EFECTELE REFRIGERARII SI ATMOSFEREI MODIFICATE ASUPRA CALITATII CAPSUNILOR
EFFECTS OF REFRIGERATION AND MODIFIED ATMOSPHERE PACKAGING ON QUALITY OF STRAWBERRIES

Cristina Petrisor, Alina Ilie, Adela Barbulescu, Andreea Petcu, Maria Dumitru
Research and Development Station for Pomiculture Baneasa, Bd. Ion Ionescu de la Brad, No.4, Sect.1, Bucharest, Romania

Abstract

The objective of the present study is to evaluate the effect of refrigeration and modified atmosphere during storage on some quality parameters of strawberries. The samples were analyzed 2, 4, 6, and 8 days during storage. Were analyzed fruit weight, soluble solids content, chromatic parameters L*, a*, b*, fruit firmness, total titratable acidity, pH, the anthocyanin content. The result suggested that modified atmosphere packaging (MAP) can be beneficial for reducing mass loss and firmness after 8 days storage. However, acidity, soluble solids, did not change during storage and shelf life.

Keywords: strawberry, quality, storage, firmness
Cuvinte cheie: capsun, calitate, pastrare, fermitate

1. Introduction

The natural appearance, colour and nutritional value of wild strawberries (*Fragaria vesca* L.) are characteristics which make these fruits highly appreciated by consumers. However, the postharvest preservation of wild strawberries is very complex owing to a very fast metabolism and the presence of microbial contamination during storage (Almenar et al., 2007).

Strawberries have short shelf life due to highly perishability and are susceptible to mechanical injury, physiological disorders, watter loss, and decay (Caner et al., 2008).Several studies reported different strategies to reduce postharvest losses, combination of low temperature, high – humidity storage and the use the carbon dioxide (Ke et al., 1991; Nunes et al., 1995; Krivorot & Dris, 2002).

The purpose of present study was to determine the quality changes of strawberry in modified atmosphere packaging and refrigeration conditions during storage.

2. Material and methods

The experimentation used fruits classified as excessively perishable commodities, respectively, strawberries. Were analyzed two varieties of strawberry: Premial and Redgauntlet. Damaged, nonuniform, unripe or overripe fruits were discarded. The selected fruits were stored for at least 2 h at 3º C to ensure equilibrium.

In this experiment strawberry fruits were stored at 1°C and about 90% relative humidity under storage conditions: modified atmosphere packaging (MAP) or normal cold storage conditions (refrigeration conditions). MAP was created by the application of two types of films unperforated and perforated (PVC and POFF). In refrigeration conditions fruits were without film.

The samples were analyzed 2, 4, 6, and 8 days during storage. Were analyzed weight loss, soluble solids content, chromatic parameters L*, a*, b*, fruit firmness, total titratable acidity, pH, the anthocyanin content.

In this sense, were used specific methods to analyze each component:

- weight was determined by weighing each fruit, and is expressed in grams, establishing the average weight of 20 fruit;
- firmness was measured as the force required to compress the fruit with a TA –XT2 penetrometer. Results were expressed in Newton.
- soluble solids was determined in fruit juice using a hand refractometer Atago type with correction of temperature and it was expressed as a º Brix;
- determination of total titratable acidity was achieved by neutralization of free acids in fruit juice with 0.1 N NaOH solution in the presence of acid-base indicator (phenolphthalein) and was calculated as a percentage of citric acid which is predominantly acid;
- fruit surface color was measured with a hand-held tristimulus reflectance colorimeter (Model MiniScan XE Plus). Color was recorded using the CIEL* a*b* uniform color space, where L*indicates lightness, a* indicates chromaticity on a green (-) to red (+) axis, and b* chromaticity on a blue (-) to yellow (+) axis.
- the pH of the juice samples was determined using a pH meter (model) that had previously been standardized to pH 4 and 7.

- the total anthocyanin content was determined using the pH differential method (Giusti, Wrolstad, 2001). Samples were diluted in pH 1.0 and pH 4.5 buffers, and absorbance measurements were made at 510 and 700 nm on Camspec spectrophotometer. The pigment content was calculated and expressed as cyanidin-3-glucoside (Cyd-3-glu)/100 g FW, using an extinction coefficient of 26900 L cm^{-1} mol^{-1} and a molecular weight of 449.2 g mol^{-1}.

3. Results and discussions

Even when harvested fully red, strawberries continue to slowly change color and darken during storage. During storage, the L^* value tended to decrease in both MAP and refrigeration conditions. However, strawberries from refrigeration conditions were significantly darker in color (lower L^* value) than fruit storage in MAP. As in the present study, decrease in the L^* value of strawberry fruit have previously been reported by others researches (Nunes et al., 2005; Almenar et al., 2007).

The b^* values of the strawberries no visible change during storage. However, the parameter a^* value increase significantly during 8 days of storage, which is supported by the accumulation of anthocyanin pigments and high degree of red fruit.

As Table 1 and 2 shows, colour evolution was affected by storage time and packaging material. Maximum anthocyanin content was found in the refrigeration storage conditions while the lowest content was obtained by the MAP storage (with unperforated films). The percent of anthocyanin increase during storage, ranged from 27.29-30.17mg/100 g FW without film for Redgauntlet variety and between 16.08-26.30 mg/100 g FW for Premial variety. These results indicated an increase in anthocyanin content after storage in MAP and in refrigeration conditions. We support that refrigeration conditions enhanced anthocyanin synthesis during storage comparated to MAP storage.

It is possible that the great loss of moisture observed in the unwrapped fruit might have contributed, along with oxidative mechanism, to degradation of the pigments and/or to changes in the anthocyanin pigments structure during storage. These results are in agreement with those obtained by Abu-Zahra et al. (2007), Nunes et al. (2005) and Almenar et al. (2007) who found an increase in anthocyanin concentration during strawberry storage, due to continuous synthesis of this pigment especially in fruits wrapped with PVC film.

One of the characteristics of strawberry fruit that contributes to their highly perishable character is rapid loss of water (Ozkaya et al., 2009). Packaging reduces water loss from fresh produce by maintaining a relatively high humidity in the headspace atmosphere.

The weight loss of the strawberries increased with storage time, particularly in strawberry samples without film (data not shown). The findings of the current study suggested that after 8 days in MAP storage, strawberry samples lost about 0.6% of their weight while strawberry without film lost about 6% of the initial weight. Previous work of Nunes et al. (2005) and Abu-Zahra et al. (2007) showed greater weight loss of unwrapped strawberry samples, but Ozkaya et. al (2009) showed similar results with as in terms of weight loss during storage at 1ºC. the loss of water from the fruit had a negative effect on the visual appearance, resulting in superficial shriveling and less bright color.

Total soluble solids determined on strawberries suggested that MAP did not influence influence this parameter during storage, ranged between 8.5-8.9 º Brix were found in unwrapped film and MAP stored for Premial variety. Storage time influenced total soluble solids content, this parameter increase slight during storage in MAP and refrigeration conditions.

Strawberry pH varied in range 3.6-3.8 during storage. pH of fruit for both varieties remains almost constant during storage either in MAP and refrigeration conditions. This is supported by the values obtained for the titratable acidity contents which does not change during storage strawberry samples. In the present studies, the value of pH observed are in according to the results reported by Souza et al. (1999). However, our results regarding to pH and titratable acidity are not in agreement with thouse obtained by Ozkaya et al. (2009) and Almenar et at. (2007), who reported the increase in acidity of strawberries during storage and MAP. An explanation of this is that they use other varieties.

Overall, strawberry firmness decreased during storage either in MAP or refrigeration conditions for both varieties (Table 1 and 2). The strawberry stored in MAP were consistently firmer than thouse stored at low temperature. The results obtained in this study are in agreement with other studies, which have generally reported that fruits stored in MAP or CA are firmer than those stored in air (Nunes et al., 1995; Ozkaya et al., 2009).

4. Conclusions

Modified atmosphere storage play an important role in preserving the appearance as well as the nutritional value of strawberries by delaying ripening or senescence of the fruits;

Modified atmosphere has not affected acidity and pH of strawberry samples during storage;

Fruits color was affected by storage; berries color parameters moved toward a more intense red color (a^*) and a less intense yellow color (b^*) as not changes during storage; also the L^* value decreased in both MAP and refrigeration conditions during storage fruit becoming darker in color;

Our results indicated an increase of anthocyanin content in MAP and refrigeration conditions, this being supported by high values of the a^* parameter;

Firmness decreased during storage of strawberry samples in MAP and refrigeration conditions, but intensly in fruit stored at 1º temperature (refrigeration conditions).

5. References

1. Abu-Zahra T.R., Al-Ismail K., Shatat F., 2007, Effect of organic and conventional systems on fruit storage of strawberry (Fragaria x ananassa duch) grow Ander greenhouse conditions, J. Plant Sci., 2: 162-170;

2. Almenar E., Del-Valle V., Hernandez-Munoz P., Lagaron J. M., Catala R and Gavara R, 2007, Equilibrium modified atmosphere packaging of wild strawberries. J. Sci. Food & Agric. 87: 1931-1939;

3. Caner C., Aday M. S., Demir M, 2008, Extending the quality of fresh strawberries by equilibrium modified atmosphere packaging, European Food Research & Tehnology 227: 1575-1583;

4. Giusti, M.M; Wrolstad, R.E. Unit F 1.2: Characterization and measurement with UV – visible spectroscopy. In Current Protocols in Food Analytical Chemestry; Wrolstad, R. E., Ed.; John Wiley & Sons: New York, 2001; pp F1.2.1 – F1.2.13;

5. Ke D., Goldstein L., O'Mahony K and Kader AA, 1991, Effects of short-term exposure to low O_2 and high CO_2 atmospheres on quality of strawberries. J Food Sci 56:50-54;

6. Krivorot, A.M. & Dris R., 2002, Shelf life and quality changes of strawberry cultivars. Acta Hortic., 567: 755-758;

7. Nunes M.C.N, Brecht J.K., Morais A. M.M.B., Sargent S.A., 2005, Possible influences of water loss and polyphenol oxidase activity on anthocyanin content and discoloration in fresh ripe strawberry (cv. Oso grande) during storage at 1ºC, Journal of Food Science, 70 (1): 79-84

8. Nunes M.C., Morais A. M. M. B., Brecht J.K., Sargent S.A., 1995, Quality of strawberries after storage in controlled atmospheres at above optimum storage temperatures, Proc. Fla. State Hort. Soc. 108:273-278;

9. Ozkaya O., Dundar O., Scovazzo G.C., Volpe G., 2009, Evaluation of qyality parameters of strawberry fruits in modified atmosphere packaging during storage, African Journal of Biotechnology, 8 (5), 789-793;

10. Souza A.L.B., Scalon S.P.Q., Chitarra M.I.F., Chitarra A.B., 1999, Post-harvest application of $CaCl_2$ in strawberry fruit : Evaluation of fruit quality and post-harvest life, Cienc. E agrotec, Lavras, 23 (4): 841-848.

Tables and figures

Table 1. Variation of quality attributes at Premial varieties wrapped with unperforated film

	Storage time (days)			
	0	4	6	8
Sample	pH			
Premial	3.8	3.77	3.73	3.80
	Total titratable acidity			
	0.90	0.90	0.87	0.90
	Total Soluble solids			
	8.5	8.6	8.8	8.9
	Firmness			
	2.35	1.98	1.7	1.6
	L*			
	37.8	36.89	36.65	36.45
	b*			
	28.09	28.53	31.21	32.67
	a*			
	49.17	50.21	55.6	58.8
	Anthocyanins			
	16.08	18.90	22.71	26.30

Table 2. Variation of quality attributes at Redgauntlet varieties without film

	Storage time (days)			
	0	4	6	8
Sample	pH			
Redgauntlet	3.7	3.65	3.59	3.68
	Total titratable acidity			
	0.74	0.78	0.73	0.70
	Total Soluble solids			
	6.7	6.9	7.1	7.4
	Firmness			
	2.5	1.3	1	0.9
	L*			
	37.5	36.8	37.3	37.2
	b*			
	20.19	20.5	22.13	22.88
	a*			
	52.12	55.08	59.44	62.3
	Anthocyanins			
	27.29	28.92	29.98	30.17