THE EFFECT OF CONTROLLED ATMOSPHERE STORAGE CONDITIONS ON SOME PHYSICO-CHEMICAL AND SENSORIAL CHARACTERISTICS OF APPLES

UTICAJ KONTROLISANE ATMOSPHERE U SKLADIŠTU NA NEKE FIZIČKO-HEMIJSKE I SENZORNE KARAKTERISTIKE PLODA JABUKE

Mirela CALU, Camelia BONCIU, Gabriela IORDACHESCU, Ioan TOFAN
Dunarea de Jos University, Galați, Romania
e-mail:mirelacalu@yahoo.com

SUMMARY

Freshness represents one of the main characteristics of consumer choice of fruits and vegetables. The apple storage by controlled atmosphere is a technique for quality fruit preservation involving careful control of temperature, oxygen, carbon dioxide and humidity. During storage in controlled atmosphere storing rooms for a long period fruits lose their freshness and some of their characteristics depreciate. The objective evaluation of the quality of fruits is a difficult task, mainly due to the fact that every single person is not necessarily influenced by the same attributes and that the quality scale may vary strongly from one person to another. In this article we characterized four types of apples stored in refrigeration industrial conditions concerning their freshness, smell, aroma, juiciness, crispness using sensorial analysis and some physico-chemical characteristics as extract content, pH and firmness.

Key words: refrigeration, apple, sensorial analysis, sugar, firmness.

INTRODUCTION

The quality of fruits is an extremely complex matter, difficult to describe objectively. The consumer does not judge the nutritional quality of a certain fruit but he can make statements about sensory aspects such as shape, color, texture, juiciness, firmness, taste and aroma [1]

Most widely consumed fruits in Romania are apples. After the apples are harvested, they are commercialized. Today, the extended availability of seasonal fruit in the market place is common due to both post-harvest technologies and fruit varieties that allow longer periods of storage [4]. The apples which are not sold after harvest are stored in cold storage rooms, where the temperature and air humidity are maintained at optimal conditions. During storage fruits lose their properties, although low temperatures slow the ripening process. In the controlled atmosphere storage temperatures are kept constant according to apple variety, fruits chemical composition and fruit ripening level.

Refrigeration warehouses with controlled atmosphere, although need a supplementary costs, are widely used for fruit storage because of the longer period of fruit storage in these storehouses. Fruit losses are lower and fruits have better quality [5].

In this article the apple storage in controlled atmosphere is analyzed for three months period (December, January and February). One of the analyses was sensorial characteristics of stored apples in refrigeration warehouses with controlled atmosphere. The apples analyzed were kept in a controlled atmosphere separately storage rooms of a storehouse in Reghin from harvest to the moment of analysis. The parameters (temperature and air humidity) in the storage rooms were permanently recorded during storage. The Figures 1 and 2 shows the temperature and air humidity respectively records over a three months period (December, January and February).

RESULTS AND DISCUSSION

The apples analyzed were kept in a controlled atmosphere separately storage rooms of a storehouse in Reghin from harvest to the moment of analysis. The parameters (temperature and air humidity) in the storage rooms were permanently recorded during storage. The Figures 1 and 2 shows the temperature and air humidity respectively records over a three months period (December, January and February).

MATERIALS AND METHODS

Four varieties of apples were used for the experiment: Jonathan, Starkimson, Gala and Golden. The apples were harvested from Reghin territory, Romania. They were stored in four different cells of the storehouse placed in Reghin. The temperature and air humidity in the storage room were continuously recorded during storage and were specific for each apple variety.

The apples were analyzed for pH using a pH-meter HI 99181 (from Hanna Instruments, Romania), for extract content using a hand refractometer Mettler Toledo (from Optika, Romania) and for texture using a digital firmness tester Penefel DFT 14 (from Agro-Technologie, France). The results were analyzed using statistical control methods.

The apples were tested using sensorial analysis every month. The sensory panel was formed from students at Food Science and Engineering Faculty, Dunarea de Jos University, Galați, Romania. Students used for apple analysis were selected for food sensory analysis using specific sensorial analysis methods for panel selection. The subjects were asked to rate the following sensory attributes: odor, aroma, sweetness, acidity, firmness, juiciness and to give their overall appreciation. The panel rated the different parameters on a 1 to 15 scale (eg. 1 – very weak aroma intensity and 15 – very strong aroma intensity). Panelists were given water and bread as neutralizing agents between sample testing. The sensory analysis was carried out in the standard sensory laboratory under well controlled conditions.

**Fig. 1. Temperature records during December, January and February in the storage rooms of each apple variety**

**Sl. 1. Temperature zabeležene tokom decembra, januara i februara u komorama skladišta za sve sorte jabuka**

**Fig. 2. Air humidity records during December, January and February in the storage rooms of each apple variety**

**Sl. 2. Relativna vlažnost vazduha zabeležena tokom decembra, januara i februara u komorama skladišta za sve sorte jabuka**
The extract content of the apples juice was measured using the refractometer. The results obtained are given in Figure 3. As it can be observed, the extract content of the apples is lower in February as in December due to fruit losses during storage. The results represent average of ten determinations.

![Figure 3](image3.png)

**Fig. 3. The extract content variation during three months of storage for the apples varieties studied**

**Sl. 3. Promene u sadržaju ekstrata tokom tri meseca skladištenja za istraživane sorte jabuka**

The apples pH was monthly determined and the results are given in the Figure 4. It can be observed that apples pH is higher in February than in December due to acid accumulation during storage. The results represent average for ten determinations.

![Figure 4](image4.png)

**Fig. 4. The pH variation during three months of storage for the apples varieties studied**

**Sl. 4. Promene u pH vrednosti tokom tri meseca skladištenja za istraživane sorte jabuka**

The apples firmness was measured using a firmness tester. As it can be seen from Figure 5, fruits loose their firmness during storage, the penetration level is higher in February than in January. The results represent average of 30 determinations.

![Figure 5](image5.png)

**Fig. 5. The firmness variation during three months of storage for the apples varieties studied**

**Sl. 5. Promena čvrstoće tokom tri meseca skladištenja za istraživane sorte jabuka**

As it can be observed, generally, apples have lower expressed acid, grassy, honey, fruity, chemical and almond smell and bitter, chemical and almond aroma too.

The sensorial characteristics of the apples were determined using ten panelists in December, January and February. The characteristics evaluated were: smell intensity, acid smell, grass smell, honey smell, fruit smell, chemical smell, almond smell, aroma intensity, fresh acid aroma, grass aroma, honey aroma, fruit aroma, acid aroma, sweet aroma, bitter aroma, chemical aroma, almond aroma, firmness, masticability, hardness, mealiness, juiciness, aftertaste. Applying ANOVA analysis method to the results obtained, we can conclude that the differences between panelists are low concerning the grades given for each characteristic of every apple variety, so average of the grades given by panelists can be used for apples sensorial characterization. The radar sensorial profile is presented in Figures 6 to 9 for each variety of apples.

![Figure 6](image6.png)

**Fig. 6. The sensorial profile of Jonathan apples analyzed in December, January and February**

**Sl. 6. Profil senzornih osobina ploda jabuke sorte “Jonathan” analizirane u decembru, januaru i februaru**

![Figure 7](image7.png)

**Fig. 7. The sensorial profile of Golden apples analyzed in December, January and February**

**Sl. 7. Profil senzornih osobina ploda jabuke sorte “Golden” analizirane u decembru, januaru i februaru**
In Figures 6 to 9 it can be seen that during storage apples lose their characteristics. Smell and aroma intensity, aftertaste, juiciness, mealinness, hardness, masticability and firmness are, generally, better expressed in December than in February. Also, acid aroma, fruity aroma and sweet aroma had higher scores in December than in February.

**CONCLUSIONS**

Apples represent the most important fruit of temperate zone for direct consumption. Fruit storage during winter is an important problem for cultivars all over the world. Freshness represents one of the main attributes of consumer choice of fruits. Fruit storage in controlled atmosphere storerooms is one of the best storage solutions because of the low losses during storage and good quality fruits kept for a longer period of time.

During three months of storage in controlled atmosphere conditions, all apple varieties had extract losses, firmness loses and lower sensorial characteristics. But the differences are minor that is why controlled atmosphere storagehouses represent one of the most valuable storage option.

**REFERENCES**


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