

Effect of Modified Atmosphere Packaging on Storage Life of Cucumber

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ABSTRACT

Fruits and vegetables are among the most important horticultural products that play an important role in meeting food needs and human health. This group of agricultural products are perishable due to high moisture content and major part of them are destroyed after harvest. According to the recommendations of the World Health Organization, every person should consume 2-4 units of fruits and 3-5 units of vegetables daily. In some regions the climatic changes cause fruits and vegetables not to be produced in all seasons, endangers the health of the people in those areas. Making this important food group available in such conditions improves nutritional status. This research was conducted to investigate the effect of modified atmosphere packaging to increase the storage life of cucumber in the year of 2019 in the Food Technology Laboratory, Faculty of Agriculture, Herat University. Cucumbers packed in different plastic and stored at ambient temperature $25 \pm 5^\circ\text{C}$ and RH of $35 \pm 5\%$. The result indicated that plastic materials were more efficient in maintaining quality of cucumber by providing microclimate around the products which could increase the storage life of cucumbers up to 18 days compared to unpackaged cucumbers which had only 6 days of storage life. Modified atmosphere packaging acts as an excellent technique in preventing loss and maintaining the quality of these products for long term storage and transportation. By Applying MAP techniques fresh products can be available throughout the year in all regions.

Keywords: Cucumber, Shelf Life, Packaging, Transportation, Waste

INTRODUCTION

Climate change threatens people's food security by reducing the availability, access, utilization and stability of the food system, which, along with high demand, increases food prices. According to the recommendations of the World Health Organization, all people should consume fruits and vegetables daily for having healthy life, but the climate conditions prevent the production of this important food group in some areas in all seasons of the year. In order to improve nutrition and ensure the health of the people in the mentioned areas at all seasons fruits and vegetables must be stored and transported from production areas in such a way that their quantity and quality are maintained. Cucumber (*Cucumis sativus* L.) is an economically important product which is consumed mainly as salad and pickle around the world. Cucumber fruits are a good source of antioxidants, magnesium, and vitamin C and are rich in dietary fiber (Shi et al., 2015). Cucumber due to having vitamins and minerals is useful for human health and it is known as an excellent cooling vegetable because of its high water content consumed during warm days (Kargwal et al., 2020). It is highly perishable and very susceptible to shriveling so it is very important that high humidity during storage, transportation and marketing is maintained. Cucumbers must be stored at temperatures between 10 and 15 °C at 90–95 % RH (Dhall et al. 2012). Most of the deteriorative changes in cucumber during storage and distribution are yellowing, and loss of moisture that leading to shriveling and physiological injury (Kargwal et al., 2021). MAP developed in recent decades as a technique to maintain fresh fruits and vegetables quality during transportation and storage (Charles et al., 2008). Modified atmosphere packaging (MAP) of fruits and vegetables combined with cold storage is considered as the best technique to prolong the shelf-life period (Sandhya, 2010). Maintaining the sensory and microbiological quality of fresh produce by MAP has been reported by (Day, 2001). MAP by lowering the respiration rate and ethylene production delays ripening and senescence, decrease, texture loss, rate of microbial growth and spoilage, chlorophyll, and other pigment degradation (Rodriguez and Oliveira, 2009). MAP creates a microclimate by maintaining high humidity around the products, increasing CO₂ and decreasing O₂ levels have been shown to reduce chilling injury of avocados, grapefruit, peaches, okra, pineapples (Caleb et al., 2013).

Sudhakar et al. (2000) reported the effect of MAP and shrink wrapping on increasing the shelf life of cucumber at 10 °C.

In many parts of Afghanistan, due to the cold climate many fruits and vegetables are not produced, and people may not have access to this important food group every day, for sustainable access, the fresh products should be transported correctly from the production areas. In this research, the aim of identifying the effect of passive modified atmosphere packaging in the storage of fresh products was studied to introduce an easy, economical and usable method for producers in our country.

MATERIALS AND METHODS

Study Area

This research was conducted in the Food Technology Laboratory of Agriculture Faculty of Herat University, Afghanistan during 2019.

Samples Collection

Uniform and immature green cucumber vegetables were harvested early morning from the farm and transported to the Food Technology Laboratory, after graded based on the uniformity, cucumbers were washed with 100 ppm sodium hypochlorite as sanitizer to make the fruits free from microbes, and postharvest pathogens, later washed cucumbers air dried to remove free water from its surface. Then uniform 3 kg cucumber were packed per replication in different packages such as., Polyethylene bag without perforation(T₁); Polyethylene bags with 0.5% perforations (T₂); Polyethylene bags with 1% perforations (T₃); Polyethylene bags with 1.5% perforations (T₄) along with control un pack (T₅) and stored at ambient condition temperature 25±5°C and 35 ± 5% relative humidity.

The Physiological loss in weight was calculated using standard formula and expressed as per cent. The PLW was calculated with the following formula and expressed as per cent.

$$PLW (\%) = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Cucumber firmness evaluation was carried out by taking cucumber and penetrating it with a 10 mm cylindrical probe of penetrometer model SIM20.

Organoleptic evaluation of cucumber was conducted after 6 and 18 days of storage on the basis of color, texture, taste, aroma and overall acceptability by a panel of ten semi trained judges using a nine-point Hedonic scale as laid out by Amerine *et al.* (1965) where 9-Excellent; 8-Extremely good; 7-Very good; 6-Moderately good; 5-Good; 4-Very fair; 3- Fair; 2-Poor; 1-Very poor.

Statistical Analysis

Completely Randomized Design (CRD) was used for conducting the experiment and the data obtained were subjected to statistical analysis as per the guidelines suggested by Panse and Sukhatme (1978).

RESULTS

Physiological loss in weight (%)

Weight loss is an important indicator of the postharvest quality of fresh produce. Results of present study showed that unpacked T₅ cucumber fruits exhibit more increasing trend in weight loss during storage reaching 9.13 % on day 6 (Table. 1) while the weight loss of T₁ was observed 4.30 percent after 18 days of storage. Due to more moisture loss, the unpacked cucumbers became more shrinkage and terminated from the experiment while other treatments stored for up to 18 days.

Treatments	Day3	Day6	Day9	Day12	Day15	Day18
T1- Polyethylene bag without perforation	0.85	1.57	1.85	3.25	3.71	4.3
T2- Polyethylene bag with 0.5% perforation	1.05	2.15	3.42	4.50	5.8	6.46
T3- Polyethylene bag with 1% perforation	1.15	2.55	3.50	4.63	5.80	76.61
T4- Polyethylene bag with 1.5% perforation	1.25	2.8	5.39	5.77	6.66	6.79
T5- Control(unpack)	3.17	9.13	--	--	--	--
S. Em	0.342	0.534	0.552	0.405	0.500	0.387
CD @5%	1.030	1.61	1.702	1.247	1.987	1.192
F-Test	S	S	S	S	S	S

--: Treatment terminated

S: Significant

Texture/ Firmness(kg/cm²)

Fruit firmness is another important parameter used to determine fruit quality, and it is well-known that postharvest handling and treatments influence fruit firmness. The texture of cucumbers decreased with prolongation of storage as indicated in Table 2. Significant differences were recorded among treatments. The minimum 5.95 Kg/cm² firmness of cucumber at day 6 was recorded in T₅, while T₁ had highest firmness 7.55 kg/cm² after 18 days of storage. Un packed cucumbers terminated from experiment in day 6 due to more softening and shrinkage while packed cucumbers maintained its firmness for up to 18 days.

Treatments	Day3	Day6	Day9	Day12	Day15	Day 18
T1- Polyethylene bag without perforation	11.52	10.75	10.03	9.25	8.2	7.55
T2- Polyethylene bag with 0.5% perforation	10.85	10.22	9.2	8.32	7.55	6.92
T3- Polyethylene bag with 1% perforation	10.4	10.10	8.75	7.60	7.45	6.90
T4- Polyethylene bag with 1.5% perforation	9.72	9.75	8.25	7.50	7.40	6.08
T5- Control(unpack)	7.65	5.95	--	--	--	--
S. Em	0.520	0.530	1.120	2.820	1.080	0.758
CD @5%	1.590	1.600	3.480	8.750	3.110	2.337
F-Test	S	S	S	S	S	S

--: Treatment terminated

S: Significant

Sensory Quality

Sensory quality is the most important parameter for consumer's acceptability approach. The sensory quality of cucumber decreased with prolonged storage as indicated in Table 3. The result showed that cucumber without packaging T₅ got 5 score of acceptability after 6 days of storage and due to more shriveling terminated from the experiment, while packed cucumber had shelf life up to 18 days of storage and got 7.50 and 7.00 score of acceptability in T₁ and T₂ respectively after 18 days of storage which was still acceptable for the consumers.

Treatments	After day 6					After day 18				
	Color	Taste	Texture	Aroma	Acceptability	Color	Taste	Texture	Aroma	Acceptability
T1	9.00	8.75	8.75	9.00	9.00	7.00	7.75	7.50	7.25	7.50
T2	8.75	8.50	8.50	8.75	9.00	6.75	7.50	7.25	7.00	7.00
T3	8.50	8.25	8.35	8.40	8.50	6.50	6.65	6.45	6.75	6.50
T4	8.00	8.00	8.15	8.25	8.00	6.00	6.00	6.15	6.25	6.00
T5	6.00	5.50	4.50	5.00	5.00	--	--	--	--	--

9-Excellent; 8-Extremely good; 7-Very good; 6-Moderately good; 5-Good; 4-Very fair; 3- Fair; 2-Poor; 1-Very poor. --: Treatment terminated

DISCUSSION

Results of the present study showed that unpacked cucumbers exhibit more increasing trend in weight loss during storage compared to packed cucumbers. One of the most important results of the present study is that MAP was found to have the highest impact on the prevention of weight loss. It could be assumed that the packaging material established a microenvironment with high relative humidity similar to vegetable moisture content, where there is a very low vapor pressure difference between cucumbers and the external environment to prevent the loss of moisture from cucumber and packaging material acts as a barrier to moisture loss. All these factors help to slow down the respiration and transpiration rates. Similar to our result the weight loss of cucumbers in plastic films during storage was reported Kahramanoglu and Usanmaz, (2019) and Manjunatha and Anurag, (2014), Elkashif et al. (1983); Homin and Woo (1999).

The texture of cucumber in this research decreased with prolonged storage which was more in unpacked cucumbers. The main cause of firmness loss in fruits and vegetables is pectin depolymerization. MAP changes the surrounding atmosphere of fruits by reducing O₂ levels and increasing CO₂ levels; according to Maftoonazad and Ramaswamy (2005), this reduces the activities of pectin esterase, which in turn allows the retention of fruit

firmness. Better texture retention in packed cucumber could be attributed to slow degradative changes during the initial period and also less moisture loss which plastic could act as a barrier in gas and water transmission rate compared to control. This result is in agreement with Singh and Sudhakar, (2005).

This result revealed that the sensory quality of cucumbers decreased with prolongation of storage which was more in unpacked cucumbers. Maintaining of better sensory quality in packed cucumber may be due to providing a microenvironment around the product which prevents from moisture loss, shriveling, color degradation, and scold development and minimized softening by decreasing metabolic activity. Our result is in agreement with those reported by Dhall et al., (2012) and Sudhakar et al., (2000).

CONCLUSION

Considering the importance of fruits and vegetables in nutrition and health, their existence is very necessary in all seasons of the year and all regions. Climatic conditions and changes have caused fruits and vegetables not to be produced in all seasons of the year and all regions, so it seems necessary to store and transport them from other regions in a way that preserves their quality and prevents waste. Based on our results, Modified atmosphere packaging was found to have important effects on preserving the quality parameters of fruits and vegetables. Packaging fresh products with polyethylene is one of the suitable techniques for increasing its storage life. So the result showed that packaged materials by minimizing respiration, senescence, and spoilage could increase the shelf life of cucumbers for up to 18 days compared to unpackaged cucumbers which stored only for 6 days.

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