well as the alimentation-biological and pleasure value of the product to the fullest possible extent from packaging until consumption.

The usage of glass bottles for packaging has a history of many thousand years. The basic composition of glass (mainly SiO_2) hasn't changed to a meaningful extent, however the way bottles are produced has developed considerably. The technical literature on packaging doesn't anticipate a long future for such usage (*Kerekes*, 1996), however in many developed countries which have a high level of environmental consciousness, its usage has increased by dramatically in recent years. Because of many of its advantageous features, it is expressly suitable for the packaging of fruit juices.

From among more modern packaging materials, the spreading of combined packaging materials produced by the combination of paper, metal and plastic components can be observed, in connection with which different aseptic filling procedures (PKL combibloc, Tetra bric aseptic, Elopak) are used.

From among plastics which are suitable for the food industry, PET (polyethylene-terephtalate) bottles – beside their wide-spread utilization in the beer, mineral water and refreshment industry – are increasingly used for the filling of fruit juices.

Because of the differing gas-blocking ability of the different packaging materials used in the food industry, there are significant differences in the preservation of the quality of the product (*Anonym*, 1995). In this respect glass bottles proved to be the best compared to combined card boxes and plastic bottles.

Manner of packaging

The traditional, so called hot-filling procedure is used even today for the filling of fruit and vegetable juices into different packaging materials. However, since the 1980s, fruit and vegetable juices have been packaged mainly into combined cartons through aseptic procedures.

Aseptic packaging means storage in such a germfree or germ-poor environment where the few existing micro-organisms can not pursue their vital functions without external impact. Under such circumstances the product can be stored preservative-free, at room-temperature for a long period of time (*Fischer*, 1981).

Numerous researchers have examined the differences in the quality of the product caused by the differing technical

and technological solutions of the different aseptic filling procedures (Tetra bric aseptic and PKL combibloc).

The dissolved oxygen content of the finished product depends also on the manner of packaging used. The Tetra bric aseptic system ensures hermetic packaging, since the whole volume of the packaging unit (box) is filled up by the fruit juice. In the case of PKL-combibloc packaging, due to the usage of a different sealing technology, there is always an air-space of a few ml remaining above the surface of the fruit juice. The remaining "head-air" can be considered an additional undesirable oxygen source (*Ackermann*, 1986), which is, on the one hand, necessary for the shaking of the fruit juice before pouring it out, however, on the other hand, it can cause detrimental oxidation processes. According to the studies of *Németh* (1988), the dissolved oxygen content of orange juice packaged by PKL-combibloc is – despite the de-aeration adopted during the preparation of the juice – significantly higher on the day of the filling, than in the case of non-de-aerated Tetra bric aseptic packaging (*Figure 2*). A considerable part of the oxygen in the PKL boxes was used up within 7-10 days of storage, and subsequently it decreased gradually. The dissolved oxygen content of fruit juice stored in Tetra bric aseptic boxes changed slightly, in direct proportion to the storage time.

Simultaneously with the reduction of the dissolved oxygen content of these products, the decrease of the C-vitamin content and the deepening of their colour could also be observed.

Storage circumstances of the finished product

Storage circumstances greatly influence the quality of fruit juices. On the basis of the concurrent results of the studies of numerous researchers it can be established that the length of the storage life is determined mainly by the storage temperature.

Mannheim & Passy (1987) examined the change in the C-vitamin content of orange juices packaged in different ways. They implemented their storage experiment at 4 °C, 25 °C and 35 °C to determine the optimal storage temperature for the preservation of the C-vitamin content (*Figure 3*).

It can be observed in the case of all temperatures examined that the ascorbic acid concentration shows a strong decrease in approximately the first 10 days of the storage time, subsequently the graph shows a slower drop. The dissolving of the ascorbic acid occurs to the smallest extent at a low storage temperature (4 °C).

In the case of products with 100% fruit content, beside the decrease of the vitamin content, also other changes take

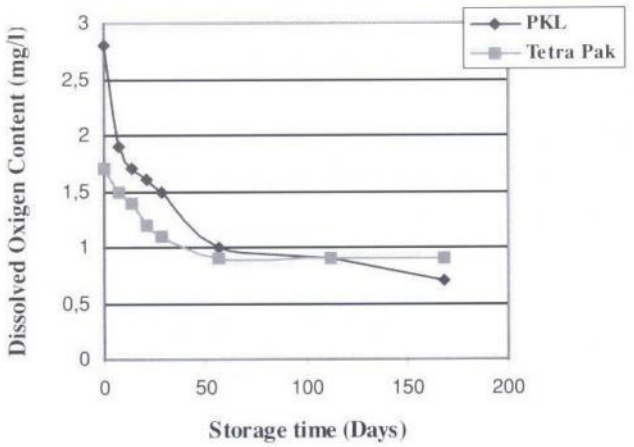


Figure 2: The changes in the dissolved oxygen content of orange juices packaged in different ways (*Németh*, 1998)

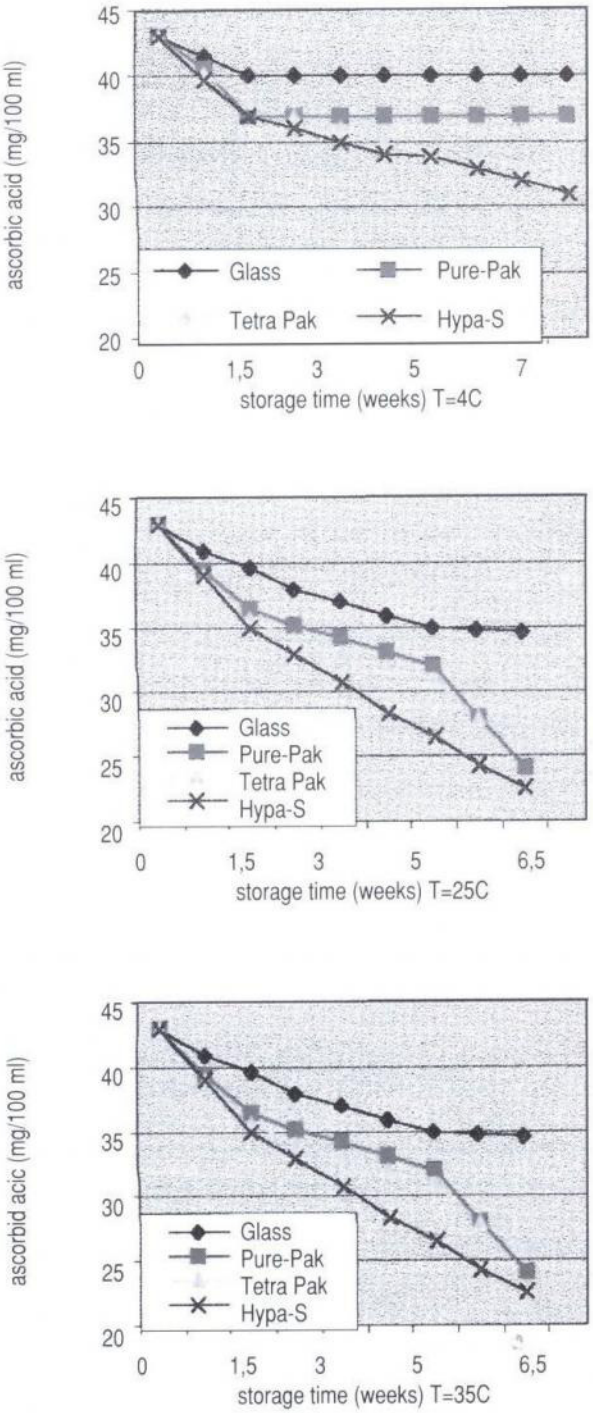


Figure 3: The change during storage in the C-vitamin content of fruit juices stored at different temperatures (*Mannheim & Passy*, 1987)

place, which are important in terms of quality. As an undesirable change, the deepening of colour can be observed in the case of every product.

Based on the results of photometric colorimetry (light absorption value measured at 420 nm) of 100% grape juice stored in aseptic combined card boxes (Tetra bric aseptic, PKL-combibloc) at different temperatures, the conclusion can be drawn that the colour of the product is decisively influenced by the storage temperature (*Figure 4*).

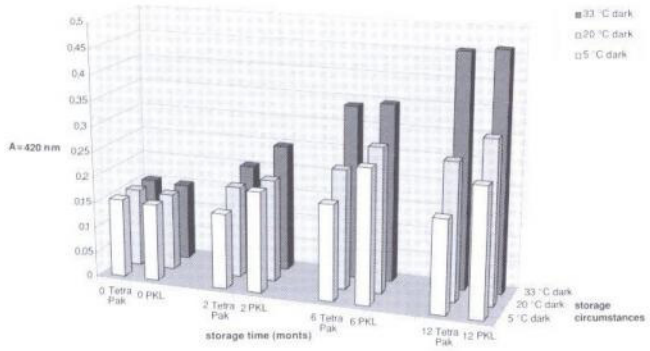


Figure 4: Changes during storage in the light absorption values of 100% grape juice filled in aseptic combined card boxes (*Nagy-Fodor*, 1997)

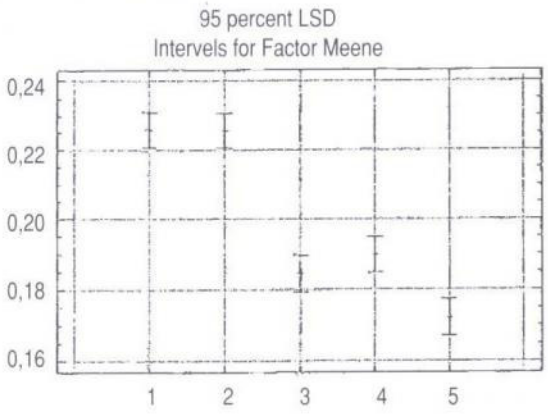
This conclusion is reinforced by the evaluation of the results of the light absorption measurement by a mathematical-statistical method, by the adoption of a statistical analysis of variance with two factors: there is a 95% probability of a significant difference in the colour of the samples stored at different temperatures. The highest difference in the detriment of the samples can be observed in those stored at 33 °C. With a 95% probability, there is also a significant difference in the deepening of the colour of the samples stored at room temperature and under cooled circumstances (to the benefit of the samples stored cool), however the extent of the difference is more limited than the difference between the deepening of the colour of the samples stored at room-temperature and of those stored heated (*Figure 5*).

When examining the effect of the two cartons according to the average of the different storage temperatures (*Figure 6*), it can be observed that there is, with a 95% probability, a significant difference throughout the whole storage experiment to the benefit of the samples filled in Tetra bric aseptic boxes. The light absorption value measured at 420 nm of the samples filled in PKL boxes is always higher (the colour of the samples is always deeper).

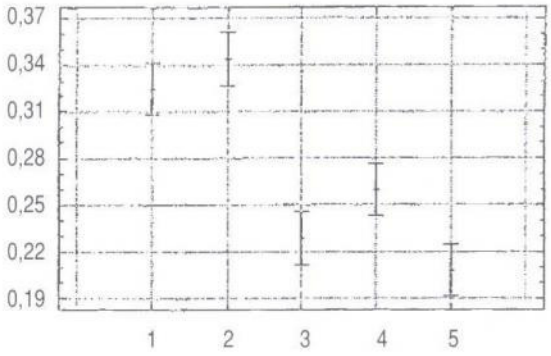
The colour of these samples was examined also by an analysis with the sensory organs. According to the result of the analysis with the sensory organs, a significant difference in the effect of the storage circumstances on the colour of the samples appeared, with a 95% probability, after 6 months storage. With the progress of the storage time the difference increased (*Nagy-Fodor*, 1997).

Also during the storage of apple juice, probably due to the high dissolved oxygen content, a deepening in the colour can be observed, the extent of which varies according to the storage temperature (*Figure 7*). The change in the colour was described by the author with the light absorption value measured at 400 nm (*Szabó*, 2002).

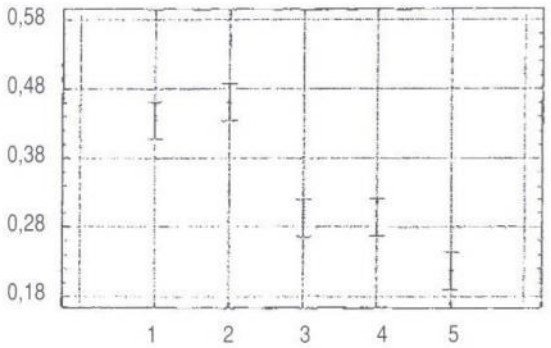
a./ After 2 monts storage times



b./ After 6 monts storage times



c./ After 12 monts storage times



1. 33 °C, birght
2. 33 °C, dark
3. room temperature, birght
4. room temperature, dark
5. 5 °C, dark

Figure 5: The effect of storage circumstances on the colour of 100% grape juice, on the basis of the light absorption values measured at 420 nm, in the average of the two different types of card boxes (*Nagy-Fodor*, 1997)

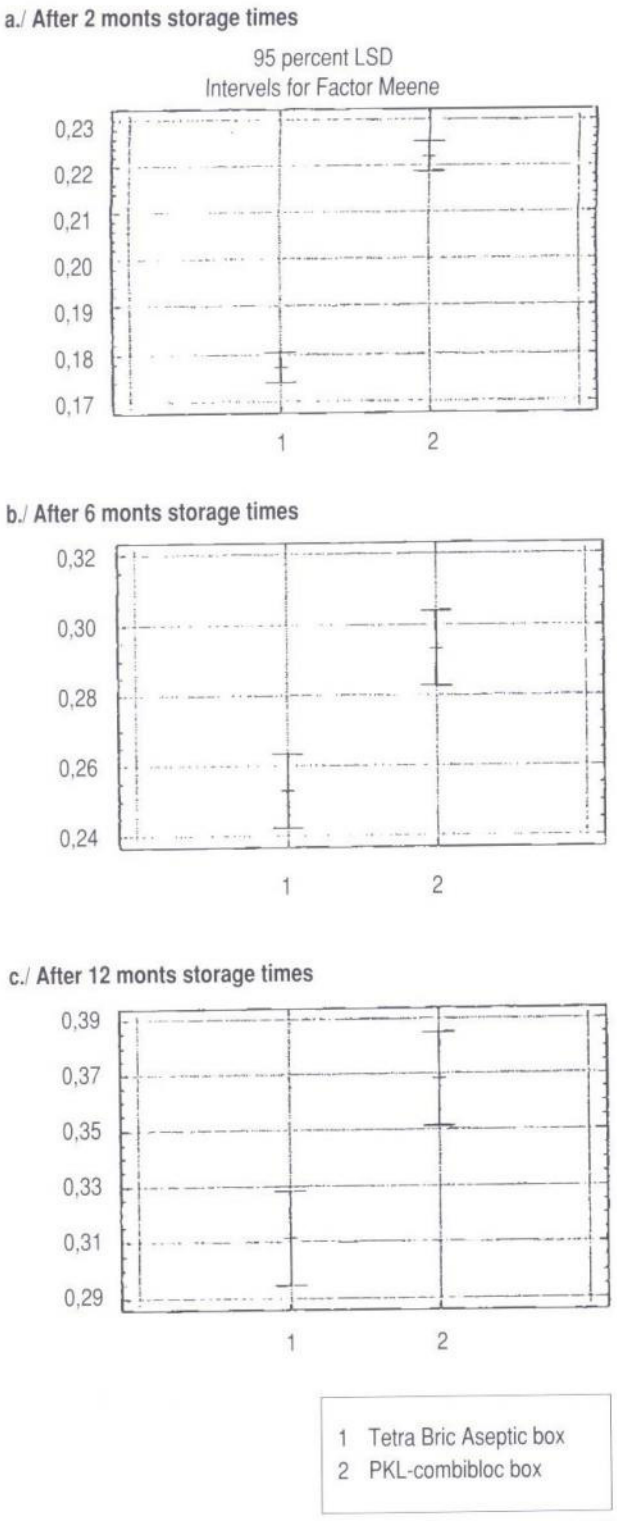


Figure 6: The effect of the two card boxes on the colour of 100% grape juice, on the basis of the light absorption values measured at 420 nm, according to the average of the storage circumstances (*Nagy-Fodor*, 1997)

Conclusions

The quality of finished products with a 100% fruit content is influenced to the greatest extent by the fruit-base (fruit pulp, fruit juice concentrate) used. The choice of the suitable raw materials requires utmost attention since, according to the relevant provision of the Hungarian Book of Fruit Products, its physical and chemical parameters cannot be improved by additives.

In terms of the production of fruit juice, the minimization of the quantity of the dissolved oxygen which can cause detrimental oxidation processes is a very important aspect. Scientific experiments specify de-aeration before pasteurization as the solution to the problem.

The choice of the packaging material and the manner of packaging also contribute to the preservation of the alimentation-biological and pleasure value of fruit juice.

Due to many of their advantageous features (excellent aroma-preservation and gas-blocking ability, they are chemically indifferent etc.), glass bottles are ideally suited for the packaging of fruit juices. Nevertheless, they are only used to a very limited extent in Hungary.

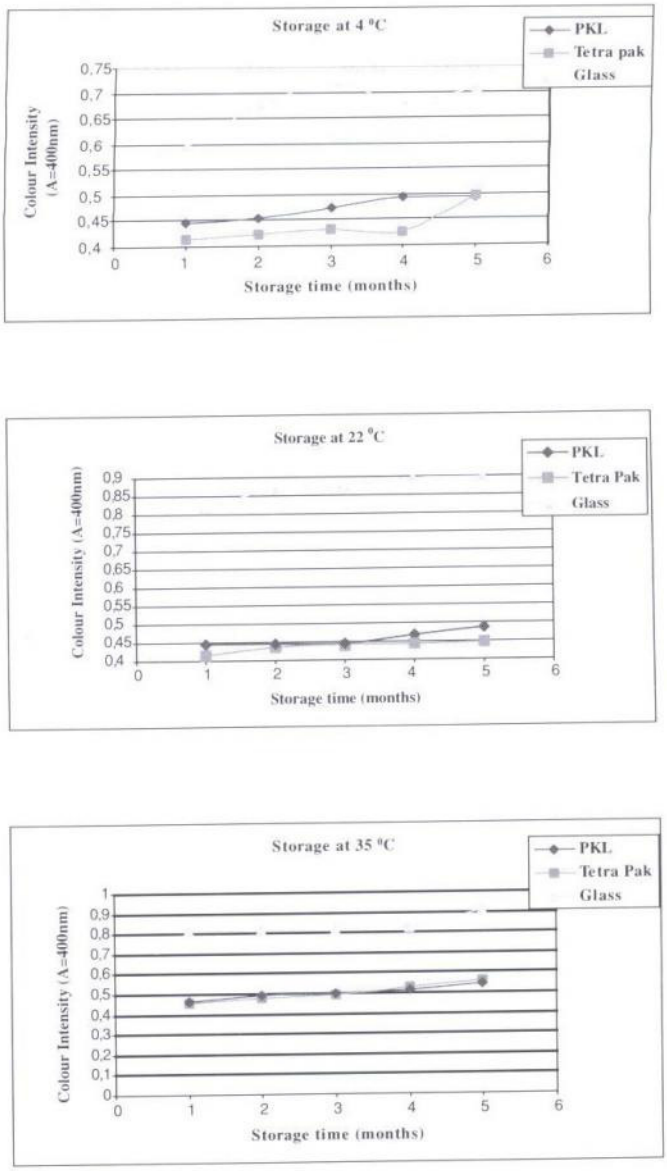


Figure 7: The colour intensity of apple juice stored in aseptic card boxes at different temperatures (*Szabó*, 2002)

PET bottles are less suitable for the preservation of the quality of fruit juices.

There is, due to the application of different filling and sealing technologies, a difference in the quality of the products packaged using different aseptic filling procedures (Tetra Bric Aseptic, PKL-combibloc). On the basis of the results of the experiments, regarding the parameters which are important in terms of quality, i.e. dissolved oxygen content, C-vitamin concentration, deepening in the colour and sensory features, Tetra Bric Aseptic packaging proved to be better in the examined cases. However, in order to be able to give a more firm opinion, further examinations are necessary.

Storage circumstances also influence the quality of fruit juice. According to the concurrent opinion of numerous researchers, the length of the storage life is determined mainly by the storage temperature. In the case of fruit juices stored at a low temperature the dissolving of the ascorbic acid, the deepening in the colour and the modification of the sensory characteristics are more limited even after a longer storage time.

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