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RESEARCH ARTICLE

EFFECT OF PACKAGING MATERIALS AND STORAGE CONDITIONS ON SHELF LIFE AND QUALITY OF OKRA*

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Abstract

The present study was undertaken with consisting of three storage conditions (room temperature, zero energy cool chamber and refrigerated storage) as main factor and six types of packaging material such as 150, 200, 300, 400 gauge polyethylene bags with 2% vents, punnets and control i.e. without packaging with three replications in factorial randomized block design during summer season of 2015. The physiological loss in weight exhibited increasing trend while the fruit firmness, total chlorophyll and ascorbic acid content and sensorial qualities of okra fruits exhibited decreasing trend through the storage period irrespective packaging materials and storage conditions. The shelf life of okra was found to be three days at room temperature, nine days at zero energy cool chamber and fifteen days at refrigerated storage when packed in 400 gauge polyethylene bags with 2% vents with more retention of organoleptic qualities and minimum total microbial counts.

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Introduction:-

Okra (*Abelmoschus esculentus* (L.), Moench) also known as Lady's finger is an important vegetable crop and belongs to family Malvaceae. It is major vegetable being cultivated throughout India particularly in states of Uttar Pradesh, Bihar, Orissa, West Bengal, Andhra Pradesh, Karnataka, Assam, Maharashtra and Gujarat (Anon., 2014). The Okra has prominent position among the vegetables due to its wide adaptability, year round cultivation, export potential and high nutritive value as well as medicinal value. It is good source of vitamin A, B and C and also rich source of proteins and minerals. It is also excellent source of iodine and is useful for the treatment of goiter. It is also good source of fibre hence it is used in prevention of many diseases and disorders (Gopalkrishnan, 2007). Fresh vegetables are inherently perishable, during the process of distribution and marketing a substantial losses are incurred which ranges from a slight loss of quality to total spoilage which can be avoided by giving proper pre-storage treatments such as pre-cooling, packaging, low temperature storage etc. Resistance to water vapour permeability and freedom from undesirable flavour is an important consideration in the choice of suitable packaging materials (Leonard, 1987).

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Major factors affecting storage of fruits and vegetables are environmental factors viz; temperature, relative humidity, composition and proportion of gases in storage and exposure to light. At high temperature okra exhibits high rate of respiration resulting in rapid production of heat and subsequent deterioration. Therefore, it is necessary to find out the suitable packaging material and method of storage for okra during summer months. Hence, the present investigation was undertaken at College of Agriculture, Kolhapur to study the effect of packaging materials and storage conditions on storage behaviour of okra.

Materials and methods:-

Sample preparation:-

The tender, healthy and freshly harvested okra fruits were brought in Postharvest Technology Laboratory of Horticulture Section, College of Agriculture, Kolhapur and were sorted out manually in order to remove damaged, bruised, misshaped over aged and diseased fruits. About 250g of okra fruits were packed in different packaging material under study and stored at ambient temperature, zero energy cool chamber (90-95% RH) and refrigerated storage (RS) 10-13^oC and 85-90% RH.

Bio-chemical analysis:-

Physiological loss in weight of okra was determined by weighing the samples before and after each storage interval and expressed in terms of percentage. The fruit firmness of the okra was measured with the help of firmness tester in terms of kgcm⁻². The ascorbic acid content was estimated by 2, 6-dichlorophenol indophenols-dye and the total chlorophyll content was extracted in 80% acetone and the absorbance at 663 nm and 645 nm was read on spectrophotometer and expressed in terms of mg100g⁻¹(AOAC, 1990).

Microbial Analysis:-

Total yeast and mould count of okra was determined by following the standard procedures described in USFDA (BAM) IS 5401: 2002, 5402: 2002 (Anon, 2011).

Sensorial analysis:-

The sensory evaluation was performed by a panel of seven trained judges for colour, tenderness, appearance and overall acceptability of okra by Amerine, *et al.* (1965) on nine point hedonic scale.

Statistical analysis:-

The data with respect to physico-chemical and sensory parameters was analyzed for the statistical significance according to the procedure given by Panse and Sukhatme (1985).

Results and Discussion:-

Bio-chemical composition of okra:-

Physiological loss in weight (PLW, %):-

The physiological loss in weight of okra was significantly increased with increase in storage period in all 18 treatment combinations as shown in Table 1. At the end of the storage period at ambient temperature i.e. after 3 day of storage, S₁T₄ (400 gauge polyethylene bag with 2% vents) recorded the lowest physiological loss in weight (3.50%) followed by treatment combination S₁T₂ and S₁T₃ (3.61%), whereas the highest physiological loss in weight was recorded in the treatment combination S₁T₅ (3.83%). The similar trend was observed in case of zero energy cool chamber, the treatment S₂T₄ recorded the lowest physiological loss in weight (6.57%) closely followed by S₂T₃ (6.60%) at the end of ninth day storage. Under refrigerated storage conditions, the treatment S₃T₄ i.e. 400 gauge polyethylene with 2% vents registered the minimum physiological loss in weight of 7.50% closely followed by S₃T₃ (7.57%) while the highest physiological loss in weight was registered in S₃T₅ (8.11%) at the end of 15th day of storage. The weight loss was due to uncontrolled water loss and food reserve from tissues of okra due to biochemical activities such as transpiration and respiration (Santi, *et al.*, 1992). The results of present investigation are in close conformity with results reported by Roy and Khurdiya (1986), Negi and Roy (2004), Koraddi (2005) and Reddy, *et al.* (2013) in different vegetables.

Fruit firmness (kgcm⁻²):-

The firmness of okra significantly influenced by different packaging materials and storage conditions (Table 1). It was observed that the firmness was found to be decreased rapidly during storage conditions. The rate of decrease was found to be faster under room temperature as compared to zero energy cool chamber and refrigerated storage. The firmness of okra samples packed in 400 gauge polyethylene bags with 2% vent and stored at refrigerated

storage was found to be 5.13 kgcm⁻² closely followed by the treatment T₃ (5.12 kgcm⁻²) at the end of 15th day of storage while minimum firmness was recorded in S₃T₅ (5.09 kgcm⁻²). At the end of storage period, the treatment S₂T₄ (400 gauge polyethylene with 2% vent) registered the highest firmness (5.18 kgcm⁻²) immediately followed by S₂T₃ (5.17kgcm⁻²) on 9th day of storage under cool chamber. The decrease in firmness of okra might be due to loss in moisture during storage. These results are in accordance with the results reported by Jain, *et al.* (2014) in okra.

Table 1:- Effect of packaging materials and storage conditions on physiological loss in weight (%) and fruit firmness (kgcm⁻²) of okra during storage.

Storage	Physiological Loss in Weight			Fruit Firmness (Initial: 5.29)		
	Storage period (days)					
	3	9	15	3	9	15
S ₁	3.67	-	-	5.23	-	-
S ₂	2.22	6.64	-	5.24	5.16	-
S ₃	1.31	5.34	7.69	5.26	5.22	5.11
SE (m) +	0.03	0.03	-	0.00	0.01	-
CD at 1%	0.11	0.13	-	0.01	0.02	-
Treatments						
T ₁	2.04	6.06	7.67	5.24	5.18	5.10
T ₂	1.96	5.99	7.61	5.25	5.19	5.11
T ₃	1.91	5.93	7.57	5.25	5.20	5.12
T ₄	1.83	5.89	7.50	5.26	5.21	5.13
T ₅	2.08	6.08	8.11	5.23	5.17	5.09
T ₆	7.83	0.00	0.00	5.22	0.00	0.00
SE (m) +	0.04	0.06	-	0.00	0.01	-
CD at 1%	0.15	0.23	-	0.01	0.04	-
Interaction						
S ₁ T ₁	3.78	-	-	5.22	-	-
S ₁ T ₂	3.61	-	-	5.24	-	-
S ₁ T ₃	3.61	-	-	5.24	-	-
S ₁ T ₄	3.50	-	-	5.25	-	-
S ₁ T ₅	3.83	-	-	5.21	-	-
S ₁ T ₆	-	-	-	-	-	-
S ₂ T ₁	2.33	6.72	-	5.24	5.15	-
S ₂ T ₂	2.28	6.64	-	5.24	5.16	-
S ₂ T ₃	2.11	6.60	-	5.25	5.17	-
S ₂ T ₄	2.00	6.57	-	5.25	5.18	-
S ₂ T ₅	2.40	6.67	-	5.23	5.14	-
S ₂ T ₆	-	-	-	-	-	-
S ₃ T ₁	0.00	5.40	7.67	5.26	5.21	5.10
S ₃ T ₂	0.00	5.33	7.61	5.27	5.22	5.11
S ₃ T ₃	0.00	5.25	7.57	5.27	5.23	5.12
S ₃ T ₄	0.00	5.20	7.50	5.27	5.24	5.13
S ₃ T ₅	0.00	5.50	8.11	5.26	5.20	5.09
S ₃ T ₆	7.83	-	-	5.22	-	-
SE (m) +	0.07	0.08	0.13	0.01	0.01	0.01
CD at 1%	0.27	0.33	0.60	0.02	0.05	0.05
‘-‘ indicate termination	T ₁ - 150 gauge polyethylene with 2% vent					
S ₁ -Ambient temperature	T ₂ -200 gauge polyethylene with 2% vent					
S ₂ -Zero Energy Cool Chamber	T ₃ -300 gauge polyethylene with 2% vent					
S ₃ -Refrigerated storage	T ₄ -400 gauge polyethylene with 2% vent					
	T ₅ - Punnet					
	T ₆ - Control					

Total chlorophyll content (mg100g⁻¹):-

The total chlorophyll content of okra was significantly influenced by different packaging material and storage conditions (Table 2). The maximum total chlorophyll content of okra was recorded in refrigerated storage (8.62 mg100g⁻¹) followed by cool chamber (8.25 mg100g⁻¹) and ambient temperature (7.29 mg100g⁻¹) at the end of 3rd day

of storage. Among the treatment combinations the highest total chlorophyll content was recorded in the samples packed in 400 gauge polyethylene bags with 2% vent ($4.20 \text{ mg}100\text{g}^{-1}$) closely followed by S_3T_3 ($4.17 \text{ mg}100\text{g}^{-1}$) at the end of 15th day of storage under refrigerated conditions. The chlorophyll content was decreased with increase in temperature and decrease in humidity. Higher losses of chlorophyll may be due to degradation of chlorophyll which is accelerated by exposure to higher temperature and low humidity. Presence of vents has failed to increase carbon dioxide concentration, thus leading to higher amount of yellowing. The principle cause of the breakdown of chlorophyll is the change in pH mainly due to leakage of organic acids from the vacuole, oxidative system and chlorophyllases (Wills, *et al.*, 1989). The decreasing trend of chlorophyll content with advancement of storage has been reported Abe and Watada, (1991) and Rai, *et al.* (2009) in shredded cabbage.

Table 2:- Effect of packaging materials and storage conditions on total chlorophyll and ascorbic acid contents ($\text{mg}100\text{g}^{-1}$) of okra during storage.

Storage	Total chlorophyll (Initial : 9.89)			Ascorbic acid (Initial : 14.00)		
	Storage period (days)					
	3	9	15	3	9	15
S_1	7.29	-	-	10.38	10.43	-
S_2	8.25	6.83	-	12.54	11.27	-
S_3	8.62	7.60	4.11	13.35	0.07	8.72
SE (m) \pm	0.02	0.00	-	0.02	0.30	-
CD at 1%	0.05	0.01	-	0.07		-
Treatments					10.84	
T_1	8.14	7.21	4.07	12.04	10.85	8.64
T_2	8.15	7.23	4.10	12.15	10.87	8.73
T_3	8.19	7.24	4.17	12.28	10.88	8.80
T_4	8.17	7.24	4.20	12.36	10.82	8.85
T_5	8.01	7.16	4.00	11.95	0.00	8.56
T_6	7.49	0.00	0.00	12.35	0.10	0.00
SE (m) \pm	0.03	0.00	-	0.02	0.43	-
CD at 1%	0.08	0.01	-	0.10		-
Interaction					-	
S_1T_1	7.37	-	-	10.25	-	-
S_1T_2	7.37	-	-	10.38	-	-
S_1T_3	7.40	-	-	10.54	-	-
S_1T_4	7.33	-	-	10.58	-	-
S_1T_5	7.00	-	-	10.13	-	-
S_1T_6	-	-	-	-	10.41	-
S_2T_1	8.22	6.81	-	12.43	10.43	-
S_2T_2	8.25	6.83	-	12.48	10.46	-
S_2T_3	8.30	6.84	-	12.66	10.48	-
S_2T_4	8.30	6.84	-	12.78	10.38	-
S_2T_5	8.20	6.80	-	12.35	-	-
S_2T_6	-	-	-	-	11.26	-
S_3T_1	8.84	7.60	4.07	13.43	11.27	8.64
S_3T_2	8.85	7.62	4.10	13.59	11.28	8.73
S_3T_3	8.87	7.63	4.17	13.66	11.28	8.80
S_3T_4	8.87	7.64	4.20	13.72	11.26	8.85
S_3T_5	8.83	7.52	4.00	13.35	-	8.56
S_3T_6	7.49	-	-	12.35	0.17	-
SE (m) \pm	0.05	0.01	0.02	0.04	0.74	0.02
CD at 1%	0.13	0.02	0.06	0.17		0.08
‘-’ indicate termination			T_1 - 150 gauge polyethylene with 2% vent			
S_1 -Ambient temperature			T_2 -200 gauge polyethylene with 2% vent			
S_2 -Zero Energy Cool Chamber			T_3 -300 gauge polyethylene with 2% vent			
S_3 -Refrigerated storage			T_4 -400 gauge polyethylene with 2% vent			
			T_5 - Punnet			
			T_6 - Control			

Ascorbic acid content (mg100g⁻¹):-

The ascorbic acid content of okra fruit was found to be decreased significantly with increase in storage period irrespective of packaging materials and storage conditions (Table 2). However, the rate of decrease was found to be faster under room temperature as compared to zero energy cool chamber and refrigerated storage. At the end of ninth day of storage under cool chamber, the highest ascorbic acid content was noticed in the treatment S₂T₃ (10.48 mg100g⁻¹) which was at par with the remaining treatments. The treatment combination S₃T₄ (400 gauge polyethylene with 2% vent) recorded the highest ascorbic acid 8.85mg100g⁻¹ followed by S₃T₃ (8.80 mg 100g⁻¹) while minimum ascorbic acid was noticed in S₃T₅ i.e. punnets (8.56 mg100g⁻¹). The chief reason for the loss in ascorbic acid was the solubility in water, thermal destruction and enzymatic oxidation during storage (Selmon, 1994). The ascorbic acid content of okra decreased gradually with increase in storage period as reported by Rani, *et al.* (2015), Sreeramulu, *et al.* (1983) in leafy vegetables; Jagtap (1986) in fenugreek and spinach; Yadav and Sehgal (1997) in fenugreek; Waskar, *et al.* (1999) in bottle gourd and Negi and Roy (2004) in amaranthus and fenugreek.

Total yeast and mould count (log cfu g⁻¹):-

The effect of packaging materials and storage conditions on total yeast and mould count of okra was found to be non-significant. However, the gradual increase was noticed in total yeast and mould count of okra with the advancement of storage period (Table 3). During storage period, the maximum total yeast and mould count was recorded in the samples stored at ambient temperature (4.85 log cfu g⁻¹) followed by cool chamber (4.79 log cfu g⁻¹) and refrigerated storage (4.74 log cfu g⁻¹). At the end of 15th day storage under refrigerated conditions, the maximum total yeast and mould count was noticed in the treatment S₃T₅ (4.90 log cfu g⁻¹) followed by S₃T₁ (4.86 log cfu g⁻¹) whereas the minimum count recorded in S₃T₆ (4.79 log cfu g⁻¹). These results are in agreement with the findings of Ngure, *et al.* (2009) who reported that okra samples stored in polyethylene recorded low yeast and mould count but very high bacteria counts. This could be because of high moisture content (high water activity level) which gave room for more bacterial growth than yeast and mould count. Babarinda and Fabunmi (2009) who concluded that the high microbial load in these samples could be due to high heat of respiration in the polyethylene bag at the early period of storage.

Table 3:- Effect of packaging materials and storage condition on total yeast and mould count of okra (log cfu g⁻¹)

Particulars	Total yeast and mould count		
	Initial day	Final day count	Storage life
Storage conditions			
S ₁	3.72	4.85	3
S ₂	3.72	4.79	9
S ₃	3.72	4.74	15
SE (m) ±	-	0.01	-
CD at 1%	-	0.05	-
Treatment			
T ₁	3.72	4.82	15
T ₂	3.72	4.81	15
T ₃	3.72	4.79	15
T ₄	3.72	4.78	15
T ₅	3.72	4.85	15
T ₆	3.72	4.70	15
SE (m) ±	-	0.02	-
CD at 1%	-	0.06	-
Interaction			
S ₁ T ₁	3.72	4.79	3
S ₁ T ₂	3.72	4.76	3
S ₁ T ₃	3.72	4.75	3
S ₁ T ₄	3.72	4.74	3
S ₁ T ₅	3.72	4.79	3
S ₁ T ₆	3.72	4.64	1
S ₂ T ₁	3.72	4.81	9
S ₂ T ₂	3.72	4.80	9
S ₂ T ₃	3.72	4.79	9
S ₂ T ₄	3.72	4.77	9

S ₂ T ₅	3.72	4.87	9
S ₂ T ₆	3.72	4.67	2
S ₃ T ₁	3.72	4.86	15
S ₃ T ₂	3.72	4.86	15
S ₃ T ₃	3.72	4.84	15
S ₃ T ₄	3.72	4.83	15
S ₃ T ₅	3.72	4.90	15
S ₃ T ₆	3.72	4.79	3
SE (m) ±	-	0.03	-
CD at 1%	-	NS	-
‘-‘ indicate termination	T ₁ - 150 gauge polyethylene with 2% vent		
S ₁ -Ambient temperature	T ₂ -200 gauge polyethylene with 2% vent		
S ₂ -Zero Energy Cool Chamber	T ₃ -300 gauge polyethylene with 2% vent		
S ₃ -Refrigerated storage	T ₄ -400 gauge polyethylene with 2% vent		
	T ₅ - Punnet		
	T ₆ - Control		

Organoleptic evaluation:-

The organoleptic score of okra as influenced by different packaging materials and storage conditions revealed that, the decrease in organoleptic score for colour, tenderness, appearance and overall acceptability was rapid at room temperature as compared to zero energy cool chamber and refrigerated storage (Table 4 and 5).

Table 4:- Effect of packaging materials and storage conditions on colour and tenderness of okra during storage

Storage	Colour				Tenderness			
	Storage period in days				Storage period in days			
	0	3	9	15	0	3	9	15
S ₁	8.94	6.68	-	15	8.94	7.24	-	-
S ₂	8.94	7.76	6.51	-	8.94	7.71	6.95	-
S ₃	8.94	8.48	7.60	-	8.94	8.56	7.36	6.26
Treatments				6.49				
T ₁	9.00	7.66	7.07		9.00	7.89	7.13	6.25
T ₂	9.00	7.71	7.14	6.48	9.00	7.89	7.20	6.26
T ₃	9.00	7.77	7.17	6.50	9.00	7.89	7.22	6.28
T ₄	9.00	7.79	7.24	6.51	9.00	7.96	7.31	6.28
T ₅	9.00	7.50	6.65	6.51	9.00	7.78	6.90	6.23
T ₆	8.67	7.78	0.00	6.47	8.67	7.89	0.00	0.00
Interaction				0.00				
S ₁ T ₁	9.00	6.63	-		9.00	7.22	-	-
S ₁ T ₂	9.00	6.70	-	-	9.00	7.33	-	-
S ₁ T ₃	9.00	6.77	-	-	9.00	7.33	-	-
S ₁ T ₄	9.00	6.80	-	-	9.00	7.22	-	-
S ₁ T ₅	9.00	6.50	-	-	9.00	7.11	-	-
S ₁ T ₆	8.67	-	-	-	8.67	-	-	-
S ₂ T ₁	9.00	7.67	6.47	-	9.00	7.78	6.93	-
S ₂ T ₂	9.00	7.78	6.50	-	9.00	7.67	6.96	-
S ₂ T ₃	9.00	7.89	6.57	-	9.00	7.67	7.00	-
S ₂ T ₄	9.00	7.89	6.60	-	9.00	8.00	7.07	-
S ₂ T ₅	9.00	7.56	6.42	-	9.00	7.44	6.80	-
S ₂ T ₆	8.67	-	-	-	8.67	-	-	-
S ₃ T ₁	9.00	8.67	7.67	-	9.00	8.67	7.33	6.25
S ₃ T ₂	9.00	8.67	7.78	6.48	9.00	8.67	7.44	6.26
S ₃ T ₃	9.00	8.67	7.78	6.50	9.00	8.67	7.44	6.28
S ₃ T ₄	9.00	8.67	7.89	6.51	9.00	8.67	7.56	6.28
S ₃ T ₅	9.00	8.44	6.89	6.51	9.00	8.78	7.00	6.23

S ₃ T ₆	8.67	7.78	-	6.47	8.67	7.89	-	-
				-				
‘-‘ indicate termination				T ₁ - 150 gauge polyethylene with 2% vent				
S ₁ -Ambient temperature				T ₂ -200 gauge polyethylene with 2% vent				
S ₂ -Zero Energy Cool Chamber				T ₃ -300 gauge polyethylene with 2% vent				
S ₃ -Refrigerated storage				T ₄ -400 gauge polyethylene with 2% vent				
				T ₅ - Punnet				
				T ₆ - Control				

Table 5:- Effect of packaging materials and storage conditions on appearance and overall acceptability of okra during storage

Storage	Appearance				Overall acceptability			
	Storage period in days				Storage period in days			
	0	3	9	15	0	3	9	15
S ₁	8.94	6.91	-	-	8.67	7.11	-	-
S ₂	8.94	7.78	6.75	-	8.67	7.62	6.17	-
S ₃	8.94	8.77	7.49	6.33	8.67	8.06	7.58	6.18
Treatments								
T ₁	9.00	7.74	7.03	6.31	8.67	7.63	6.80	6.17
T ₂	9.00	7.79	7.15	6.33	8.67	7.70	6.87	6.18
T ₃	9.00	7.90	7.23	6.34	8.67	7.78	6.94	6.18
T ₄	9.00	7.98	7.34	6.35	8.67	7.81	7.05	6.20
T ₅	9.00	7.78	6.83	6.30	8.67	7.52	6.71	6.17
T ₆	8.67	8.50	0.00	0.00	8.67	6.67	0.00	0.00
Interaction								
S ₁ T ₁	9.00	6.90	-	-	8.67	7.00	-	-
S ₁ T ₂	9.00	6.92	-	-	8.67	7.11	-	-
S ₁ T ₃	9.00	6.92	-	-	8.67	7.22	-	-
S ₁ T ₄	9.00	6.93	-	-	8.67	7.33	-	-
S ₁ T ₅	9.00	6.88	-	-	8.67	6.89	-	-
S ₁ T ₆	8.67	-	-	-	8.67	-	-	-
S ₂ T ₁	9.00	7.67	6.73	-	8.67	7.56	6.15	-
S ₂ T ₂	9.00	7.78	6.75	-	8.67	7.67	6.19	-
S ₂ T ₃	9.00	7.89	6.78	-	8.67	7.78	6.20	-
S ₂ T ₄	9.00	8.00	6.80	-	8.67	7.78	6.21	-
S ₂ T ₅	9.00	7.56	6.67	-	8.67	7.33	6.09	-
S ₂ T ₆	8.67	-	-	-	8.67	-	-	-
S ₃ T ₁	9.00	8.67	7.33	6.31	8.67	8.33	7.44	6.17
S ₃ T ₂	9.00	8.67	7.56	6.33	8.67	8.33	7.56	6.18
S ₃ T ₃	9.00	8.89	7.67	6.34	8.67	8.33	7.67	6.18
S ₃ T ₄	9.00	9.00	7.89	6.35	8.67	8.33	7.89	6.20
S ₃ T ₅	9.00	8.89	7.00	6.30	8.67	8.33	7.33	6.17
S ₃ T ₆	8.67	8.50	-	-	8.67	6.67	-	-
‘-‘ indicate termination				T ₁ - 150 gauge polyethylene with 2% vent				
S ₁ -Ambient temperature				T ₂ -200 gauge polyethylene with 2% vent				
S ₂ -Zero Energy Cool Chamber				T ₃ -300 gauge polyethylene with 2% vent				
S ₃ -Refrigerated storage				T ₄ -400 gauge polyethylene with 2% vent				
				T ₅ - Punnet				
				T ₆ - Control				

The okra fruits packed in 400 gauge polyethylene with 2% vents and stored in refrigerated storage recorded the highest score for colour (6.51), tenderness, (6.28) appearance (6.35) and overall acceptability (6.20) at the end of 15th day storage followed by S₃T₃ i. e. 300 gauge polyethylene with 2% vents. The rapid loss of texture of fruits and vegetables attributed to their exposure to atmospheric gases with resultant fading out of their greenish colour. The

physical damage increases respiration and ethylene production with associated increases in the rate of other reactions responsible for biochemical changes in colour, texture and nutritional quality. The effect of carbon dioxide and chlorophyll retention was attributed to inhibition of ethylene production and low water activity (Martinez and Whitaker, 1995). The results of present study are in close conformity with the results reported by Jagtap (1986) in spinach and Ngure et al. (2009) in okra. Refrigerated storage found to be effective in maintaining the colour and appearance, texture, quality throughout the storage period and maximum overall acceptability might be due to low temperature during storage which led to reduced minimum moisture and physiological loss in weight. The present findings are in agreement with the results reported by Kim et al. (2004) in salad savoy and Komolafe and Idah (2008) in okra.

From the present study it can be concluded that, the shelf life of okra was found to be increased up to three days at room temperature, nine days at zero energy cool chamber and fifteen days at refrigerated storage when the samples packed in 400 gauge polyethylene bags with 2% vents which helps in better retention of quality parameters. There was a reduction in microbial count under refrigerated samples as compared with the ambient temperature. A gradual decrease was observed in organoleptic score for colour, tenderness, appearance and overall acceptability during storage of okra.

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