Effects of Vegetable Oils on The Quality Parameters of Red Pepper During Storage*

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Sunflower, cottonseed, hazelnut, soybean and sesame oils at the concentration of 0, 2, 4 or 6 g/100g red pepper were added into red pepper to determine the effects of the oils on color and oxidative stability during 12-month storage at room temperature. The changes in color, free fatty acid content and peroxide value were determined in 2 month intervals. Initial colors of samples were ranged between 75.26 and 79.95 (ASTA unit), and decreased as the amount of the added vegetable oils increased. Color losses were increased by increasing time for all samples while the color of the soybean oil added samples was more stable. Free fatty acid content and peroxide value of red pepper extracted oils increased significantly as the storage time increased. At the end of storage, free fatty acid content of sesame oil added red pepper was higher than that of others and the lower peroxide value was observed in the control.

Keywords: Red pepper, vegetable oil, storage, color, oxidation

Depolama Sürecince Bitkisel Yağların Kırmızıbiberin Kalite Parametreleri Üzerine Etkileri

Ayçiçek, pamuk, fındık, soya ve susam yağları kırmızıbibere 2,4 ve 6 g/100 g kırmızıbiber oranlarında ilave edilmiştir. Yağların, oda sıcaklığında 12 ay süre boyunca renk ve oksidatif stabilite üzerine etkileri araştırılmıştır. Renk, serbest yağ asit içeriği ve peroksit değerlerindeki değişimler 2 aylık periyotlar halinde belirlenmiştir. Başlangıçta örneklerin renk değerleri 75,26-79,95 (ASTA değeri) aralığında bulunmuş ve ilave edilen yağ miktarı artıkça renk değeri düşmüştür. Bütün örneklerde renk kayıpları depolama süresinin artması ile artmış, bununla birlikte soya yağı ilaveli örneklerin renkleri daha stabil olmuştur. Kırmızı biberden ekstrakte edilen yağların serbest yağ asit içerikleri ve peroksit değerleri depolama süresinin artmasıyle önemli ölçüde artmıştır. Depolamanın sonunda susam yağı ilave edilmiş kırmızıbiber örneklerinin serbest yağ asit içerikleri, başlangıç değerine bağlı olarak, diğerlerinden yüksek olmuş ve en düşük peroksit değeri kontrol örneğinde bulunmuştur**.**

Anahtar kelimeler: kırmızıbiber, bitkisel yağ, depolama, renk, oksidasyon

Introduction

Red pepper (*Capssicum annum L.*) produced in large quantities world wide is one of the oldest, most important and widely used food flavoring and colorant (Ade-Omowaye *et al*., 2001; Topuz and Özdemir, 2004). It is used in cheese, sauces, gravies, condiments, salad dressings, baked goods, snacks, icings, cereals, direct compression tablets, lipsticks, shampoos (Nieto-Sandoval *et al*., 1999).

The red color of red pepper is due to the presence of carotenoids, mainly capsanthin, capsorubin, zeaxanthin and cryptoxanthin (Klieber and Bagnato, 1999), and the yellow colors are violalaxanthin, cucurbitaxanthin A, cis-zeaxanthin, β-criptoxanthin, β-carotene and cis-β-carotene (Perez-Galvez *et.*, 2000).

Carotenoids are very stable when they are intact in plant tissue, but when the plant tissues are processed, carotenoids become isolated and vulnerable to the effects of heat, light and high oxygen tension. Loss of red color is occurred by autoxidation of the carotenoids. A number of factors influence the rate of autoxidation e.g cultivar, heat exposure during drying and

*This article was prepared from the PhD thesis storage, and presence of oxygen (Carnevale *et al.,* 1980; Malchev *et al.,* 1982). However, intact pigments are more liposoluble and at the same time more stable to photo- and thermoxidative reactions resulting in longer conservation of the color (Perez-Galvez *et al.,* 1999).

Fats and oils play an important role in the flavor, aroma, texture, color and nutritional quality of foods, pet foods, and feeds. Fats and oils may either be added during manufacturing or be inherent to the product or ingredient. Regardless of the source or the amount of oil, in the loss of food wholesomeness by deterioration of flavor and aroma, as well as in decay of nutritional and food safety qualities (Eriksson, 1982). Aroma changes result from new volatile odorous compounds formed, flavor modifications are caused by hydroxy acids, the color darkens as the result of condensation reaction between oxidation products and proteins, and finally, a new texture might be attributed to the oxidative induction of protein crosslinks. Not unexpectedly, the nutritive value and safety of food are impaired.

The physical apperance and presentation of red pepper, like most foodstuffs, significantly influence a prospective consumer's sensory evaluation and play a prominent role in final selection and consumption (Clydesdale, 1993). The color of red pepper is the main quality factor for determining storage stability. Seed oil is used by the spice industry for a glossy final or the product composition, predicting and monitoring oil and oil quality is an important step in developing and manufacturing high quality products. Starting from manufacturing food, feed, or ingredient, oxidation of lipids are responsible for rancid flavors and aromas predicted by PV and FFA. At the biological level, the oxidation of lipids means damage to membranes, hormones and vitamins, which are vital components for the normal cell activity (Mc Brien and Slater, 1982) and, at the nutritional level, the oxidation of fatty constituents is the major chemical factor
appearance to the powder (Minguez-Mosquera and Hornero-Mendez, 1993).

Previous studies have focused on addition of antioxidant or seed (such as red pepper seed or sunflower seed) to red pepper to prevent color loss during storage (Daood *et al.,* 1996; Osuna-Garcia *et al.,* 1997; Perez-Galvez *et al.,* 1999; Klieber *et al.*, 1999; Perez-Galvez *et al*., 2000; Perez-Galvez and Minguez-Mosquera, 2001). There is a limited research little info on the addition of vegetable oils on the stability of red pepper.

Therefore, the present work aims to analyse (1) the effects of vegetable oil addition on quality of red pepper during storage by using ASTA (2) to determine color changes (3) to monitor peroxide value and free fatty acid concentration for oxidative stability of added oil.

Material and Methods

1 Material

Dried red pepper fruits (*Capssicum annum* L.) were purchased from a red pepper manufacturer (Kahraman Maras city, Turkey). Sunflower (SF), cotton seed (CS), hazelnut (HN), soybean (SB) and sesame (SS) oils were supplied from a local market. All vegetable oils were refined, bleached and deodorized except for sesame oil; being naturel

2 Preperation of materials

Fruits were milled in a hammer mill and passed through a 5 mm sieve after seperation of seed and stalk. Ground red peppers were placed in a plastic container, homogenized and mixed with SF, CS, HN, SB or SS oils at the concentration of 2, 4 or 6 g/100g red pepper and coded as R_{SF}, R_{CS}, R_{HN}, R_{SB} and R_{SS}, respectively. Coded samples and no oil added red pepper (R_C) were placed in glass jars, tightly closed and stored in dark medium at 25±3°C for 12 months. The storage temperature was chosen for adjusting the experiment to industrial condition.

3 Color measurement

Extractable color was measured bi-monthly for 12 months using AOAC method 971.26 (Anon., 2000). 0.07-0.10 g of samples were weighed and placed in a 150 mL flask with 100 mL acetone. The mixture was shaken and left overnight in the dark at room temperature (25°C). The absorbance of the extract was measured using a Shimadzu UV-160 spectrophotometer set at 460 nm wavelength and calibrated with an acetone blank. Colour unit reported in ASTA were calculated from the equation as expressed in the method.

4 Extraction and oxidative stability of the oils in red pepper

Red pepper samples were soaked in petroleum ether (b.p. 40-60°C) at room temperature (25°C), several times until no oil was extracted. Petroluem ether was evaporated and the oil samples were stored separately in a refrigator inside a dark tight-stoppered glass bottle for analysis. The extracted oil sample comprised of the added vegetable oil and natural red pepper oil. The oxidative stability of the oils were studied by determining the change in peroxide value (PV) and free fatty acids (FFA) content. PV (method Cd 8-53) was expressed in milliequivalent peroxide/kg oil (meq/kg oil) and FFA (method Ca 6a-40) were reported as percent FFA expressed as oleic acid, g/100g (AOCS, 1973).

5 Statistical analyses

Data were subjected to analysis of variance (ANOVA) using SAS software. Significant differences between any two means were determined at the 1% level. Tukey's multiple-range test ascertained the treatment effect on the color, PV and FFA content of the samples.

Results and discussion

Initial color values in ASTA units and changes in the percentage of color loss of samples were given in figure 1 and figure 2. Initially, R_C had higher ASTA value than the others and colors of the samples decreased as a result of dilution by the increasing vegetable oils. Differences in color were detected between R_C and oil added samples during storage (**$P< 0.01$).

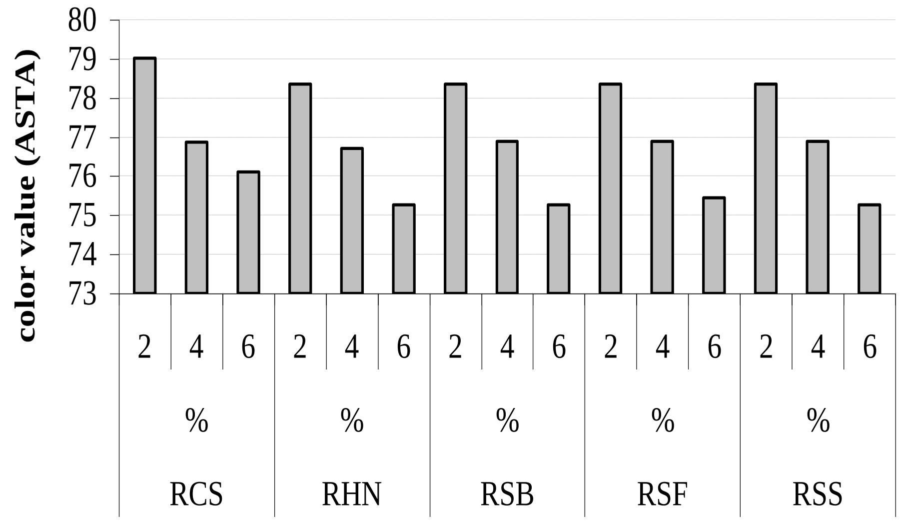
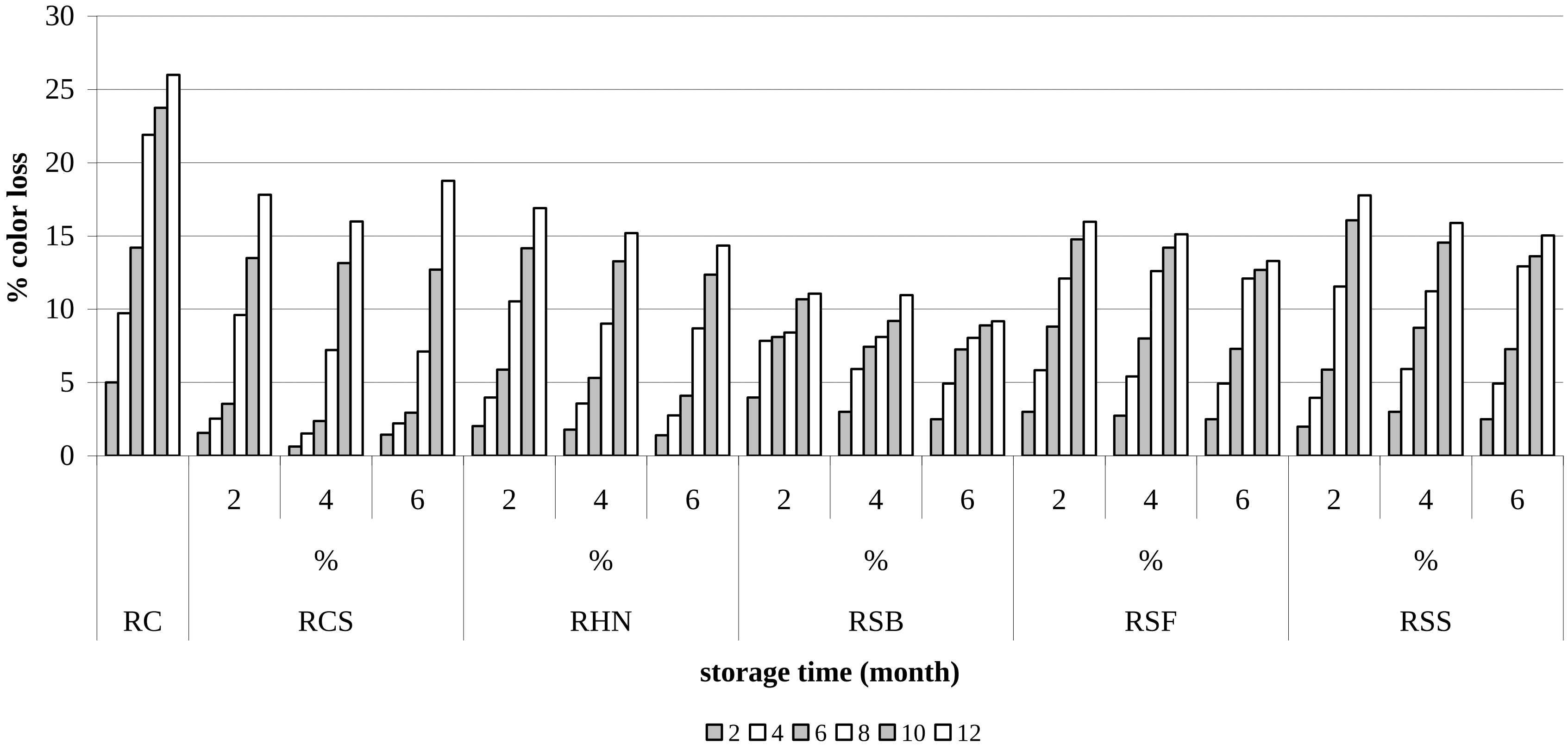


Figure 1. Initial color values (ASTA) of samples

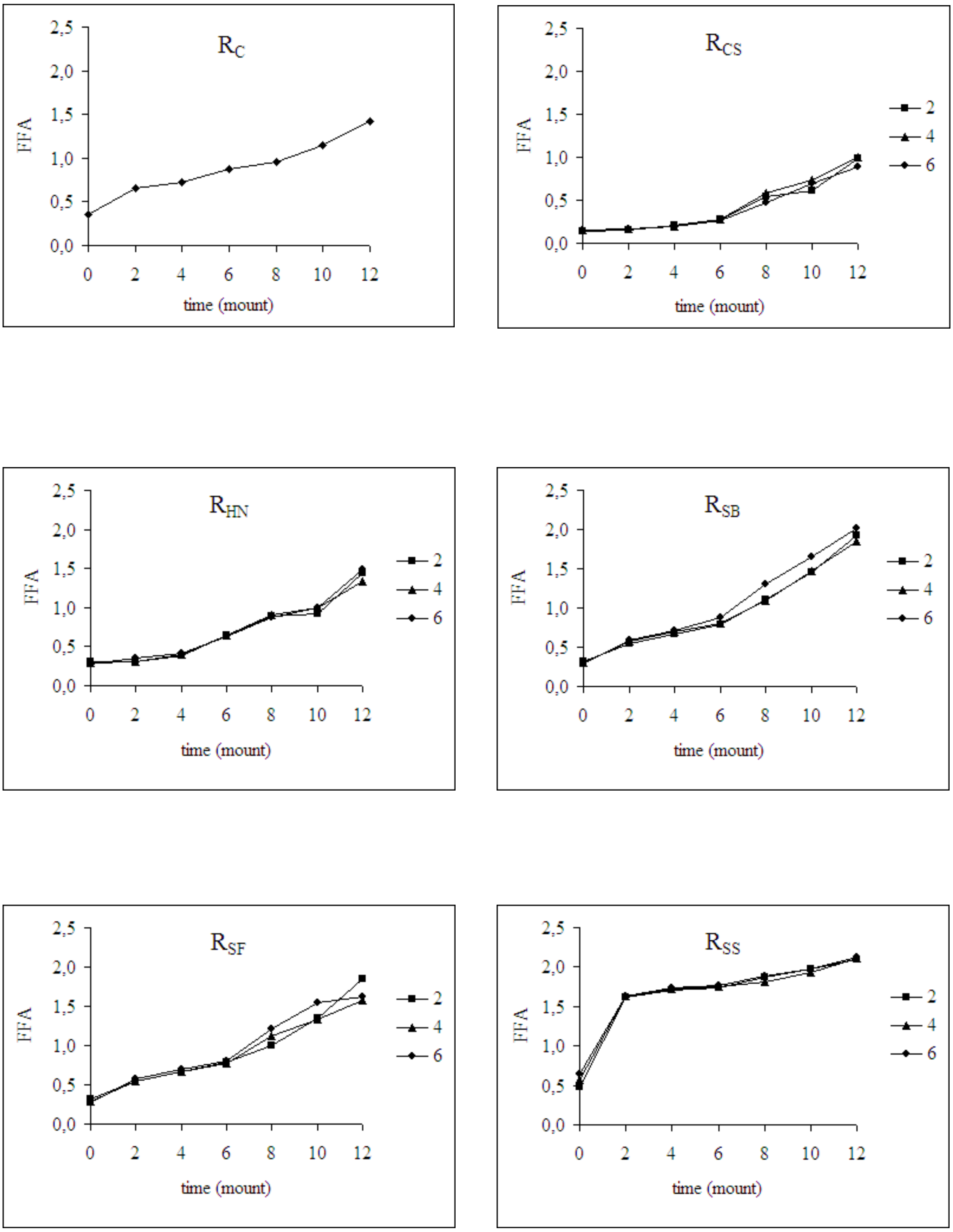
Color loss in samples increased by storage time. R_{CS} samples at concentration of 2, 4, 6 g/100g R_C and R_{SS} sample at concentration of 2 g/100g R_C had lower color loss up to 6 mo. then, increased. After 12 mo. storage, R_C lost 25.98% of initial color, but it was observed that there was a loss of 9.17-18.75 % in oil added samples. R_{SB} samples at concentration of 2, 4, 6 g/100g R_C had the least loss as R_{CS} and R_{SS} samples at concentration of 2 g/100g R_C showed the lower in color stability. In general there was a tendency for color stability to decrease when the amount of added vegetable oil inreased although the addition of vegetable oil was beneficial. SB, SF and HN oils were more effective on color compared to CS and SS oil.

The added vegetable oils surrounds and impregnates the pigmentation of red pepper and affect the degradation. The differences in behavior of vegetable oils are the result of in difference the fatty acid composition, particularly regarding the presence of polyunsaturated fatty acids (Perez-Galvez *et al*., 2000). It has been previously shown that increased unsaturation gives increased color stability and saturated fat decrease stability (Lime, 1969; McDonald, 1993). Similarly, the same kind of trend was followed the results found for samples in present work.



RC: no oil added red pepper, RCS: red pepper mixed with cotton seed oil, RHN: red pepper mixed with hazelnut oil, RSB: red pepper mixed with soybean oil, RSF: red pepper mixed with sunflower oil, RSS: red pepper mixed with sesame oil
%: Oil additions at conc. of 2, 4, 6 (g oil/ 100 g)

Figure 2 Changes in the percentage of color loss of samples



R_C: no oil added red pepper (control sample), R_{CS}: red pepper mixed with cotton seed oil, R_{HN}: red pepper mixed with hazelnut oil, R_{SF}: red pepper mixed with sunflower oil, R_{SS}: red pepper mixed with sesame oil, R_{SB}: red pepper mixed with soybean oil

■ , ▲, ●: Oil additions at concentrations of 2, 4, 6 (g oil/ 100 g), respectively

Figure 3. Changes in FFA content as oleic acid (g/100g) of samples

Figure 3 shows the changes in FFA content as oleic acid (g/100g) of samples as a function of oil addition and storage. The red pepper extracted oil was sum of the added vegetable oil and red pepper oil, only the control extracted oil contained no vegetable oil. Initially, FFA contents of R_{SS} samples were the higher than those of R_C and other oil added red peppers due to the value (0.89) of SS oil before addition to red pepper at initial time (data was not shown). The FFA contents of samples decreased as the amount of added oil increased due to dilution.

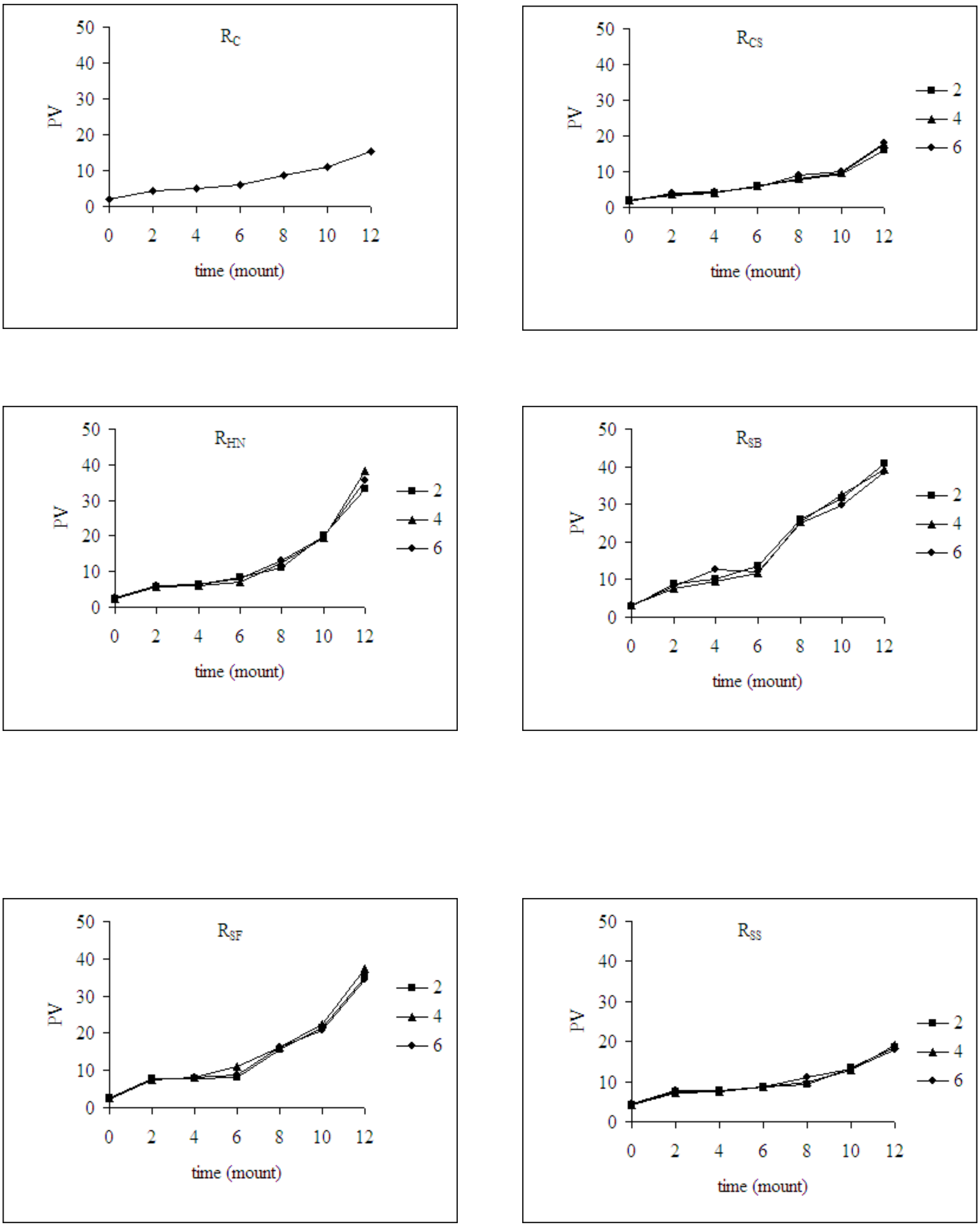
FFA values in the extracted oils increased as the storage time increased, resulting in 0.89-2.13 and the most values were found in R_{SS}, R_{SB}, R_{SF}, R_{HN} and $R_{CS,}$ respectively after 12 mo. of storage at room temperature (**P< 0.01). On a oil concentration basis, no significant difference was observed among FFA in 2's and 4's whereas 6's (g/100 g R_C) have significantly high values. The increase in FFA value was result of reaction of triglycerides of oil with water under the proper conditions. When the amount of oil in pepper increased, the oil spreaded more to surface and contact with water in it (Formo *et al.*, 1979).

Changes in PV of samples are presented in figure 2. The initial PV were between 1.77-4.54 meq/kg oil. Initially, R_{SS} at concentration of 2, 4 and 6 g/100g R_C have higher PV compared to other samples as a result of initial PV of SS oil before addition. PV of all samples was increased while storage time increased, resulting between 15.17-40.88 meq/kg oil after 12 month. Significant differences were found between R_C and oil added samples during storage. At the end of storage, the most PV were found in R_{SB} samples. The values of R_{SB}, R_{SF} and R_{HN} were significantly higher than R_{CS} and R_{SS}, and also the amount of added oil was affected PV of the samples; PV of samples at the concentration of 4 and 6 g/100g R_C in which be similar were significantly high than samples at concentration of 2 g/100g R_C as R_C has the lowest value (**P< 0.01).

In the present work the oxidation was involved, more or less, in bacterial action, enzyme-catalyzed hydrolsis and oxidation, or direct chemical attack by oxygen of the air, that is, autoxidation. Unlike an enzyme reaction or any bacterial action, autoxidation occured so easily since it is a chemical reaction with a very low activation enery (Marcuse and Fredriksson, 1968).

Conclusion

The unsaturated oils, responsible for the generation of peroxides being the main initial products of autoxidation, played an important role in color loss of the tested samples. The unsaturated constituents of oils determine the oxidation rate. Addition of vegetable oil highly reduced the oxidation of color, but oxidation of oil took place. Thus, the best color stability was determined in soybean oil added samples but oxidation of the extracted oil was higher than the other samples, except control. Oil in red pepper is more stable than added oil because they are intact in plant tissue. As increasing the amount of added oil, the degradation of color increased as a result of rapid oxidation of oil content. The oxidation of oil leads to rancidity and is the source of the most of the spoilage in fats and oils. This reaction leads to problems in off-flavor and off-odor development, problems of great importance in red pepper industries.



R_C: no oil added red pepper (control sample), R_{CS}: red pepper mixed with cotton seed oil, R_{HN}: red pepper mixed with hazelnut oil, R_{SF}: red pepper mixed with sunflower oil, R_{SS}: red pepper mixed with sesame oil, R_{SB}: red pepper mixed with soybean oil

■ , ▲, ●: Oil addition (g oil/ 100 g)

Figure 4. Changes in PV (meq/kg oil) of samples

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