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Storage studies of okra under ambient storage conditions

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Abstract- **A study was conducted on okra (Variety: Novel hybrid) for storage under ambient storage conditions (32.7±2.5°C, 72±5% RH). Okra were kept unwrapped as well as packaged in LDPE packages of various thicknesses viz. 25, 37.5 and 50 µm and 0, 4 and 8 perforations of 1.0 mm diameter each were provided in these packages. The unwrapped okra pods were referred as control samples. Gas concentrations (O_2 and CO_2) in the packages and quality parameters such as physiological loss in weight (PLW), colour, total chlorophyll and firmness in the packages as well as control were determined at regular intervals during the entire storage period. Among all the packages, 37.5 µm LDPE packages having 8 perforations were found to be the best package and okra could be stored for 10 days under ambient storage conditions.**

Index Terms- **Okra, packaging, shelf life, storage.**

I. INTRODUCTION

Okra is highly perishable commodity. Post-harvest losses of fresh okra are caused due to continued respiration and transpiration after harvest. The normal shelf life of fresh and raw okra is 2 to 3 days. here is a slight benefit from storage at 7 to 12°C (44.6 to 53.6°F) in air with 4 to 10% CO_2 [1a]. Few researches on okra includes comparison of cooling and packaging methods to extend post harvest life of okra [2]; effects of packaging materials and storage temperature on quality of fresh okra (Abelmoschus *esculentus* L.) fruit [3a] and temperature and modified atmosphere affect the quality of okra [4]. Ordinary packaging films such as LDPE, PP, OPP and PVC can generate suitable in-pack gaseous environment for fresh produce with low and medium rates of respiration. These films contained a large number of micro perforations for enhancement of gaseous diffusion of O_2 and CO_2 across these film packages, which avoided anaerobic respiration of the packaged produce [5]. A reduced level of oxygen and increased level of carbon dioxide can reduce respiration, delay tissue ripening, retard chlorophyll degradation and maintain nutritional quality of fresh produces. Hence, the study was undertaken on okra (*Abelmoschus esculentus* L.) for its shelf life extension by designing of modified atmosphere packaging (MAP) for the selection of appropriate polymeric films of desired physical and gas exchange characteristics.

II. MATERIALS AND METHODS

The variety of okra selected for the study named 'Novel hybrid' was procured from a field near Mullanpur. Extremely low O2 levels are responsible for stress-induced changes in metabolism [6]. The best suitable polymeric film (LDPE) [3b] was selected and evaluated for extending the shelf life of okra under ambient storage conditions (32.7±2.5°C, 72±5% RH). The okra pods were kept without packaging as wella ss in the packages. The LDPE packages 25 µm (100 gauge), 37.5 µm (150 gauge) and 50 µm (200 gauge) having 0, 4 and 8 perforations. In-package gas composition analysis (in terms of O_2 and CO_2 concentration) was measured with the help of gas analyser (Make: PBI Dansensor; Model: Checkpoint II Portable Gas Analyser), physiological loss in weight (PLW) weighing was done with the digital balance having least count of 0.5, colour was measured by Konica Minolta CR 10 Tristimulus Colorimeter, total chlorophyll was analyzed spectrophotometrically using procedure proposed by [7] with the help of electronic spectrophotometer and firmness of the okra was measured with the help of texture analyser. The observations were recorded after every alternate day at ambient storage conditions.

III. Results and Discussion

Respiration rate was assessed for okra at 32.7 ± 2.5°C, 72 ± 5% RH and out of three types of packages viz. LDPE, HDPE and PP. Out of these LDPE was selected as the best film for the packaging of okra. Okra were then packaged in LDPE packages of various thicknesses viz. 25, 37.5 and 50 µm and 0, 4 and 8 perforations of 1.0 mm diameter each were provided in these packages. The packages were then stored at ambient conditions. Quality parameters namely, gas concentrations (O_2 and CO_2) and quality parameters such as physiological loss in weight (PLW), colour, total chlorophyll and firmness were determined at regular intervals during the entire storage period.

A. Gas Concentrations

The oxygen concentration in various LDPE packages containing okra pods was measured at regular intervals was expressed in percentage. The oxygen gas concentration measured in each non-perforated package that oxygen concentration decreased with an increase in the thickness of the package. In case of perforated packages, LDPE packages having 8 perforations had the maximum oxygen concentration followed by LDPE packages having 4 perforations and least in the non-perforated LDPE packages. It was also observed that as the storage period increased, the oxygen concentration within the package decreased and in non-perforated 25 µm and 37.5 µm thick packages, the values of oxygen concentration indicated anaerobic conditions after 10 days of ambient storage. The anaerobic conditions in 50 µm thick non-perforated packages occurred after 4 days of storage whereas it was not the case in perforated packages even after 10 days of storage. LDPE packages having 8 perforations were found to be the best as regards to desired range of oxygen concentration requirement for maintaining the quality of okra pods [1b]. The results for effect of each package with respect to each other and its perforations were statistically significant.

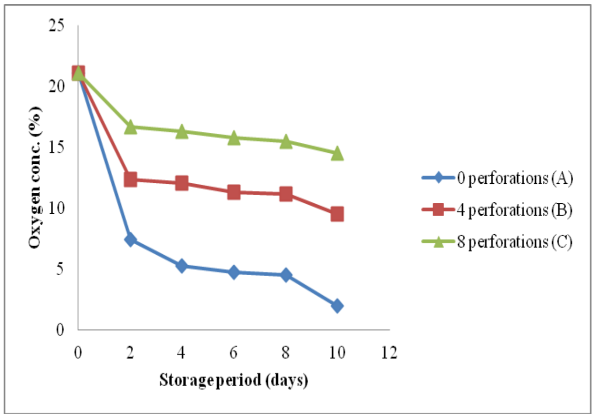

Fig 1: Oxygen concentration (%) in 25 µm thick LDPE packages under ambient storage conditions

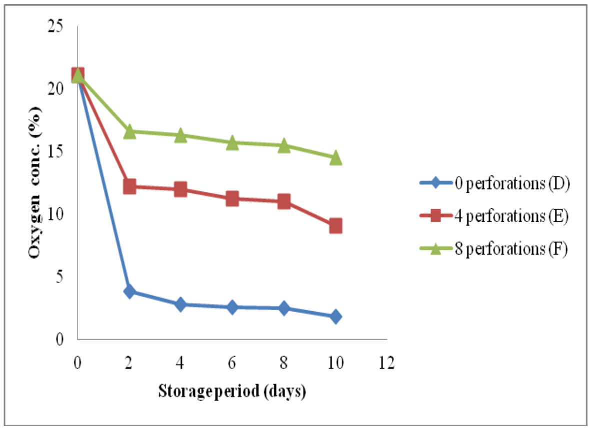

Fig 2: Oxygen concentration (%) in 37.5 µm thick LDPE packages under ambient storage conditions

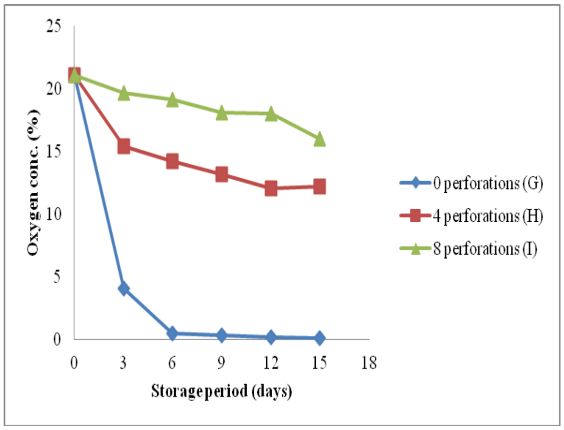

Fig 3: Oxygen concentration (%) in 50 µm thick LDPE packages under ambient storage conditions

The carbon dioxide concentration in various LDPE packages containing okra pods was measured at regular intervals and was expressed in percentage. It was evident from the carbon dioxide gas concentration measured in each non-perforated package that carbon dioxide concentration increased with an increase in the thickness of the package and it was highest in 50 µm non-perforated package. In case of perforated packages, LDPE packages having 8 perforations had the minimum carbon dioxide concentration followed by LDPE packages having 4 perforations and highest in the non-perforated LDPE packages. It was also observed that as the storage period increased, the carbon dioxide concentration within the package increased and in non-perforated 25 µm and 37.5 µm thick packages, the values of carbon dioxide concentration indicated off flavour in these packages after 10 days of ambient storage. The off flavour in 50 µm thick non-perforated packages occurred after 4 days of storage period whereas it was not the case in perforated packages even after 10 days of storage. 25 µm and 37.5 µm LDPE packages having 8 perforations were found to have desired range of carbon dioxide concentration to maintain the quality of okra [1c].The results for effect of each package with respect to each other and its perforations were statistically significant.

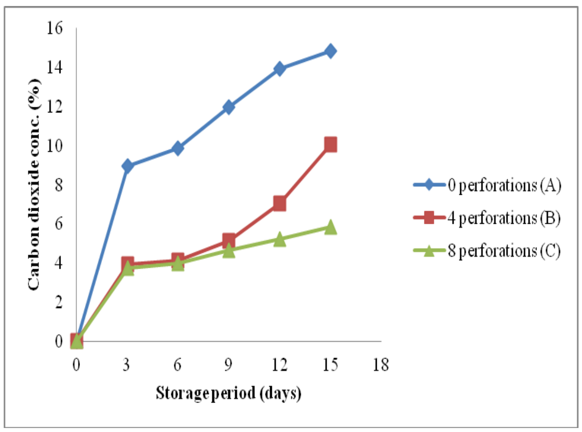

Fig 4: Carbon dioxide concentration (%) in 25 µm thick LDPE packages under ambient storage conditions

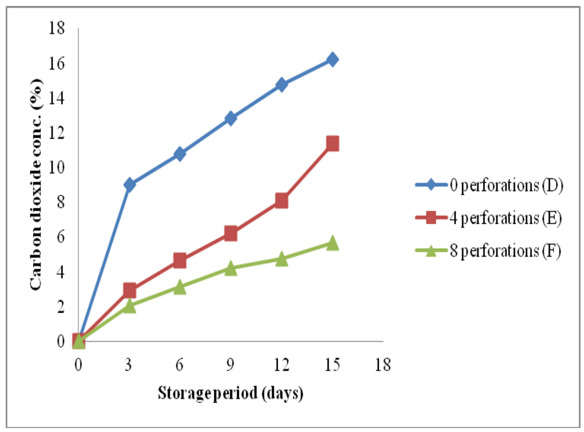

Fig 5: Carbon dioxide concentration (%) in 37.5 µm thick LDPE packages under ambient storage conditions

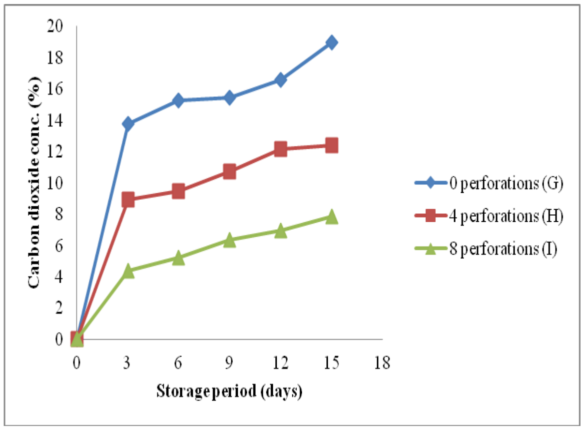

Fig 6: Carbon dioxide concentration (%) in 50 µm thick LDPE packages under ambient storage conditions

B. *Physiological Loss In Weight (PLW)*

The physiological loss in weight in various LDPE packages containing okra pods was measured at regular intervals of time during the ambient storage conditions and was expressed in percentage. It was observed that as the storage period increased, the PLW (%) increased. The physiological loss in weight was highest in the control samples. It was observed that okra in non-perforated 25 µm LDPE packages had the lowest weight loss followed by okra in the packages having 4 perforations and highest weight loss was recorded for okra in packages having 8 perforations. Similar trends were observed in 37.5 and 50 µm LDPE packages. The PLW of okra was much lower in packages than the control. Among all the packages having 8 perforations, PLW (%) was found to be minimum in case of 37.5 µm packages and therefore, can be referred as a most suitable package as it also maintained the required gaseous concentration for okra. The effect of packages with respect to control was significant but effect of each package and its perforations were non-significant.

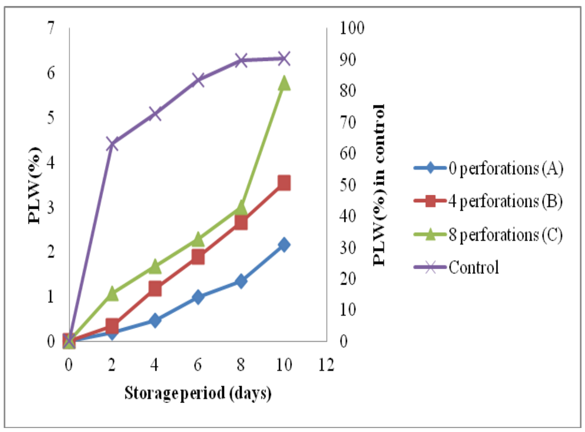

Fig 7: PLW (%) for 25 µm thick LDPE packages under ambient storage conditions

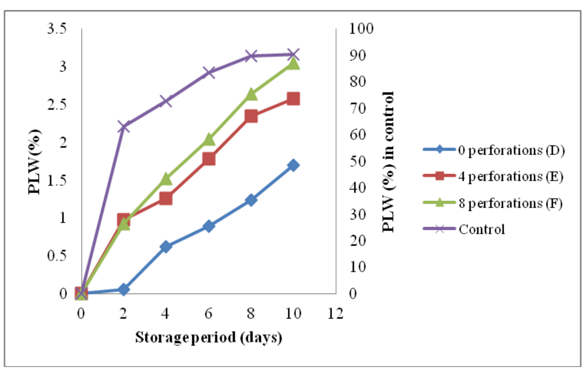

Fig 8: PLW (%) for 37.5 µm thick LDPE packages under ambient storage conditions

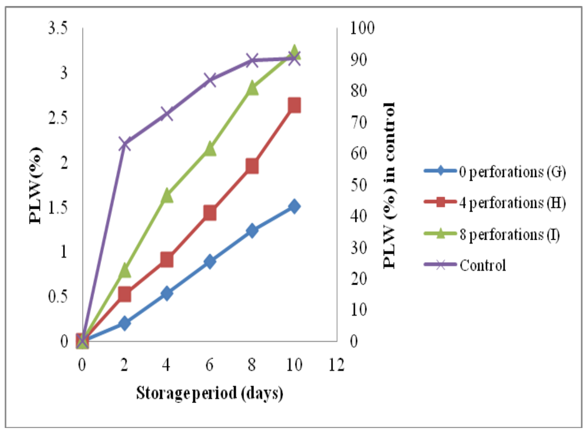

Fig 9: PLW (%) for 50 µm thick LDPE packages under ambient storage conditions

C. *Total Colour Difference (ΔE)*

The total colour difference (ΔE) values in various LDPE packages containing okra pods was measured at regular intervals of time during the ambient storage conditions. The increase in ΔE values signified colour change. It was observed that as the storage period increased, the ΔE values increased. The ΔE value was highest in the control samples. It was evident from the ΔE values measured for okra in each package that ΔE for okra increased with an increase in the thickness of the package. It was concluded that ΔE values were highest for okra in the non-perforated packages followed by okra in the packages having 4 perforations whereas lowest for okra in the packages having 8 perforations. It was also observed that okra in the 37.5 µm LDPE packages remained in the desired range of 4-10% [1d] at the end of storage period and provided better gaseous environment to okra pods. The effect of packages with respect to control, effect of each package with respect to each other and its perforations were significant.

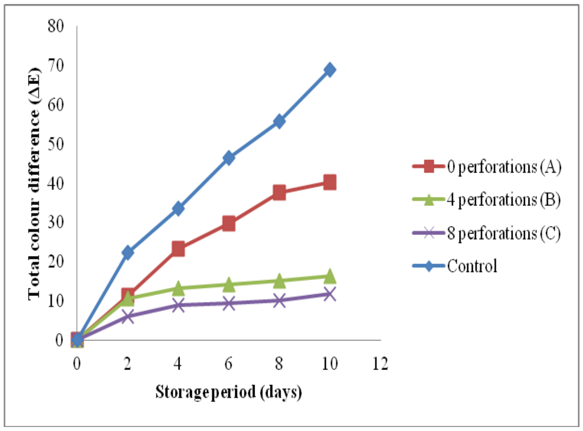

Fig 10: ΔE values for 25 µm thick LDPE packages under ambient storage conditions

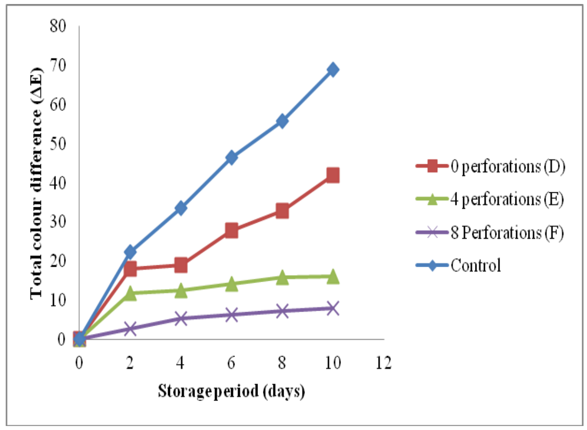

Fig 11: ΔE values for 37.5 µm thick LDPE packages under ambient storage conditions

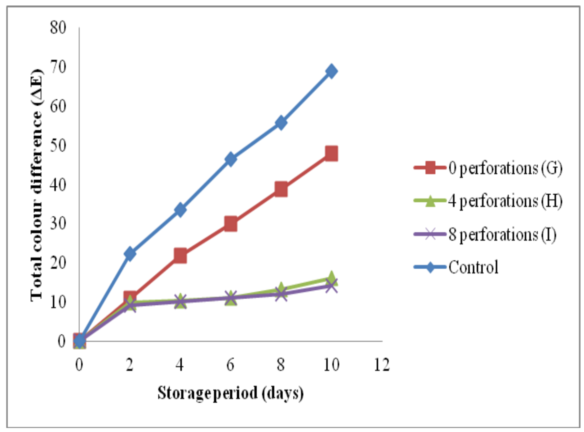

Fig 12: ΔE values for 50 µm thick LDPE packages under ambient storage conditions

D. Total chlorophyll

The total chlorophyll (mg/100g) in various LDPE packages containing okra pods was measured at regular intervals of time during the ambient storage conditions. The total chlorophyll was also found to be decreasing with increase in the storage period. The total chlorophyll was observed to be least in the control sample i.e. for unwrapped okra pods (0.67 mg/100 g) on the 10th day. It was evident from the total chlorophyll measured for okra in each non-perforated package that total chlorophyll decreased with an increase in the thickness of the package. It was found that the total chlorophyll decrease was less in perforated packages than in non-perforated packages. It was evident that maximum chlorophyll was retained in 25 and 50 µm LDPE packages having 4 perforations followed by okra in the packages having 8 perforations and least amount of chlorophyll content was retained for okra in non-perforated packages after 10 days of storage. It was found that maximum chlorophyll was retained for okra in 37.5 µm LDPE packages having 8 perforations followed by okra in the packages having 4 perforations and least amount of chlorophyll content was retained in the non-perforated packages after 10 days of storage. It was observed that 37.5 µm LDPE packages having 8 perforations retained maximum total chlorophyll after 10 days of storage. The effect of packages with respect to control, effect of each package with respect to each other and its perforations were significant.

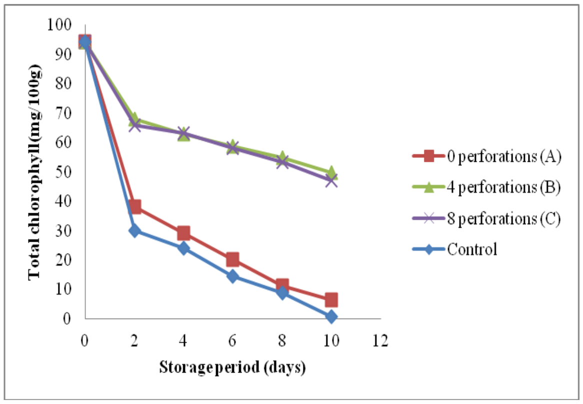

Fig 13: Total chlorophyll for 25 µm thick LDPE packages under ambient storage conditions

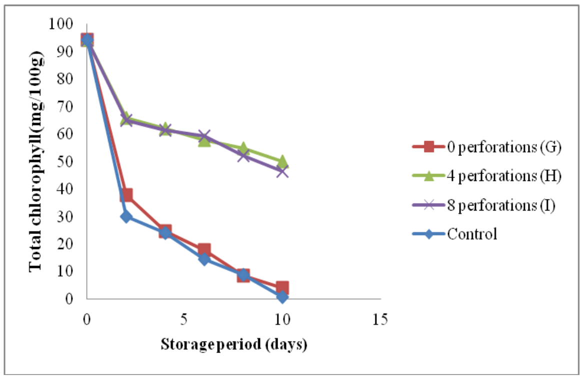

Fig 15: Total chlorophyll for 50 µm thick LDPE packages under ambient storage conditions

E. Firmness

The firmness in various LDPE packages containing okra pods was measured at regular intervals of time during measured for okra in each

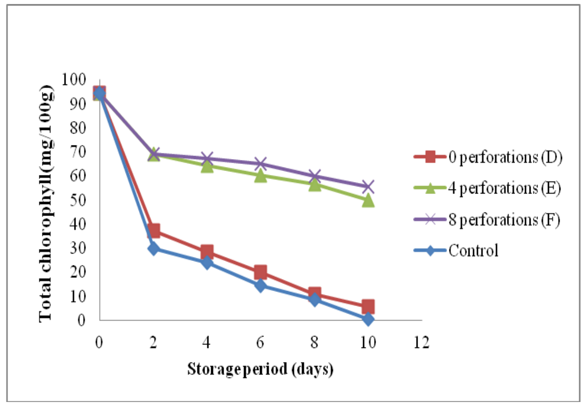

Fig 14: Total chlorophyll for 37.5 µm thick LDPE packages under ambient storage conditions

non-perforated package that firmness decreased with an increase in the thickness of the package. It was observed that minimum firmness was the ambient storage conditions. The firmness was found to be decreasing with minimum in the control sample i.e. for unwrapped okra pods (0.06 kg on the 10th day). It was evident from the firmness increase in the storage period. The firmness value decreased rapidly under ambient storage conditions and was observed to be obtained for okra in non-perforated 25, 37.5 and 50 µm LDPE packages whereas okra in the packages having 4 perforations had more firmness and highest firmness for okra was observed in the packages having 8 perforations. It was observed that okra pods kept in 37.5 µm LDPE packages having 8 perforations had the maximum firmness after 10 days of storage period.

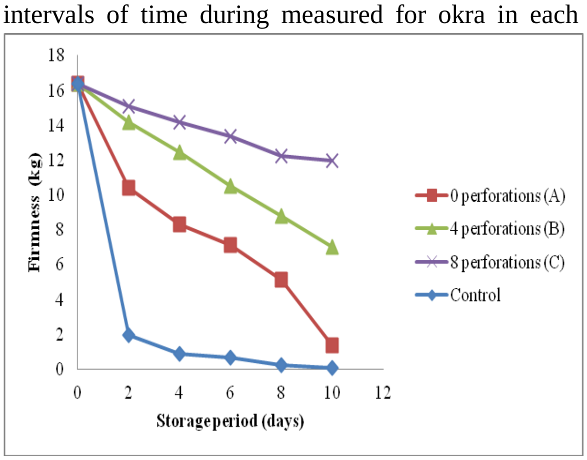

Fig 16: Firmness (kg) for 25 µm thick LDPE packages under ambient storage conditions

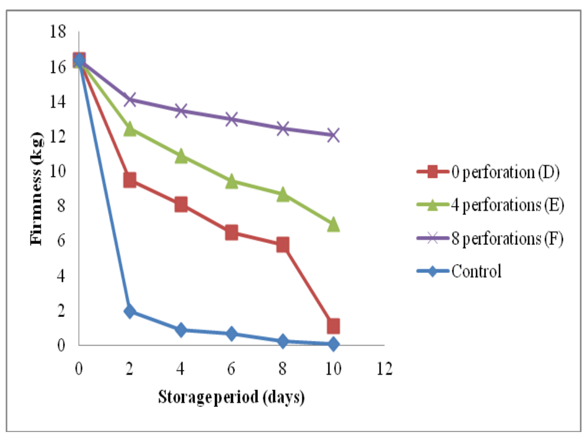

Fig 17: Firmness (kg) for 37.5 µm thick LDPE packages under ambient storage conditions

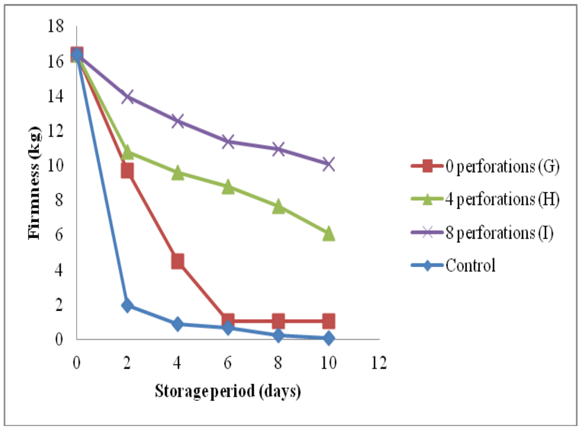

Fig 18: Firmness (kg) for 50 µm thick LDPE packages under ambient storage conditions

IV. CONCLUSIONS

The study showed that okra is best stored in 37.5µm LDPE packages having 8 perforations out of LDPE films of 25, 37.5, and 50 µm having 0,4 and 8 perforations. These packages were given 0, 4 and 8 perforations of 1mm diameter. The samples were also kept as control i.e. without packaging. All the packaged and control samples were stored under ambient storage conditions (32.7±2.5°C, 72±5% RH). The shelf life of okra was observed to be 10 days under ambient storage conditions. The quality parameters in terms of PLW, colour, chlorophyll and firmness were found to be better in packages as compared to control i.e. without packaging. In non-perforated packages, anaerobic conditions prevailed at the end of the storage period. In 37.5 µm LDPE packages having 8 perforations, the in-pack oxygen and carbon dioxide concentrations were found to be 14.53% and 8.56% respectively at the end of storage period, which were in the desired range of gas concentrations required for safe storage of okra. PLW for okra kept in LDPE packages was least for non-perforated packages, followed by 4 perforation packages and highest for the packages having 8 perforations. Total colour difference was found to be minimum in 37.5 µm LDPE packages having 8 perforations. Total chlorophyll content and firmness of okra were found to remain better in perforated packages, and 37.5 µm LDPE packages having 8 perforations were considered best.

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