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Effect of Modified Atmosphere on Quality and Shelf Life of Tomatoes

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ABSTRACT

Study was conducted for increasing the quality and shelf life of tomatoes under modified atmosphere packaging. The tomatoes were packed under modified atmosphere packaging with concentrations of 3% O_2, 9% CO_2 and 88% N_2 in LDPE, PP and PVC packaging materials. Packed tomatoes were stored at 15°C (90-95% RH), 20°C (85-90% RH) and room temperatures. For every three days, the CO_2 and O_2 concentration changes in tomatoes kept in different packing materials and their physical, chemical and sensory characteristics were determined. The change in weight loss, shrinkage, ascorbic acid, lycopene content, TSS and P^H were less in tomatoes packed under LDPE covers stored at 15°C temperature and given the shelf life of 45 days where as the shelf life of 36 days, 27 days was observed when the packed tomatoes stored at 20°C and at room temperature.

Key words : Ascorbic acid, LDPE, Lycopene content, Modified Atmospheric Packaging, PP, PVC, Tomatoes,Weight loss.

Tomato (*Lycopersicum esculentum*) is one of the most popular and widely grown vegetables throughout the world and is known for excellent nutritive, medicinal and food values, but the poor shelf life of tomato is one drawback. Extending the shelf life of tomatoes is very important for domestic and export marketing.

Modified atmosphere packaging is well established technology, which along with low temperature storage helps in extending the shelf life and maintenance of the quality of perishable by altering the relative proportion of atmospheric gases that surround the product.

Akubudak *et al.*, (2007) reported that. The highest values of acidity and ascorbic acid contents were recorded at the end of storage from the fruit stored under HWT+ 50µ PE (polyethylene). HWT+ 50µ PE gave best results at the end of 28 days of storage in tomato.

Ali and Thompson (1998) reported that all unwrapped tomatoes were overripe and soft after 30 days. Under modified atmosphere packaging, especially using with PE50 and PP films, delayed the development of the red color of tomatoes until 30 days of storage and those tomatoes were also still very firm even after 60 days of storage. Tomatoes sealed within PE50 and films had also the lowest weight loss and the highest soluble solids after 60 days of storage.

MATERIAL AND METHODS

Tomatoes:

Fully matured, firm, fresh tomatoes (Variety: *Marutham*) of local variety were procured, sorted tomatoes were used for storage studies. The tomatoes of 200 g taken for each treatment.

Modified Atmospheric Packaging Machine:

Advanced Vacuum Packaging Machine of model QS 400V3G XT was used in this study. This is capable of flushing up to 3 gases using Modified Atmosphere Packing Software, MoDat that provides accurate, easy and convenient settings.

Packaging materials:

Different packaging materials like LDPE, PP and PVC covers were used for packing the tomatoes.

Physical and Chemical properties of stored tomatoes:

Weight loss:

The weight loss of the tomatoes was measured on electronic digital weighing machine having an accuracy of 0.01 g (AOAC, 2000).

Moisture content:

Moisture content was determined on wet basis as AOAC (2000).

Concentration of CO_2 and O_2 gases:

With concentrations of 3% O_2, 9% CO_2 and 88% N_2.The change of concentrations of O_2 and CO_2

gases in packs were determined by portable oxygen/ carbon dioxide analyser of (Quantek model 902D).

Lycopene content:

Lycopene is responsible for the red colour of tomato. Lycopene content determined by standard method given by *Sadasivam and Manickam,1985*.

Ascorbic acid content:

Ascorbic acid otherwise known as vitamin C is an antiscorbutic and it is determined by method given by *Sadasivam and Manickam, 1985*.

Total soluble solids (TSS):

Total soluble solids (TSS) of fruit samples were measured using Hand Refractometer and expressed in terms of % Brix.

pH:

The pH measurement was performed using a Digital pH meter (Didisun Electronics, model: DI. 707).

Sensory evaluation of stored tomatoes:

The sensory quality was evaluated by a panel of members. Samples were scored for overall visual quality using a hedonic scale *(Joshi, 2006).*

The packaged tomatoes were stored at 15°C (90-95% RH), 20°C (85-90% RH) and room temperatures. The unwrapped tomatoes were also kept at room temperature. For every three days, the CO_2 and O_2 concentration changes in tomatoes kept in different packing materials were determined. The physical, chemical and sensory properties of tomatoes were also studied for every three days.

RESULTS AND DISCUSSION

Oxygen and Carbon dioxide concentration:

The oxygen concentration gradually decreased from 3% to 1.7% and reached a steady state concentration of 1.7% in LDPE covers after 15 days and reached steady state concentration of 1.5% and 1.3% in PP and PVC covers respectively after 12 days at 15°C temperatures. The oxygen concentration gradually decreased from 3% to 1.4% and reached a steady state concentration of 1.4% in LDPE covers after 12 days and 1.2% and 1.0% in PP and PVC covers respectively after 9 days at 20°C temperature. At room temperature the oxygen concentration gradually decreased from 3% to 1.1% and reached a steady state concentration of 1.1% in LDPE covers after 9 days and 0.8% and 0.6% in PP and PVC covers respectively after 6 days (Fig.1).

The carbon dioxide concentration gradually increased from 9% to 16%in LDPE covers kept at 15°C during first 15 days of storage and then reached steady state equilibrium and in PP and PVC covers steady state equilibrium occurred after 12 days of storage. The level of carbon dioxide concentrations in tomato packed PP and PVC covers kept at 20°C and at room temperatures reached steady state concentrations after 9 days and 6 days respectively where as in LDPE the steady state was established after 12 days of storage (Fig. 2).

Therefore it was observed that the respiration rate of tomatoes was very slow in LDPE covers compared to PP and PVC covers and reached a steady state concentration after 15 days at 15°C and the shelf life was observed as 45 days. But when the MAP packed tomatoes stored at 20°C and at room temperature, the respiration rates were increased compared to 15°C and found that the shelf life was decreased to 36 days and 27 days respectively.

PHYSICAL CHARACTERISTICS OF STORED TOMATOES:

Weight loss:

The weight losses of plastic film packed tomatoes were less compared to unpacked tomatoes. The weight loss of stored tomatoes kept at 15°C temperature was less compared to 20°C and at room temperature. The weight losses were minimum in LDPE and PP pouches, which are having 1.00% and 1.20% respectively over a storage period of 45 days at 15°C temperature. For unpacked fruits kept at room temperature, weight losses were higher i.e. about 5.5%. From figure 3 the weight losses in packaged covers were linearly increased with time and rate of weight loss was less in packed tomatoes, whereas in unpacked tomatoes it was rapidly increased over a storage period of 6 days.

Moisture content:

The reduction in moisture content of stored tomatoes packed in LDPE, PP and PVC covers was very less compared to unpacked tomato fruits. Initially the tomatoes having moisture content of 95.66% (w.b.) and it reduces slightly to 94.47% (w.b.), 93.69% (w.b.) and 93.37 % (w.b.) respectively in LDPE, PP and PVC covers at 15°C temperature. When the storage temperature increased there was an increase in the reduction of moisture. At the room temperature the moisture reduction was maximum (90.64% (w. b.)) over a period of 6 days

Fig. 1. Variation in oxygen concentration during MAP storage period in different packaging covers at different temperatures.

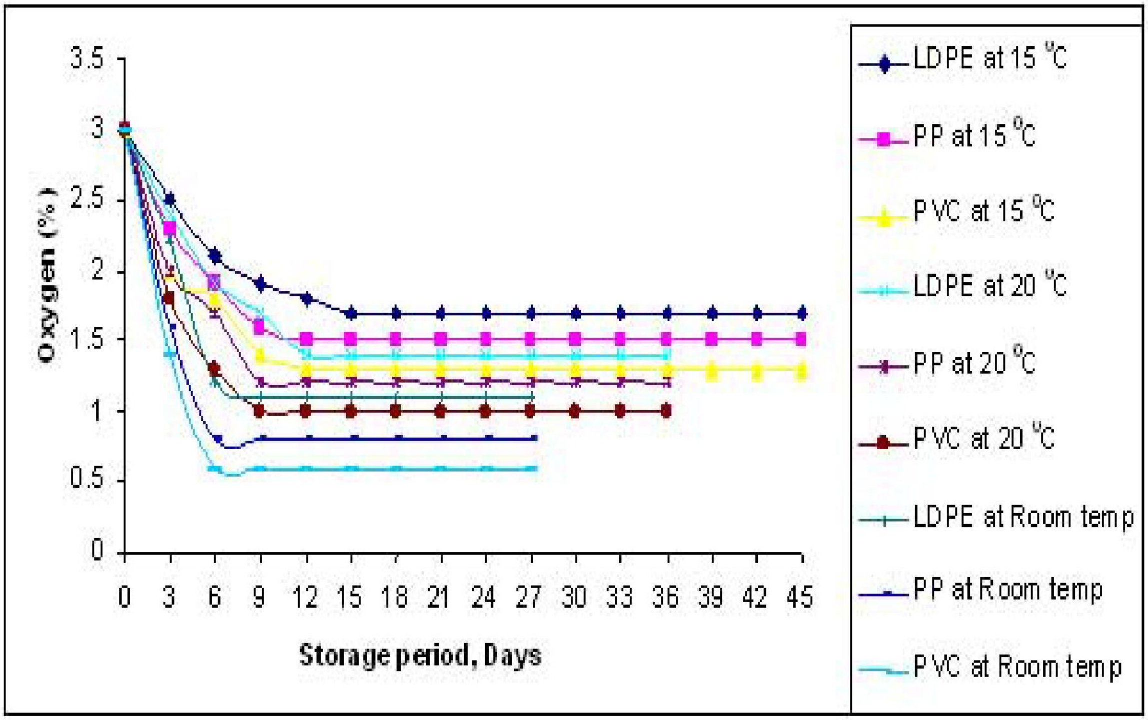


Fig. 2. Variation in carbon dioxide concentration during MAP storage period in different packaging covers at different temperatures

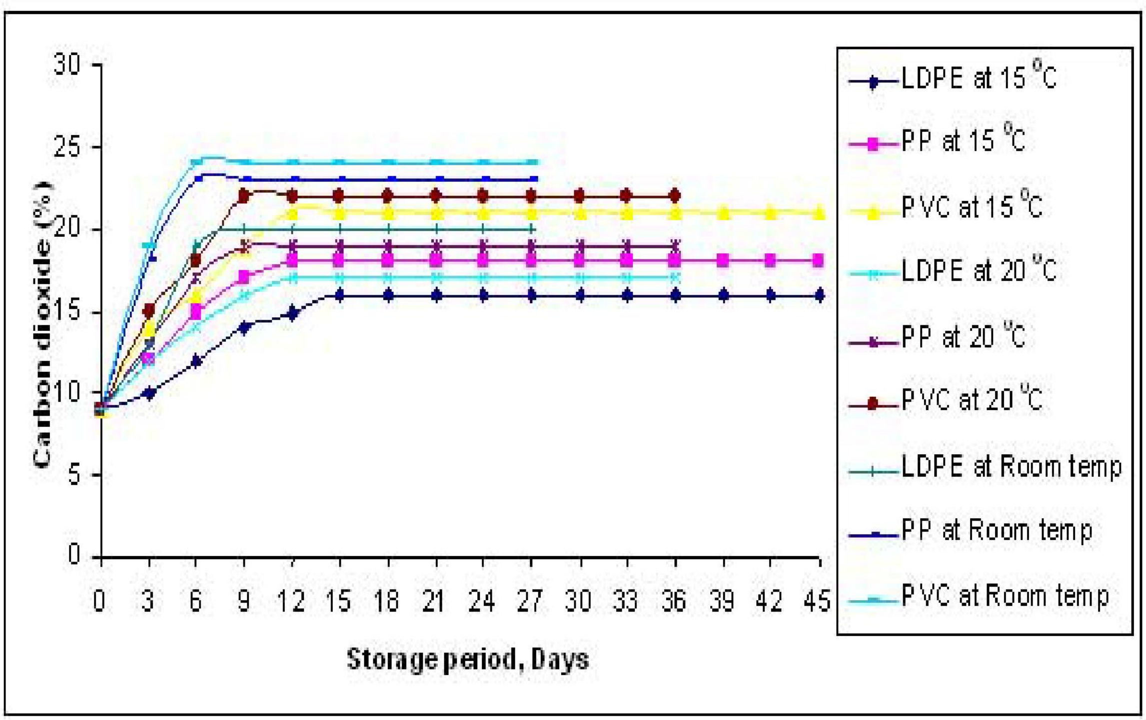


Fig. 3. Variation in weight loss during MAP storage period in different packaging cover at different temperatures.

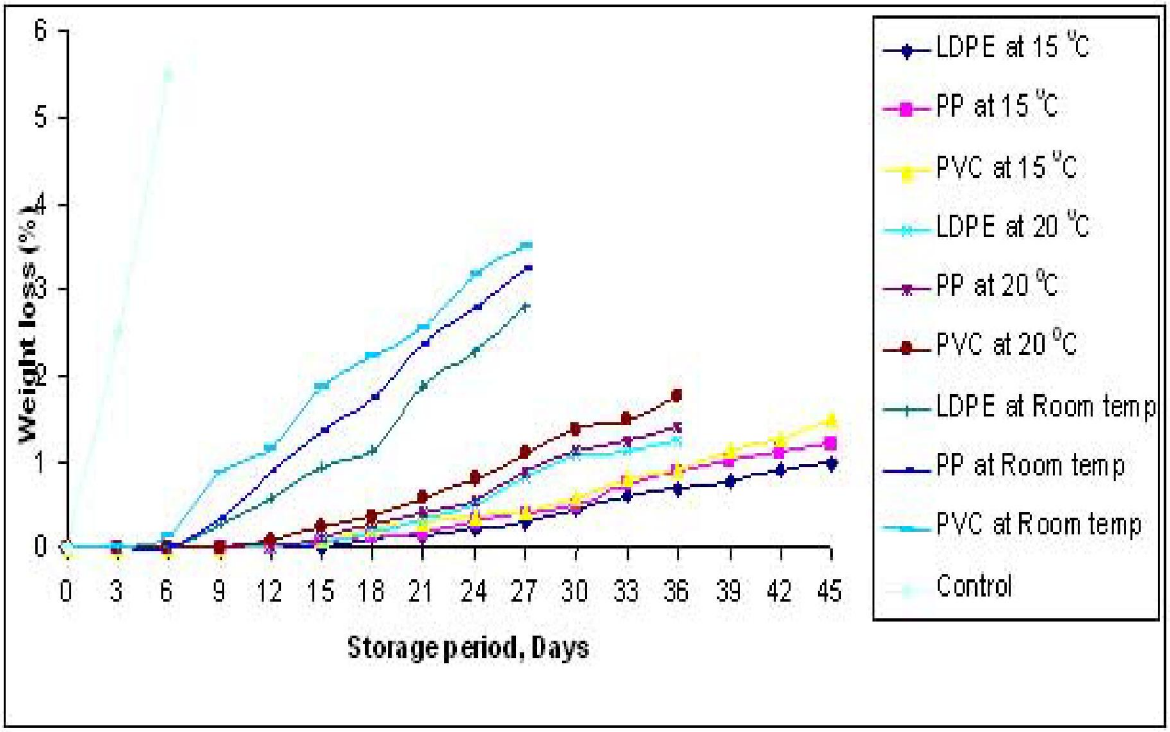
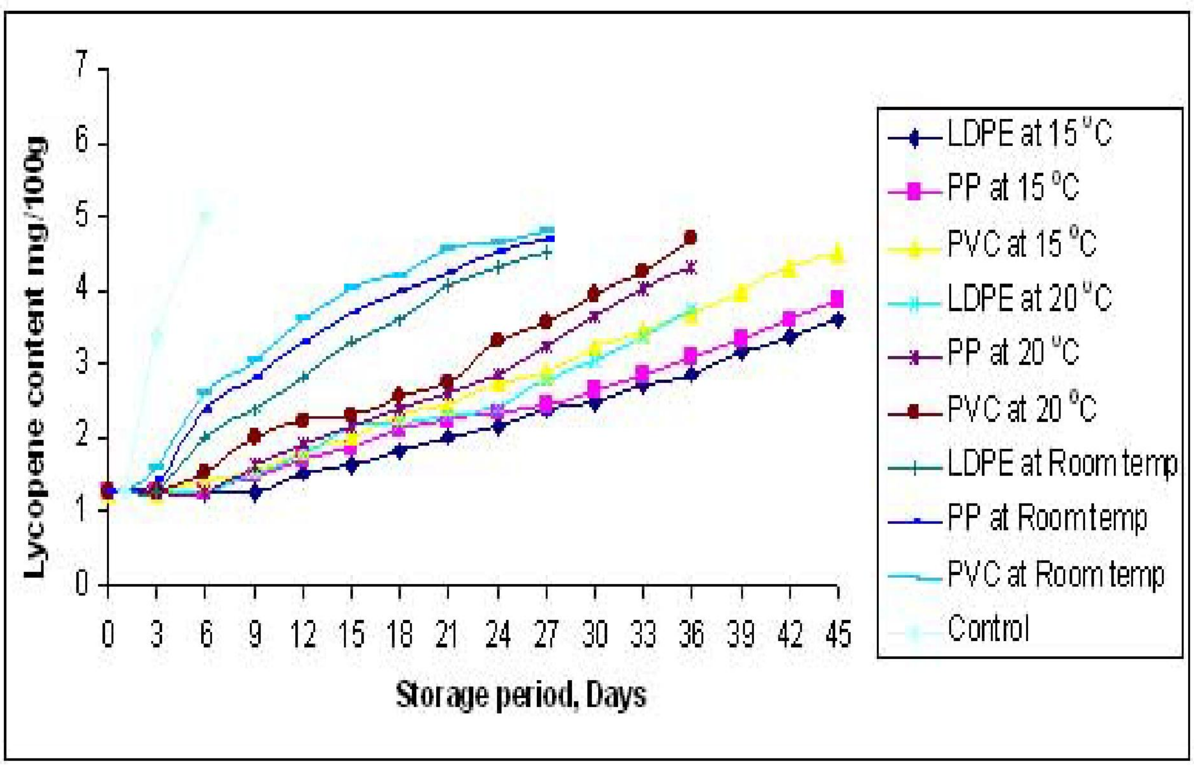


Fig. 4. Variation in lycopene content during MAP storage period in different packaging covers at different temperatures.



CHEMICAL CHARACTERISTICS OF STORED TOMATOES

Lycopene content:

Lycopene constitutes the main red pigments of tomatoes and their concentrations increases steadily through ripening. Formation of lycopene was dependent upon the presence of O_2.The CO_2 concentration effected the color development of tomatoes by suppression of ethylene production. It was indicated that color development was inhibited in tomatoes while exposed to high levels of CO_2.The initial lycopene content of fresh tomatoes was 1.248 mg/100 g and it was increased to 3.619 mg/100 g over a period of 45 days in LDPE covers which was less compared to PP and PVC covers. The increase in lycopene content was less at low temperature i.e. at 15°C compared to 20°C and at room temperature as shown in Fig. 4. The increase in lycopene content in unpacked tomato samples is more i.e. 4.992 mg/100 g. It shows that the ripening of tomatoes was slow in LDPE at 15°C compared to other covers.

Ascorbic acid content:

From the figure 5 it was absorbed the reduction in ascorbic acid values during storage. The initial ascorbic acid content in fresh tomatoes was 36.5 mg/100 g. At the end of storage, the highest ascorbic acid content (24.0 mg/100 g) was found in tomatoes stored at 15°C in LDPE covers after 45 days of storage compared to other storage conditions. Ascorbic acid content is 23.5 mg/100 g in LDPE cover stored at 20°C for 36 days of storage as compared to PP and PVC covers. Reduction in ascorbic acid due to high CO_2 concentration retarded the change in ascorbic acid. An ascorbic acid contents in tomatoes stored at room temperature for 27 days has values of 20.5 mg/100 g, 18 mg/100 g and 16.5 mg/100 g in LDPE, PP and PVC pouches respectively. Lowest in ascorbic acid content in unpacked tomatoes stored at room temperature, was recorded i.e. 16.5 mg/100 g.

Total soluble solids:

TSS values generally increased due to increase in CO_2 concentrations in film packages. Because during normal ripening, starch and pectin compounds are degraded into sugar and acids and contribute in increasing the amount of TSS. The LDPE and PP films may be having lowest gas permeability and have lowest values of CO_2 concentrations in pouches compared to PVC pouches. Therefore, the tomatoes in PVC covers showed high values of TSS contents as compared to LDPE and PP pouches. Further TSS contents effected with storage temperatures also. The TSS contents of tomatoes increased rapidly at both 15°C and 20°C and at room temperatures during the days of storage as shown in Fig. 6. But tomatoes stored at 15°C were shown to be slightly lower in TSS contents than fruits stored at 20°C and at room temperatures during storage period. Increasing TSS levels during storage period could be due to the ripening process.

pH:

There was slightly increase in pH of tomatoes during storage period as shown in Fig.7. The initial pH of tomatoes was 3.40 and at the end of storage, it was increased to 4, 4.11 and 4.24 in LDPE, PP and PVC pouches at 15°C temperature. The value of pH was least at the end of 45 days of storage in LDPE pouch compared to PP and PVC at 15°C temperature. And at 20°C temperature the shelf life of tomatoes was 36 days and having the pH values of 4.10, 4.21 and 4.32 in LDPE, PP and PVC pouches respectively. At room temperature the pH values of 4.25, 4.30 and 4.39 in LDPE, PP and PVC films respectively over a period of 27 days while the unwrapped fruits having a pH of 4.24 at the end of 6 days of storage.

SENSORY QUALITY EVALUATION OF STORED TOMATOES

Shrinkage:

The shrinkage of stored tomatoes packed in LDPE covers at 15°C temperature obtained a low rating on the hedonic scale as shown in Fig. 8. The unpacked tomatoes showed high value of shrinkage. This indicated that the shrinkage of tomatoes was much delayed under MAP conditions packaged in LDPE films compared to PP, PVC films and unpacked control tomatoes. The shrinkage of stored tomatoes also very less at 15°C compared to 20°C and at room temperature.

Texture:

The Texture of stored tomatoes packed in LDPE covers obtained a low rating on the hedonic scale compared to PP and PVC covers as shown in Fig. 9. The unpacked tomatoes received high value in the hedonic scale. This indicated that the textures of tomatoes are very good under MAP conditions packed in LDPE films compared to PP, PVC and unwrapped tomatoes. The texture of stored tomatoes also very good at 15°C compared to 20°C and at room temperature.

Fig. 5. Variation in ascorbic acid in tomatoes during MAP storage in different packaging covers at different temperatures.

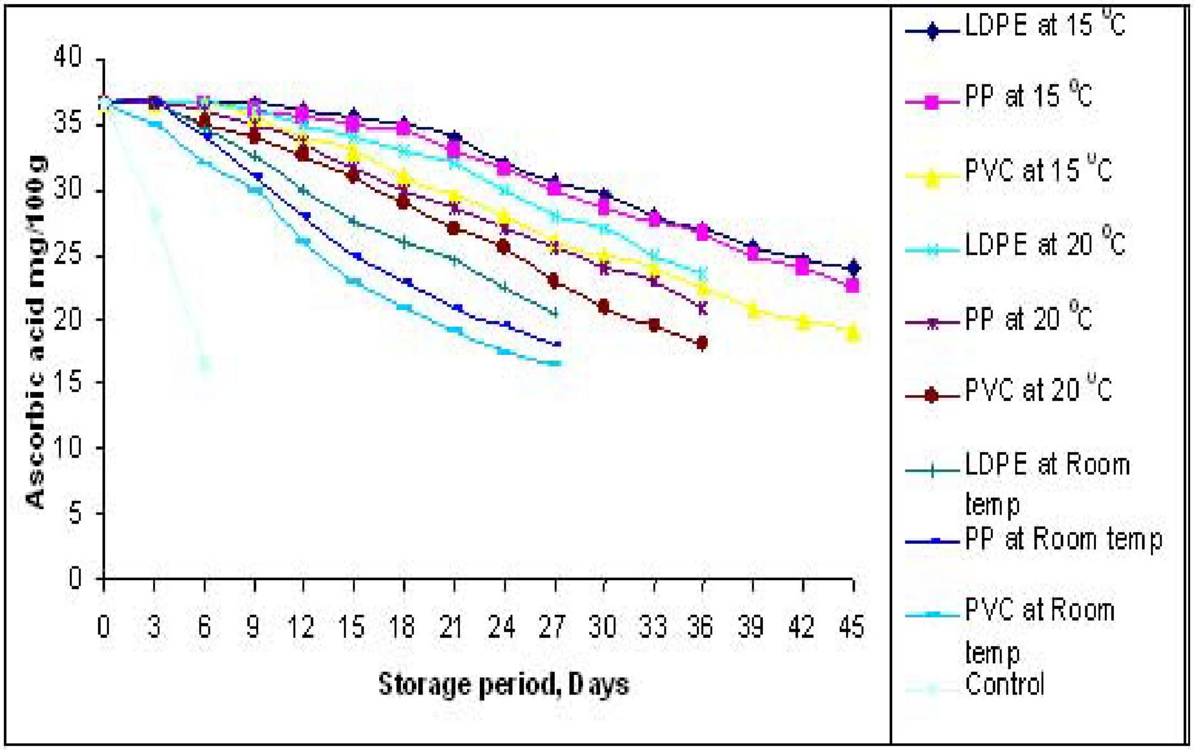


Fig. 6. Variation in TSS during MAP storage period in different packaging covers at different temperatures.

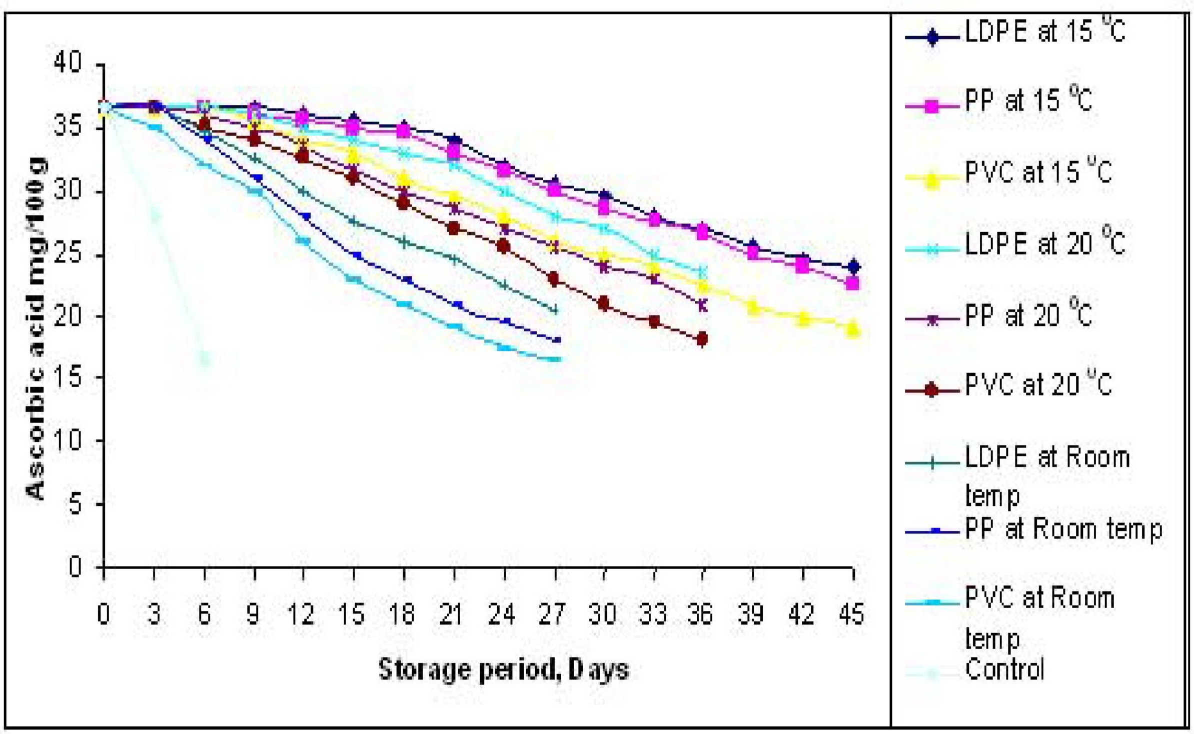


Fig. 7. Variation in pH during MAP storage period in different packaging covers at different temperatures.

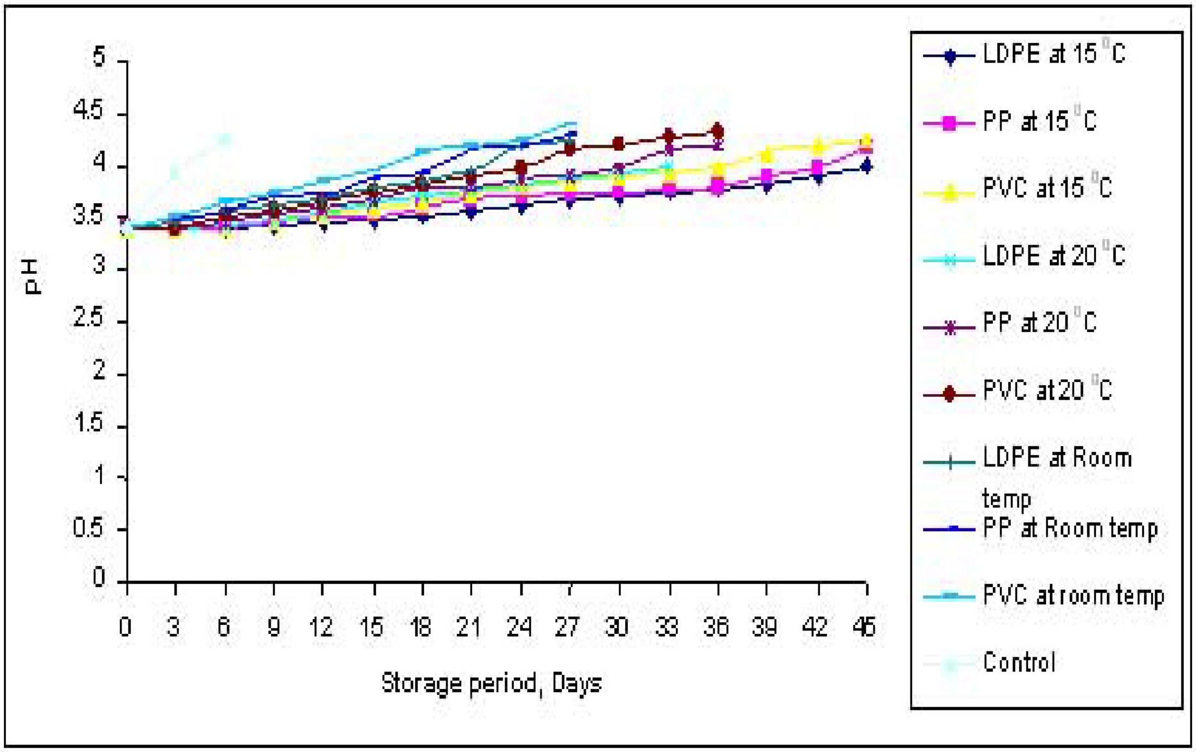


Fig. 8. Shrinkage evaluation of tomatoes under MAP storage using Hedonic scale

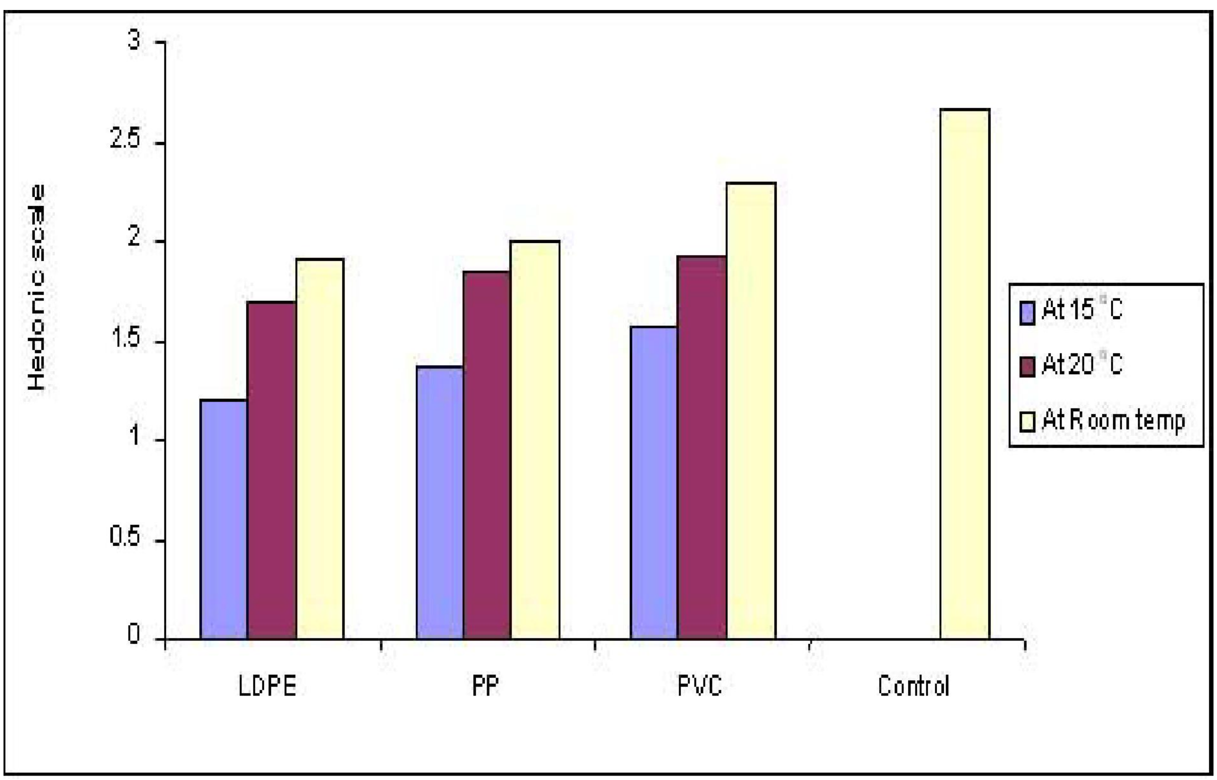
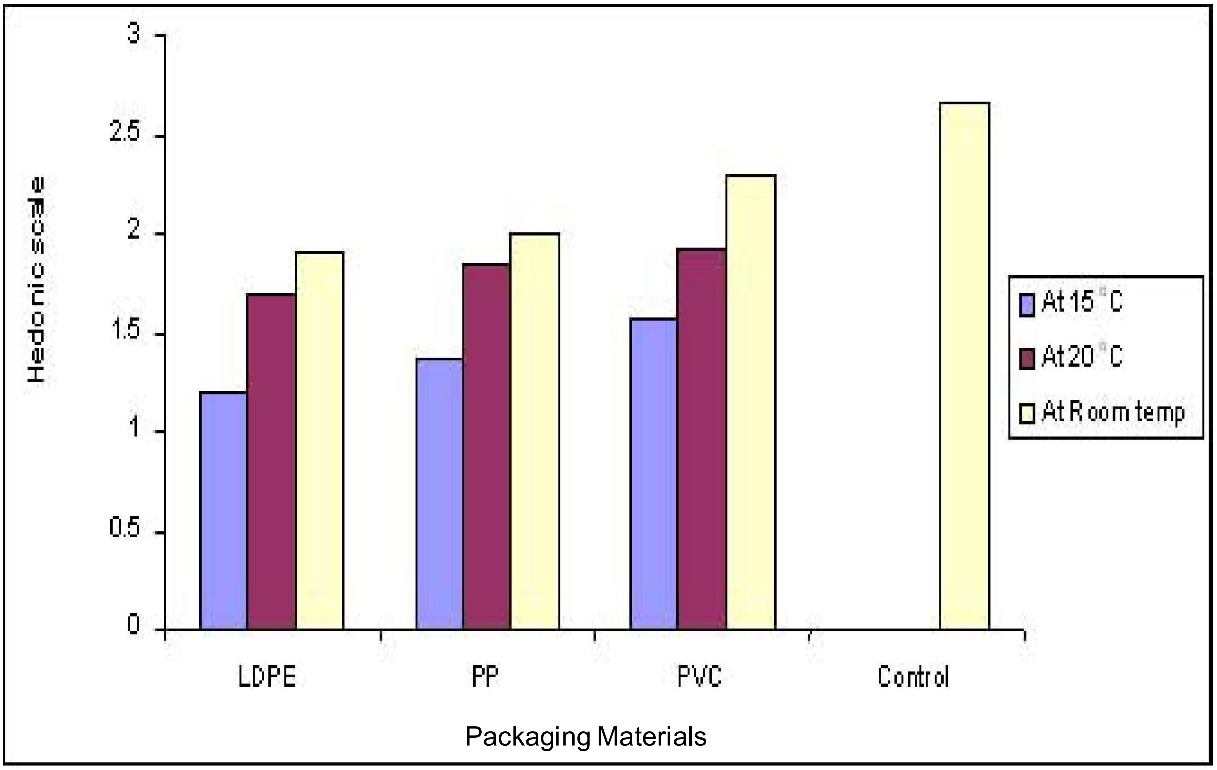


Fig. 9. Texture evaluation of tomatoes under MAP storage using Hedonic scale



The effect of modified atmosphere packaging on quality and shelf life of tomatoes were studied. It was concluded that the shelf life of tomatoes was increased up to 45 days under modified atmosphere packaging. The shelf life of tomatoes was 45, 36 and 27 days at 15°C, 20°C and room temperature respectively. The shelf life of unpacked tomatoes was only 6 days kept at room temperature. It was observed that the overall quality of tomatoes was good in LDPE covers compared to PP and PVC covers.

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