Tr. J. of Agriculture and Forestry
22 (1998) 365-372

Effects of Modified Atmosphere Packaging on Post Harvest Qualities of Pink Tomatoes

Ali BATU, A. Keith THOMPSON
Gaziosmanpasa University, Agricultural Faculty, Food Engineering Department, Tokat-TURKEY

Received: 04.04.1996

Abstract: An experiment retail plastic packaging system was used to compare the atmospheric composition within sealed packs containing tomato fruits. A range of plastic films with different permeability properties were tested to study the effects of these conditions on the changes in postharvest qualities of tomatoes harvested at the pink stage of maturity and stored at 13°C for 60 days. The films used were 20 micron (PE20) and 50 micron (PE50) polyethylene, 10 micron polyvinylcholoride (PVC) or 25 micron polypropylene (PP) compared with unwrapped fruit as a control. Tomatoes were evaluated for changes in colour, firmness, weight, titratable acidity, total soluble solids, decay and sensory attributes. All unwrapped tomatoes were overripe and soft after 30 days. Sealed packaging, especially using with PE50 and PP films, delayed the development of the red colour 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 PP films had also the lowest weight loss and the highest soluble solids after 60 days of storage.

Modifiye Atmosfer Koşullarında Depolamanın Pembe Olum Döneminde Hasadı Yapılan Domateslerin Hasat Sonrası Kalitesi Üzerine Etkisi

Özet: Bu araştırmada, parakende olarak satılabilecek tipte olan küçük paketleme sistemi kullanılmıştır. Pembe olum aşamasında hasadı yapılan domatesler 13°C de 60 gün depolanarak domatesin hasat sonrası kalitesi üzerine farklı gaz geçirgenliğine sahip plastik filmlerin etkileri araştırılmıştır. 20 mikron (PE20), 50 mikron (PE50) kalınlığındaki polietilen, 10 mikron kalınlığında polivinilklorür (PVC) ve kalınlığı 25 mikron olan polipropilen (PP) ile paketlenmiş domates meyveleri, 'tanık' olarak aynı ortamda paketlenmeden depolanan domatesler ile kalite değerleri açısından karşılaştırılmıştır. Depolama sırasında meyve sertliği, ağırlık kaybı, asitlik, suda çözünür toplam katı madde ve çürüme niceliklerinde oluşan değişmeler araştırılmıştır. Paketlenmeyerek depolanan domateslerin 30 gün depolanması sonucunda aşırı olgunlaşıp ve yumuşadıkları gözlenmiştir. Paketlenen domateslerin renk ve sertliklerinde oluşan değişmelerin geciktiği ve özellikle PP ve PE50 filmleri ile paketlenen domateslerin 30 gün sonra bile renklerinde önemli bir değişikligin olmadığı gözlenmiştir. Aynı domateslerin 60 gün sonra bile yeterince sert oldukları ve en az ağırlık kaybına uğradıkları belirlenmiştir.

Introduction

Tomato quality changes continuously after harvesting. During these period tomato fruits ripen and may become overripe quickly depending on their temperature and harvest maturity. This can rusult in loss of quality and restricted shelf life since overripe fruit may be too soft and an unacceptable shade of red (1). Fresh tomato quality is determined by appearance, colour, firmness and flavour (2). Packaging and temperature are very important in terms of tomat colour and firmness. During ripening of tomato fruits, changes in firmness were highly correlated with surface colour (3), and these two were shown to be major factors in the consumer preference of tomatoes (4).

Extending the shelf life of tomatoes is very important for domestic and export marketing. Generally shelf life of tomatoes is extended by refregerated storage (2). Many fruits and vegetables can be maintained for several weeks or even months in refrigerated storage (5). However extension of the shelf life by slowing ripening of tomato has been achevied by packaging. This has been achivied by sealing them in polyethylene films. The levels of carbon dioxide and oxygen inside the package changed with time due to the respiration of the fruit and the permeability of the film. This method is called modified atmosphere packaging (MAP) which is particularly useful for storage for chilled perishable crops such as tomatoes (5).

MAP results in a reduction of O_2 and elevation of CO_2 concentrations around the fruit ihside the film. Effects of this reduced O_2 had increased CO_2 levels on fruit varies with gas concentration, exposure time and variety of

* Postharvest Technology Department, Silsoe College, Cranfield University Silsoe, Bedford MK45 4DT, England

fruit but it generally reduces respiration rate and softening of fruits, retards any fungal infection on fruit and can inhibit the effects of ethylene in causing deteoration (6). MAP also creates a water saturated or near saturated atmosphere around the fruit which reduces water loss and shrinkage. This technique has been used as an alternative or a supplement to refrigeration for preservation of fresh produce (7). Beneficial atmospheres can be generated with this inexpensive control system with MAP (8). If a film of correct permeability is chosen, a desirable equilibrium modified atmosphere can be established when the rate of oxygen and carbon dioxide transmission through the package equal the product's respiration rate (9).

Storage temperature is also very important for shelf life of tomatoes. The lower the temperature the longer will be the shelf life of the fruit (10). The optimum storage temperature of fruits must be higher than the chilling temperature. Chilling injury occurs when tomatoes are exposed to temperature below 12.5ºC (11), 12.7ºC, 12ºC (4) or 11ºC (12) for a period of depending on temperature that is the lower the temperature the shorter the necessary exposure time (11). Chilling injury refers to be physiological response to low temperature and the resultant symptoms that affect product acceptability (10). Risse et al., (13) also reported that for maximum shelf life a temperature range between 13 and 20ºC was the most suitable for tomatoes and when fruits stored at temperatures greater than 20ºC had a short shelf life and could be subject to decay.

Many researchers have studied postharvest life of tomatoes harvested at the mature green (3, 14, 15, 16, 17) and part-ripe stages. (1, 15). Maturity at harvest is very important to composition and quality of tomatoes. This is especially a problem with tomatoes picked green since it is difficult to differentiate between mature and immature green fruits. Mature green and advanced mature green tomatoes will usually attain a much better flavour at the table ripe stage than those picked at the immature or partially mature stages (11). The harvesting of tomatoes before they are ripe has an affect, not only on the peak sugar content, but also on the development of the full flavour spectrum, thus affecting consumer acceptability (12).

The present investigation was, therefore, carried out to develop a modified atmosphere packaging system which would retard deterioration and extend the shelf life of tomatoes harvested at pink stage of maturity.

Materials and Methods

In the study, tomatoes freshly harvested pink (first appearance of external pink red or tannis-yellow colour over 30% but not more than 60% pinkish or red; 11) stage of maturity (cv'Liberto') were obtained from the greenhouse at the Silsoe Research Institute in England. Fruit diameters were between 50-55 mm. The tomatoes were sorted for size, colour and physical damage followed by 1-2 minutes dipping in 100 ppm of thiabendazole to reduce the microbial load. 180 fruits were used for this experiment. The tomatoes were the divided into two groups, then one group was left unwrapped (36 fruits) and the others (144 fruits) were placed on the 15x25 cm polystyrene trays with 6 fruits (500±25 g) per trays. The trays of fruit were sealed in either polyethylene films (Courtaulds Packaging, Hawkfield Way, Bristol, B514 OBD, England) of 20 micron (PE20) and 50 micron (PO50), polyvinilchloride films of 10 micron (PVC) (British Alcan Consumer Products Limited, Raans Road, Amersham, Bucks, HP6 6JY, England) or polypropylene 25 micron (PP) (Courtauld Packaging). All the fruits were kept in a controlled environment room with air condition in PP and PE 50 packagens whereas it was not observed in PVC and PE20 ones. Sample trays from each treatment were removed from storage every 10 days for assessments as follows.

Skin colour values were measured using a Minolta Chromometer model CR 200 and average readings at three points on the circumference of the fruits were recorded. The instrument was calibrated against a standard white colour plate (Y=93.9, x=0.313, y=0.321) (18). In Minolta chromometer positive a* value corresponding to the degree of redness while a negative value corresponds to the degree of greeness whereas positive b* value represents to the degree of yellowness and the negative value represents the blueness. Therefore in this research redness values of tomatoes were recorded in a*/b* values due to particularly in tomatoes redness values were recorded in a/b of Hunter for many years (19, 20 and 21).

A destructive deformation test was used to evaluate fruit by applying a constant 50 N force using with an Instron Universal Testing Machine, model 1122. In the firmness measurements a 6 mm diameter round stainless steel probe with a flat end was used and cross-head and chart speed were 20 mm $minute^{-1}$. Three textural characteristics were determined from the force/deformation cruve in Figure 1. The amount of force (N) which was required to penetrate through the skin to the tomato flesh and deformation (mm) values, before penetration, were recorded. Firmness (N mm^{-1}) was defined as the average slope of the force/deformation curve (22).

The weight of tomatoes was recorded to an accuracy of ±0.01 g using a Mettler balance model P1200 and the rate of weight loss was calculated as g $100g^{-1}$.

Acidity was determined by titrating tomato juice to pH 8.1 with 0.3125 N NaOH using a Jenway digital pH meter model 3020.

Ten mililitre gas samples were taken from each packages and the concentration of carbon dioxide and oxygen inside the film packs were analysed daily with a Carlo Erba Instrument GC 8000 Series Gas Chromatography equipped with a thermal conductivity detector. The flow rate of carrier gas (argon) was 40 $ml.min^{-1}$ and detector, oven, and attenuation temperatures were 120°C, 70°C and 128°C, respectively.

Decay evaluations were made visually on the incidence and severity of decay at the end of storage. The severity of the decay was determined using a decay index which was indicated in literature (23).

The experiment was a complete randomised factorial design. Datas was subject to analysing of variance and least significant differences were calculate to compare means.

Results and Discussion

Internal Atmosphere of Packs

Concentration of oxygen in packs sealed with permaable films decreased and that of carbon dioxide increased during the first few days of storage (Table 1), after which a state of equilibrium was reached between respiration of the produce and the diffusion of these gases was counter balanced by production and consumption during respiration of the tomatoes (24) and no further changes in the gas concentration within the packs occurred with fruit kept at constant temperature (25).

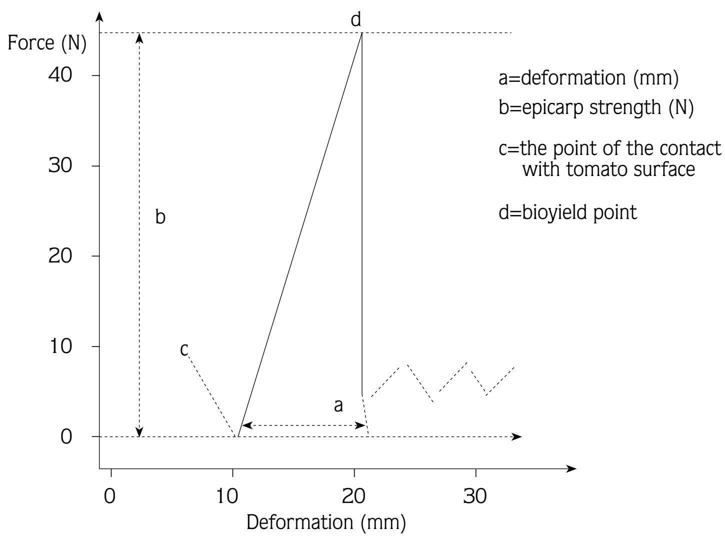


Figure 1. Typical force/deformation curve obtained during penetration of individual tomato (22)

Packaging Materials	Equilibrium Time (days)	Equilibrium Concentration (%)	Equilibrium Time (days)	Equilibrium Concentration (%)
PP	3-4	5-6	2-3	12-13
PVC	1-2	11-12	2	4
PE20	1-2	11-13	3	3
PE50	3	4	3-5	6-7

Table 1. Times for concentration of CO_2 and O_2 to equilibrate and equilibrium concentrations (%) at 13°C in experimental packs of pink tomatoes sealed with different packaging films.

Fruit Colour

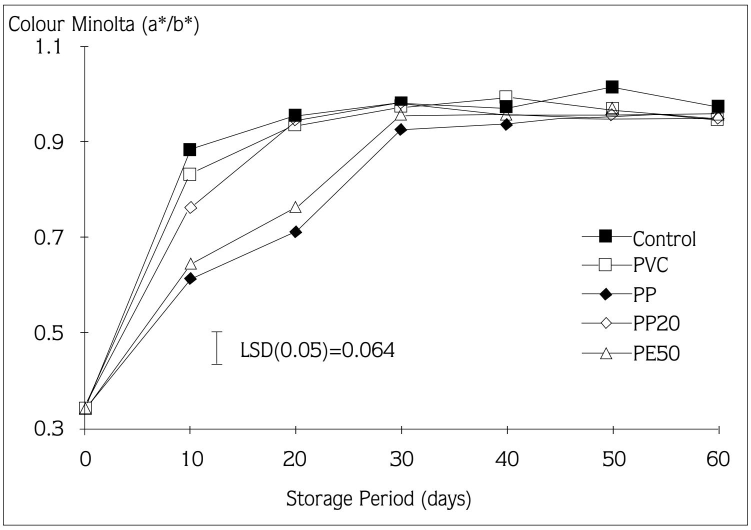
Unwrapped tomatoes changed colour rapidly over the first 10 days of storage and then at a slower rate over the next 20 days and remained the same colour after that. Furits sealed in plastic films changed colour more slowly especially those in PE50 and in PP (Figure 2). However after 30 days all fruits reached their maximum red colour and although the film wrapped fruits tended to be less red than the unwrapped fruits, these difference were not significant (p=0.05).

Although there was same indication that tomatoes stored in MAP had a lower maximum red colour, the colour was still usually acceptable and difficult to visually differentiate from the unwrapped fruit. The two films which had the greatest effects were those wihch had the lowest O_2 and highest CO_2 atmospheres (Table 1).

Lycopene constitutes the main red pigments of tomatoes and their concentrations increase steadily throughy ripening. Formation of lycopene were dependent upon the presence of O_2 (26). Its formation was inhibited by low O_2 atmosphere storage. The lower the O_2 concentration the longer the inhibitation. At 1% O_2 and 99% N_2 storage lycopene formation was completely inhibited for 50 days (21). Ethylene is trigerring the ripening of tomatoes and it is known calssy associated with a sudden change in the physiology of tomato fruits at the onset of ripening. CO_2 concentration affected colour development of tomatoes by suppression of ethylene production (27). It was indicated that colour development was inhibited in tomatoes while exposed to high levels (20, 40 and 60%) of CO_2 (28).

Fruit Firmness

All fruit softened progressively during storage, but those sealed in plastic film softened significantly (p=0.05) more slowly than those stored unwrapped (Figure 3). An arbitrary subjective estimate of fruit softness that would be the minumum acceptable on the market was established as between 1.45 (very firm) and 1.27 Nmm^{-1} (slightly soft but acceptable). Unwrapped tomatoes were shown to fall below this level after 30 and 40 days storage while all those stored in plastic films were above this level after 60 days storage.



Sealed within 20m (PE20), 50m (PE50) polyethylene, 10m (PVC) polyvinyl chloride and 25m (PP) polypropylene, Coloour Classufication: Pink: 0.08-0.57, Light red: 0.61-0.95, Red: 0.95-1.22

Figure 2. Colour (a*/b*) changes tomatoes sealed within different packaging films during storage perid at 13°C.

Storage Period	Unwrapped	PE20	PE50	PVC	PP
10	0	0	0	0	0
20	0	0	0	0	0
30	0	0	0	0	0
40	8	0	0	0	0
50	8	8	8	8	8
60	17	25	8	8	8

Table 2. The percentages of decayed tomatoes packed in different films and stored at 13°C during the storage period

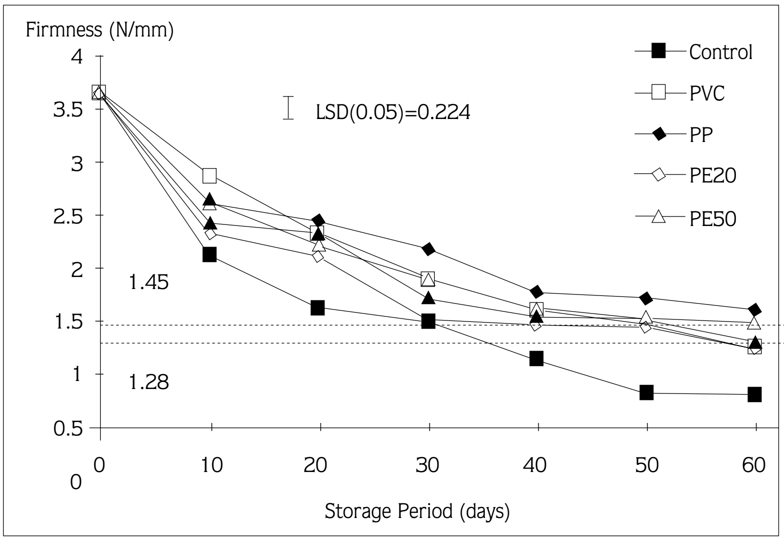


Figure 3. Firmness (Nmm^{-1}) changes in tomatoes sealed with different packaging films during storage period at 13°C.

Sealed within 20µ (PE20), 50µ (PE50) polyethylene, 10µ (PVC) polyvinly chloride and 25µ (PP) polypropylene, 1.45 Nmm^{-1}: (very firm), 1.28 Nmm^{-1}: slightly soft but acceptable

Polygalacturanase (PG) and pectinastarese (PE) are the important enzymes involved in fruit softening by solubilizing the polygalacturonic acid in the pectin fraction of the cell walls (30) during ripening. PG activity increased while firmness decreased with progressive stage of maturation and its synthesis only occurs in response to ethylene (31). High CO_2 concentration inhibited ethylene production during tomato ripening (32). It was reported that elevated CO_2 atmosphere slow down the softening rate, but the mechamism of controlled or modified atmosphere effects on texture of fresh fruits and vegetables is not fully understood (33).

Weight Loss

Weight loss of the plastic film packed fruit was lower and linearly increased throughout storage (Figure 4). For unwrapped fruit weight losses were higher but also linear overt the first 40 days, then the rate highly increased. It could be due to senescence or more desiccation of tomatoes. There was not significant difference in weight loss value of tomatoes sealed with PE20 and PVC. There was significant differences (p=0.05) between PP, PE50 and PVC (or PE20). The significant differences (p=0.05) between weight loss of fruit sealed in different films

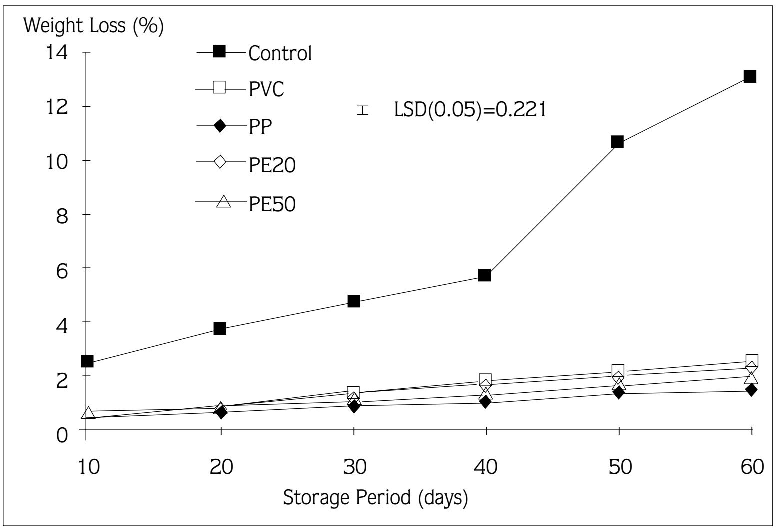


Figure 4. Changes of weight loss of tomatoes sealed within different packaging films during storage period at 13°C.

Sealed within 20µ (PE20), 50µ (PE50) polyethylene, 10µ (PVC) polyvinlyl chloride and 25µ (PP) polypropylene

indicated that their weight loses were related to film permeability (Figure 4). A small contribution may have come from the lower respiration rate of the tomatoes which would have occured with the higher CO_2 and lower O_2 levels inside these films. For example PP and PE50 had the lowest gas permeability (datas are not shown) and also the lowest weight loss. The difference between weight losses of films is also probably largely due to transmission rates of water vapour through the film.

Titratable acidity

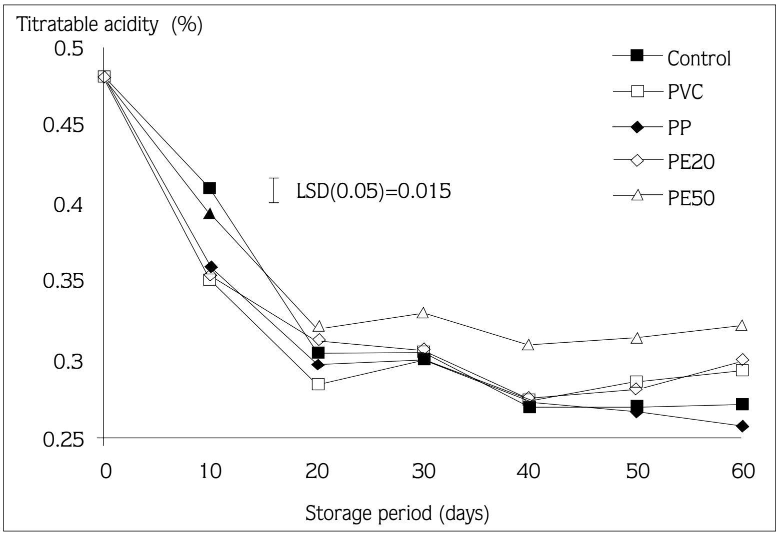
Tomatoes fruits became less acid 20 days of storage and than remained constant (figure 5). There was no correlation between the O_2 or CO_2 contents inside the films and their acidity after storage. In other work tomatoes stored at 12.8ºC for 6 weeks in 3% O_2 and 3 to 5% CO_2 tended to be more acid than fruits stored in air or in 3% O_2 and 0% CO_2 (32). However, it was reported that a decrease in titratable acidity and no change in total soluble solids in several tomato cultivars harvested at breaker stage and held at 20ºC for 12 days (39).

Decay

Decay was first observed on fruit after 40 days storage. This was on one fruit out of 60. All treatments showed some rotting after 50 days storage wihch increased again after 60 days. 8% of fruit had some infection after 50 days rising to 16% after 60 days. It was reported that the percentages of decayed tomatoes in the low oxygen atmospheres did not differ significantly over the range of 0-5% carbon dioxide levels (35). Approximately 2% of the fruit was infected at 98% RH. However they showed that in air 66% of the tomatoes were decayed after 6 weeks at 12ºC. An average of only 3.5% were decayed during the same period in atmospheres of 3% oxygen with 0, 3 or 5% CO_2 environments. CO_2 injuries was reported on tomatoes in low O_2 (o to 3%) in combination with high CO_2 (3-5%) but it was not observe CO_2 injury at 4% O_2 with 5 to 10 % CO_2. No CO_2 inwury was observed in the present experiment (28).

Conclusion

Tomatoes sealed in plastic films had an extended marketable life and the type of plastic film used affected the gaseous atmosphere around the fruit and therefore their maximum storage life. This was shown in the delayed colour changes and delayed softening of the fruits. There were no detrimental physiological characteristics detected in the tomatoes until 50 days storage.



Sealed within 20μ (PE20), 50μ (PE50) polyethylene, 10μ (PVC) polyvinyl chloride and 25μ polypropylene

Figure 5. Changes of titratable acidity of tomatoes sealed within different packaging films during storage period at 13ºC.

References

1. Geeson, J.D., Browne K.M., Maddison K., Shepherd J. and Guaraldi F. Modified Atmosphere Packaging to Extend the Shelf Life of Tomatoes. Journal of Food Techology. 20, 339-349. 1985.
2. Risse L.A., Miller W.R. and Ben-Yhoshua S. Weight Loss, Firmness, Colour and Decay Development of Individual Film Wrapped. Tomatoes. Tropical Science. 25, 117-121. 1985.
3. Yang, C.C. and Chinnan, M.S. Modelling the effect of oxygen and carbon dioxide on respiration and quality of stored tomatoes. American society of Agricultural Engineers. 31, 920-925. 1988.
4. Thorne, S. and Alvarez. J.S.S. The Effect of Irregular Storage Temperature on Firmness and Surface Colour in Tomatoes. Journal Science Food Agriculture. 33, 671-676. 1982.
5. Geeson, J.D., Maddison K. and Browne K.M. Modified Atmosphere Packaging of Tomatoes. In Packaging of Horticultures Produce. AAB/NCAE Residential Meeting. London. p:8-15. 1981.
6. Thompson, A.K. Postharvest Technology of Fruit and Vegetables. Logmans. London. 1995.
7. Ben-Yeshoshua, S. Individual Seal-packaging of Fruit and Vegetables in Plastic Film. A new Postharvest Technique. HortScience. 20, 1, 32-37. 1985.
8. Esquerra, E.B. and Bautista O.K. Modified Atmosphere Storage and Transport of 'Improved Popa' Tomatoes. ASEAN Food Journal. 5, 27-33. 1990.
9. Day, B.P.F. Fruit and Vegetables. In Principles and Application of Modified Atmosphere Packaging of Food. (R. Parry. ed) Blackie. Academic and Professional. UK. London. p: 114-133. 1993.
10. Shewfelt, R.L. Postharvest Treatment for Extending the Shelf Life of Fruit and Vegetables. Food Technology (May): 70-80, 89. 1986.
11. Grierson, D. and Kader A.A. Fruit ripening and quality. In The Tomato Crop. (J.G. Atherton and Rudich J. eds). Chapman and Hill Ltd. USA. p: 241-280. 1986.
12. Hobson, G. and Grierson D. Tomato. In Biochemistry of Fruit Ripening. (G Seymour, Taylor J. and Tucker G. eds). Chapman and Hall Ltd. London. p: 241-280. 1993.
13. Risse L.A., Miller W.R. and McDonald R.E. Effects of Film Wrapping on Mature Green Tomatoes Before and After Ethylene Treatment. Proc. Fla. State Hort. Soc. 97, 112-114. 1984.
14. Dennis, C., Browne K.M. and Adamicki E. Controlled Atmosphere Storage of Tomatoes. ActaHorticulturae. Quality of Vegetables. 93, 75-83. 1979.
15. Hobson, G.E. The Short Term Storage of Tomato Furits. Journal of Horticultural Science. 56, 4, 363-368. 1981.
16. Ramana, S.V., Mohan-Kumar B.L. and Jayaraman K.S. Estension of Stored Life of Tomatoes Under Ambient Conditions by Continuors Flashing of Storage Atmosphere. Indian Food Parker. 41, 24-29. 1987.
17. Geeson, J.D. Modified Atmosphere Packaging of Fruit and Vegetables. Acta Horticulture. 258, 143-150. 1989.
18. Anonymous. Minolta, Precise Colour Communication. Colour Control From Feeling to Instrumentation. Hand Book. Printed by Minolta Camera Co. Ltd. Japan. 1993.
19. Yang, C. and Chinnan, M. Modeling of The Color Development of Tomatoes in Modified Atmosphere Storage. American Society of Agricultural Engineers. 30(2): 548-553. 1987.
20. Weatheral, I.L. And Lee, W. Instrumental Evaluation of Some New Seland Fruit Colour Using CIELAB values. New eland Journal of Botany. 29: 197-205. 1991.
21. Yang, C.C., Brennan, P. Chinnan M.S. and Shewfelt. R.L. Characterisation of Tomatoes Ripening Process as Influenced by Individual Seal-Packaging and Temperature. Journal of Food Quality. 10, 21-33. 1987.
22. Batu, A. and Thompson A.K. Effects of Cross-head Speed and Probe Diameter on Instrumental Measurement of Tomatoes Firmness. In Proceedings of the International Conference for Agricultural Machinery and process Engineering Seoul, Korea. P: 1340-1345. 1993.
23. Kader, A.A., Chastager, G.A., Morris, L.L. And Ogawa J.M. Effects of Carbon Monoxide on Decay, Physiological Responses, Ripenin, and Composition of Tomate Fruits. J. Amer. Soc. Hort. Sci. 103(5): 665-670. 1978.
24. Geeson, J.D. and Browne K.M. New Packaging Technology Aims to Extend Shelf Life. Grower. July 14, pp: 35-38, 1983.
25. Kader, A.A. Modified Atmosphere During Transport and Storage. In Postharvest Technology of Horticultural Crops. (A.A. Kader. ed). University of California. Publication 3311. USA. p: 85-92. 1992.
26. Hobson, G.E., J.N. Davies. The Tomato. In The Biochemistry of Fruits and Their Products. (A.C. Hulme. ed). Academic Prese London and Newyork. 2, 437-482. 1971.
27. Kubo, Y., A. Inaba and R. Nakamura. Effects of High CO_2 on Respiration in Various Horticultural Crops. J. Japan. Soc. Hort. Sci. 58, 3, 731-736. 1989.
28. Buescher, R.W. Influence of Carbondioxide on Postharvest Ripening and Deterioration of Tomatoes. J. Amer. Soc. Hort. Sci. 104, 4, 545-547. 1979.
29. Batu, A. Controlled and Modified Atmosphere Storage of Tomatoes. PhD Thesis. Cranfield University, Silsoe College, Silsoe, MK45 4DT, Beds, England. 1995.

30. Themman, A.P.N., Tucker, G. and Grierson, D. Degradation of Isolated Tomato Cell Walls by Purified Polygalacturonase in Vitro. Plant Physiol. 69, 122-124. 1982.

31. Grierson, D. and Tucker, G.A. Timing of Ethylene and Polygalacturonase Synthesis in Relation to the Conrol of Tomato Fruit Ripening. Planta. 157, 174-179. 1983.

32. Herner, R?C. High CO2 Effects on Plant Organs. In Postharvest Physiology of Vegetables. (J. Weichmann. ed). Marcel Dekker Inc. New York. pp: 239-253. 1987.

33. Kader, A.A. Biochemical and Physiological Basis for Effects of Controlled and Modified Atmospheres on Fruits and Vegetables. Food Technology. 40, 99-100, 102-104. 1986.

34. Riquelme F., Pretel M.T., Martinez G., Serrano M., Amoros A. and Romajoro F. Packaging of Fruits and Vegetables: Recent Results. In Food Packaging and Preservation. (M. Mathlouthi. ed). Blackie Acadanic and Professional. London. p: 141-158. 1994.

35. Parsons, C.S., Anderson R.E. and Penney R.W. Storage of Mature Green Tomatoes in Controlled Atmospheres. Journal of American Horticultural Science. 95, 6, 791-796.

36. Floros, J.D., Chinnan M.S. and Wetztein H.Y. Extending The Self Life of Tomatoes by Individually Seal Packaging. In For Presentation at the International Winter Meeting of American Society of Agricultural Engineers. Hyatt Gegency, Chicaco, IL. USA. 1987.

37. Ottoson, L. and Wiberg L. Postharvest Changes In Green Tomatoes Lycopersicon Esculentum L. ActaHorticulturae. 62, 267-274. 1977.

38. Risse, L.A. Individual Film Wrapping of Florida Fresh Fruit and Vegetables. Acta Horticulturae. Postharvest 88, 258, 263-270. 1989.

39. Hall, C.B. Quality Changes in Fruits of Some Tomato Varieties and Lines Ripened at 68^{o}F for Varous Periods. Proc. Fla. State Hort. Soc. 79, 222-227. 1966.