SHELF LIFE AND STORAGE OF STRAWBERRY VARIETIES
SKLADIŠTENJE I OČUVANJE SVEŽINE SORTI JAGODA

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SUMMARY

Freshly picked strawberry fruit can be stored for as much as 14 days under optimal circumstances. This involves regulated temperature, humidity, and atmosphere. It is of primary economic importance, however, to know the length of shelf life of the fruit under normal room air temperature (22°C). Nine different strawberry varieties were stored and tested for changes of fruit quality as a function of storage days after harvest, without any additional treatment. Three forms of fruit quality losses were recorded independently: fruit mass loss, disease (Botrytis cinerea), and decay. While decay was identified to cause the majority of the quality loss, the varieties showed considerable differences in shelf life. All varieties kept the marketable quality during 2 days, but the quality decreases rapidly after the next day. The sample of Nerina had only 20% deteriorated fruit after 4 days, but Polka, Elsanta, and Alba had 100% deterioration. Mara de Bois, Cirafine, Alba, and Cijosee had 20-35% amount of disease, but this was only 10-15% of the other varieties. The positive correlation was found between the water loss and the fruit decay. It was also found that earlier ripening varieties are more sensitive to Botrytis than those with medium and late varieties.

Key words: strawberry varieties, shelf life, storage, water loss, decay, Botrytis.

INTRODUCTION

Strawberry (Fragaria x ananassa Duch.) is one of the earliest fresh fruits after the wintertime poor fruit supply at European market and one of the most delicious fruits not only for finished products, but also for ingredients to be included in complex foods such as ice-creams, cereals, dairy, confectionery, and bakery products (Dermesonlouoglou, 2006). Deep frozen products, jam and preserved fruit are popular, as well.

Strawberry is a non-climacteric fruit characterized by a short postharvest life, often estimated for less than 5 days. It is very prone to rapid dehydration, physiological disorders, bruising and other mechanical injuries as well as to infections caused by several pathogens that can rapidly reduce quality of ripe fruits (Sallato, 2007). Every non-climacteric fruit has problem with storage because the fruit has to be picked fully ripened. The fully ripened fruit is more sensitive to storage and transfer conditions. Climacteric fruits can be treated by ethylene and in that way it is possible to modify the timing of ripening to a moderate extent. Climacteric and non-climacteric fruits have different ripening physiology which is genetically determined (Giovannoni, 2004).

Strawberries are very susceptible to microbial contamination due to the fact that their skin is soft and easily ruptured with numerous indentations and hair-like protuberances, which allow most organisms to attach and proliferate (Tournas and Katsoudas, 2005). Optimum storage conditions for strawberries are 0°C and 90-95% relative humidity. In such conditions, strawberries can have 7-10 days of storage life. However, storage life is very dependent on handling of berries during and after harvest. The highest freezing point is -0.8°C for strawberries, although berries with high soluble solids content are less likely to freeze. Generally, strawberries are not stored for extended periods of time. However, some temporary holding is often necessary in order to achieve orderly marketing. Holding berries under optimum storage conditions even during short marketing periods is beneficial to quality retention. Detrimental processes to berry quality are reduced at low temperatures, such as respiration, softening, moisture loss, and decay development (De Ell, 2006).

The consumers demand high quality fruits, and the market has to solve the storage and quality questions. Therefore, different chemical and other treatments have to be applied to save the fruits from fungal and other damages. Sallato et al in an experiment in Chile with cv. Camarosa showed that without any chemical treatment strawberry could be stored for at least 10 days at the temperature of 5°C. The storage period could be extended with different chemical treatments, up to 20 days (Fenhexamid, Cyprodinil + fludioxonil, and Boscacilid).

To save the fruit we can use a variety of methods but different treatments can reduce the quality of the fruits. For example, Allende et al. (2007) found that strawberries in high content of O2, and CO2 storage were clearly less flavoured than those of air-stored samples after 9 and 12 days of storage, and the treatment of O2 lowered the C-vitamin content. 2-nonanone (C7H15-COCH3) treatment is a complementary technology that is capable of improving berry shelf-life. The fungal infection can be reduced at low concentration of 2-nonanone without causing sensory deterioration (Almenar et al, 2009).

It has been known for a long time that hypobaric storage of fresh fruits and vegetables helps in keeping their quality and extending their shelf-life, because this treatment generally reduces the respiration rates of fruits (An, 2009). A positive effect of hypobaric treatments on delaying the senescence of many fruits and vegetables such as apples, asparagus, bananas, mangoes, tomatoes, strawberries has been reported (Thompson 1998, and Li et al 2006). The hypobaric treatment reduces or inhibits the decay of strawberry and mould spoilage because it prevents microbial growth.

MATERIALS AND METHODS

The observed strawberry varieties samples originated from the Central Agricultural Office (MgSzH) Fruit Variety Trial Station of Póloske. The station is situated in south-west part of Hungary among the Zala hills. The climate is moderately cold – moderately humid. The sunshine duration is 1900 hours. The annual mean temperature is 9.5°C, the summer mean temperature is 15.5°C. The summer mean of the absolute maximum temperature is 32.5°C, winter mean of absolute minimal is -17.5°C. The annual precipitation amount is about 700 mm/year, in the summer: 440 – 450 mm. The type of the soil is clay brown forest soil (Marosi et al. 1990).

The experiment was planted in August of 2007 with 24 different varieties. The technological conditions were: raised bed, covered with black woven plastic material. The plants were
planted in twin rows. We have observed 9 different varieties: Elsanta, Mara de Bois, Cirafine, Cijosee, Alba, Polka, Sonata, Fraroma, and Nerina. The observation on the strawberry fruit quality was daily, after 24, 48, 72, and 96 hours of storage in 22°C in a room without air conditioning or any other type of climatisation. The chemical treatment was not used. The samples were hand picked directly in plastic boxes (size: 5.5 x 18 x 11 cm, the mass was about 500 g strawberry fruit) in the field. The containers have different effect to the fruits (Jasna et al, 2007). Berries were harvested with the calyxes attached. The strawberries were handled with care and placed gently into the container. Only the healthy berries were collected, the samples did not contain discards or any fungal lesions or injuries. Packaging strawberries in the field has the advantage that berries are handled only once. Studies of fruit quality loss have shown that most damage occurs in the field during picking and packing. Therefore, minimizing berry handling is critical to good quality maintenance and post-harvest life.

The observed varieties:

Elsanta: is the most common variety in Europe and also in Hungary. Plant vigour is medium strong with medium green leaves. The fruit is large, conically shaped, orange red. It is an early ripening variety.

Mara de Bois: plant vigour is weak. The medium sized fruits are shiny and conical in form. The taste is medium. This is a partially remontant variety.

Cirafine: medium-strong growing plant, leaves are dark green. The fruit size is medium, the predominant shape is bi-conical, strongly shiny, with red colour, early ripening, fully remontant.

Cijosee: plant vigour is medium-strong, leaves are medium green. The fruit size is medium, conically shaped, having red colour, the ripening time is medium, fully remontant.

Alba: plant vigour is strong - very strong, leaves are light green. The fruit size is large, with conical shape. Its colour is light orange and the skin is very shiny. The ripening time is early to very early. It is partially remontant.

Polka: plant vigour is medium. The fruit is medium size, conical, with dark red fruit. Medium shiny. Its ripening time is medium.

Sonata: plant vigour is strong, leaves are dark green. The fruit is medium-large, conical form and its colour is orange-red. This is an early ripening variety.

Fraroma: plant vigour is medium-strong, leaves are dark green. The fruit is medium red, very shiny, round-conical shape and the calyx is above the fruit. The fruit flesh is soft. It is characterized by late ripening.

Nerina: plant vigour is medium-strong, leaves are dark green. The fruit colour is very dark red, nearly blackish, the shape is conical. The fruit flesh is medium firm. It is a late ripening variety.

RESULTS AND DISCUSSION

Figure 1 summarizes the results of the experiment. After 24 hours of storage, the original mass (2000 g) was divided into four parts: ‘healthy’, ‘water loss’, ‘Botrytis’ (Botrytis cinerea), and ‘decay’ as shown by the bars. First the net mass of the batch was measured; the mass loss relative to the previous day ‘day 0’ is due to evaporation of the water (‘water losses’). Then the ill and decayed fruits were removed from the batch and their mass were measured (‘Botrytis’ and ‘decay’ on Fig.1). The remaining fruit (‘healthy’) was stored further. The same procedure was repeated after 48, 72, and 96 hours.

\[ A_{\text{loss}} = \sqrt{\frac{36\pi}{W}} \]  

where \( W \) is the water loss per surface area, \( W \) is the total mass loss of the batch, \( n_{\text{batch}} \) is the total number of fruits in the batch, \( A_{\text{fruit}} \) is the surface area of one fruit, \( m_{\text{fruit}} \) is the mass of one fruit and \( \rho \) is the density of the fruit, which was taken to be 0.8 g/cm^2.

It was found that while the CV of the mass loss per fruit values was 34%, the water loss per surface area showed a smaller CV=18%. Water loss values after 48 hour were considerably lower than those for 24, 72, and 96 hours.
As it is demonstrated on Fig 2, the positive correlation was found between the mass loss and the decay of the fruits: fruits with higher amount of mass loss per surface area show a larger decay. There are only two exceptions from this rule: Nerina has no decay at all after 48 hours and Polka has the highest decay (54%), though the mass loss values are medium for both varieties. This, however, can be attributed to the exceptional fruit size of these two varieties: the average fruit mass is 30 g for Nerina and 6.6 g for Polka. Excluding these two varieties results a correlation of R = 0.8.

The relation of experimentally found differences in the amount of infected fruit between the varieties was analyzed, as well. Figure 3 shows that these are related to the ripening time: those varieties with early ripening time had the greatest number of fruits infected with Botrytis, the late varieties gave the opposite result, while those with medium ripening time had a medium amount of infected fruits.

CONCLUSIONS

In this study 9 strawberry varieties were observed. They were stored at room air temperature as a model of the shelf life condition at green markets. The strawberry is a non-climacteric fruit and, therefore, the shelf-life is quite short. There are, however, considerable differences among the strawberry varieties. Significant differences were found among the tested varieties. All tested varieties keep the marketable quality within 2 days, but the quality changed dramatically after the second day. The Nerina had only 20% deteriorated fruit after 4 days, but Polka, Elsanta, and Alba had 100% of deterioration. Mara de Bois, Cirafine, Alba, and Cijosee had 20-35% amount of disease, but this was only 10-15% for the other varieties.

It can be concluded that all varieties can be stored without considerable amount of quality loss for one day, only some specially selected varieties are suitable for longer term storage in room air temperature. The results showed that varieties with larger water loss per surface area are more susceptible to fruit decay. Nerina and Fraroma varieties keep the fruit quality for 3 days, while the other varieties tested in this experiment showed great risk when storing at room temperature longer than 24 hours. For longer storage, special packing and cooling systems are necessary.

REFERENCES


Received: 17.03.2009. Accepted: 15.06.2009.