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Effect of different treatments and packaging materials on biochemical changes during storage of kagzi lime

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The experiment was conducted at Post Harvest Technology Scheme, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment deals with the storage of kagzi lime in perforated polyethylene and non-perforated polypropylene bags of 100, 200 and 300 gauges and with different treatments *viz*., chemicals and wax emulsion. The fruits stored in 200 gauged perforated polypropylene bags recorded minimum pH, TSS, brix/acid ratio and maximum content of acidity and ascorbic acid at the end of 70 days in cold storage condition. Among different chemicals and wax emulsion, waxol 6%+ captan 0.1% recorded minimum pH, TSS, brix/acid ratio and maximum content of acidity and ascorbic acid at the end of 30 days in case of CS and 20 days in cold storage. However, ,it revealed that, fruits packed in 200 gauged perforated polypropylene and polyethylene bags exhibited shelf life upto 70 by slowed down biochemical changes.

Key words : Total soluble solids, Acidity, Ascorbic acid, Wax emulsion and spoilage, Kagziline, Storage.

INTRODUCTION

Citrus fruits are among the most important fruit crop in the sub tropical regions. In India, the commercially important species are mandarin (*Citrus reticulata* Blanco), Sweet orange [*Citrus Sinesis* (L) Osb] and lemon and lime (*Citrus limon* Burm. f. and *Citrus aurantifolia* Swingle). Locally acid lime is termed as "Kagzi Nimboo" (*Citrus aurantifolia* Swingle). It is one of the most important commercial fruit crops of citrus industry. In India total area under kagzi lime occupies about 1.68 lakh ha with production of 15.42 lakh tonnes contributing 3.1 per cent of total fruit production. In Maharashtra total area under kagzi lime occupies about 0.34 lakh ha with production of 1.77 lakh tonnes (Anonymous, 2005). Thus, it is indicated that Kagzi lime is one of the economically important fruit crop of Vidarbha region, next to mandarin. The fruits become ready for harvesting during June to September and November December in Vidarbha region. But due to glut in the market, farmers fetch less price. In order to have good return and to avoid market glut of Kagzi lime fruits, it becomes essential to store the fruits for a considerable period to prolong the marketing period that will ultimately insure the availability of the fruits to the consumers. The present investigation was undertaken to find out solution to prolong post harvest life of Kagzi lime fruits by storing them in perforated and non perforated polyethylene; polypropylene bags and treated with some chemicals and wax emulsion. The present study also deals with experimentation for enhancement of shelf life of kagzi lime by using various treatments.

MATERIALS AND METHODS

The experiment was conducted at Post Harvest Technology Scheme, Dr.PDKV Akola. The experiment storage in cold storage consisting of 22 treatments. The fruits of kagzi lime were obtained in the month of January 2004 from the farmers' field. Matured fruits of uniform green colour, uniform size, and free from blemishes were used for the experiment. Fruits affected with sunburn, bruised, oversized or damaged were discarded. The fruits after washing in fresh tap water were kept for storage in perforated and non-perforated polyethylene and polypropylene bags of 100, 200, 300 gauges. The fruits stored openly treated with different chemicals and wax emulsion *viz*. Nacl (2 %), $KMnO_4$ (100 ppm), carbendazim (500 ppm), Turmeric leaf oil (1%), castor oil (1%), waxol (6 %) + captan (0.1%), waxol (6 %) + NaCl (2%), GA_3 (500 ppm) and coconut water. After dipping in different chemicals and wax emulsions, the fruits were kept in open for storage in cold storage. The fruits were kept as control without giving any treatment in both the storage conditions. The samples from each treatment were drawn for regular observation at 10 days interval.

The experiment consisting of 22 treatments replicated thrice was laid in analysis of variance technique -one way

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classification. Periodical analysis was done at 10 days interval for bio-chemical analysis of fruits. To determine pH, T.S.S. titratable acidity and ascorbic acid. The fruits were peeled and their juice was extracted. Juice was filtered with muslin cloth and mixed properly. The pH of fruits juice was determined by using pH meter and the total soluble solids (TSS) were determined by using hand refractometer.

The per cent titratable acidity was determined by titrating the diluted fruit juice with N/10 NaOH using phenolphthalein as an indicator. Ascorbic acid was determined by 2, 6- dichlorophenol indophenol dye as described. The treatment details are as under.

Packaging materials	Chemicals and wax emulsion
Polyethylene	NaCl 2 %
Polypropylene	$KMnO_4$ 100 ppm
Perforated	Carbendazim 500 ppm
Non-perforated	Turmeric leaf oil (TLO)1 %
Gauges	Castor oil 1 %
100	Waxol 6 % + captan 0.1 %
	Waxol 6 % + NaCl 2 %
200	GA_3 500 ppm
300	Coconut water
	Control

RESULTS AND DISCUSSION

The data depicted in Table 1 indicate the pH of Kagzi lime. The pH value of kagzi lime fruits were increased as the storage period advanced. However, minimum pH value was recorded in fruits stored in 200 gauged perforated polypropylene bags at all the storage intervals except that the fruits treated with Waxol 6 % + captan 0.1 % recorded minimum pH value at the end of 20 days. At the end of storage period *i.e.* 70 days, minimum pH value *viz*., 3.96 recorded in 200 gauged perforated polypropylene bags. As far as storage life of kagzi lime is concerned, minimum pH might be beneficial because of lesser the pH, higher the acidity of the fruits. Among the fruits treated with chemicals and wax emulsion, waxol 6 % + captan 0.1 % treated fruits significantly showed less pH value of fruit juice. Similar increased trend in pH was also reported by Yadav *et al.* (2006) in Nagpur mandarin.

The data presented in Table 2 indicates the total soluble solids. The TSS was increased with the enhancement of storage time. At the end of 30 days in cold storage, significantly minimum TSS was recorded by fruits stored in 200 gauged perforated polypropylene bags (6.63 ^{o}brix) and fruits treated with waxol 6% + captan 0.1% (6.7 ^{o}brix). At the end of storage period lesser TSS

Table 1 : Effect of packaging materials, chemical treatment and wax emulsion on pH of kagzi lime

Treatment	pH / Storage period (days)						
	10	20	30	40	50	60	70
100 G - PE - NP	3.70	3.81	3.93	4.05	4.15	-	-
200 G - PE - NP	3.40	3.49	3.65	3.81	3.96	4.04	-
300 G – PE - NP	3.78	3.85	4.01	4.14	-	-	-
100 G - PP - NP	3.62	3.69	3.83	3.95	4.07	-	-
200 G – PP- NP	3.32	3.43	3.58	3.70	3.85	3.91	-
300 G - PP - NP	3.75	3.79	3.93	4.08	-	-	-
100 G - PE -P	3.68	3.75	3.88	4.03	4.14	-	-
200 G – PE - P	3.38	3.42	3.56	3.68	3.89	3.96	4.05
300 G – PE - P	3.75	3.83	3.97	4.11	-	-	-
100 G - PP - P	3.50	3.60	3.74	3.88	3.99	-	-
200 G - PP - P	3.17	3.32	3.45	3.58	3.79	3.87	3.96
300 G - PP - P	3.73	3.80	3.96	4.09	-	-	-
NaCl at 2%	3.25	3.31	3.53	-	-	-	-
$KMnO_4$ 100 ppm	3.23	3.40	3.55	-	-	-	-
Carbendazim 500 ppm	3.30	3.39	3.60	-	-	-	-
TLO 1%	3.35	3.43	3.64	-	-	-	-
Castor oil 1%	3.40	3.45	3.70	-	-	-	-
Waxol 6% + captan 0.1%	3.22	3.30	3.50	-	-	-	-
Waxo l 6% + NaCl 2%	3.32	3.43	3.56	-	-	-	-
GA_3 500 ppm	3.37	3.57	3.60	-	-	-	-
Coconut water	3.40	3.59	3.62	-	-	-	-
Control	3.47	3.63	3.64	-	-	-	-
S.E. $\pm$	0.02	0.02	0.01	-	-	-	-
S.E. (D)	0.03	0.03	0.02	-	-	-	-
C.D. (P=0.05)	0.06	0.06	0.05	-	-	-	-

Initial value: 3.15
PE – Polyethylene, PP – Polypropylene, NP – Non-perforated, P – Perforated, G- Gauge, TLO – Turmeric leaf oil.

was registered in fruits stored 200gauged perforated polypropylene bag followed by 200gauged perforated polyethylene bags. Lower T.S.S. recorded in cold storage was might be due lower temperature possibly reduced the activity of the degradative enzymes responsible for ripening thereby reducing the T.S.S. As regard to chemical treatment and wax emulsion, waxol 6 % + captan 0.1 % and waxol 6 % + NaCl 2 % registered to the tune of 6.7 and 6.73 °brix, respectively as compared to other treatments. The higher TSS in untreated fruits may be due to greater water loss in these fruits. The increase in TSS during storage time were reported by Yadav *et al.* (2006) in Nagpur mandarin, Dhillon *et al.*, 1977 in kinnow mandarin, Ghosh and Sen (1984) in lime and Rana and Singh (1993) in sweet oranges.

The data depicted in Table 3 revealed that the acidity was decreased with storage time. At the end of storage time, 200 gauged perforated polypropylene bags registered highest acidity followed by fruits packed in 200 gauged perforated polyethylene bags. Among the

Table 2 : Effect of packaging materials, chemical treatment and wax emulsion on total soluble solids (^{0} brix) of Kagzi lime

Treatment	TSS / Storage period (days)						
	10	20	30	40	50	60	70
100 G PE NP	6.9	6.9	6.93	7.00	7.066	-	-
200 G PE NP	6.7	6.76	6.8	6.86	6.96	7.0	-
300 G PE NP	7.06	6.96	7.03	7.066	-	-	-
100 G PP NP	6.8	6.86	6.86	6.9	7.1	-	-
200 G PP NP	6.6	6.7	6.73	6.76	6.83	6.86	-
300 G PP NP	6.96	6.93	7.0	7.06	-	-	-
100 G PE P	6.86	6.86	6.9	6.96	7.03	-	-
200 G PE P	6.66	6.73	6.76	6.86	6.93	6.96	7.0
300 G PE P	7.00	6.96	7.03	7.13	-	-	-
100 G PP P	6.76	6.80	6.83	6.86	6.9	-	-
200 G PP P	6.51	6.66	6.63	6.66	6.73	6.80	6.90
300 G PP P	6.93	6.9	6.96	7.03	-	-	-
NaCl at 2 %	6.66	6.73	6.76	-	-	-	-
$KMnO_4$ 100 ppm	6.60	6.7	6.76	-	-	-	-
Carbendazim 500 ppm	6.66	6.8	6.83	-	-	-	-
TLO 1 %	6.7	6.83	6.86	-	-	-	-
Castor oil 1%	6.76	6.86	6.9	-	-	-	-
Waxol 6%+Captan 0.1%	6.53	6.7	6.7	-	-	-	-
Waxol 6%+NaCl 2%	6.60	6.7	6.73	-	-	-	-
GA_3 500 ppm	6.65	6.8	6.86	-	-	-	-
Coconut water	6.7	6.83	6.96	-	-	-	-
Control	6.73	6.93	7.03	-	-	-	-
S.E. $\pm$	0.024	0.035	0.031	-	-	-	-
S.E. (D)	0.034	0.036	0.044	-	-	-	-
C.D. (P=0.05)	0.068	0.072	0.089	-	-	-	-

Initial value: 6.45 (^{0} brix)
PE – Polyethylene, PP – Polypropylene, NP – Non-perforated, P – Perforated, G- Gauge, TLO – Turmeric leaf oil.

Table 3 : Effect of packaging materials, chemical treatment and wax emulsion on per cent acidity of Kagzi lime

Treatment	Per cent acidity / Storage period (days)						
	10	20	30	40	50	60	70
PE 100 G NP	7.19	7.17	7.15	7.10	7.04	-	-
PE 200 G NP	7.30	7.28	7.26	7.21	7.15	7.09	-
PE 300 G NP	7.12	7.12	7.10	7.04	-	-	-
PP 100 G NP	7.269	7.250	7.232	7.156	7.10	-	-
PP 200 G NP	7.345	7.326	7.307	7.269	7.212	7.138	-
PP 300 G NP	7.156	7.138	7.120	7.081	-	-	-
PE 100 G P	7.232	7.213	7.194	7.138	7.081	-	-
PE 200 G P	7.326	7.326	7.307	7.25	7.194	7.12	7.024
PE 300 G P	7.138	7.12	7.1	7.062	-	-	-
PP 100 G P	7.288	7.26	7.25	7.213	7.156	-	-
PP 200 G P	7.363	7.345	7.326	7.288	7.25	7.194	7.12
PP 300 G P	7.175	7.156	7.138	7.12	-	-	-
NaCl at 2 %	7.288	7.269	7.25	-	-	-	-
$KMnO_4$ 100 ppm	7.326	7.307	7.288	-	-	-	-
Carbendazim 500 ppm	7.250	7.232	7.213	-	-	-	-
TLO 1 %	7.194	7.175	7.156	-	-	-	-
Castor oil 1 %	7.232	7.213	7.194	-	-	-	-
Waxol 6%+ Captan 0.1%	7.362	7.345	7.326	-	-	-	-
Waxol 6 % + NaCl 2 %	7.344	7.326	7.288	-	-	-	-
GA_3 500 ppm	7.175	7.156	7.12	-	-	-	-
Coconut water	7.138	7.12	7.081	-	-	-	-
Control	7.12	7.081	7.024	-	-	-	-
S.E. $\pm$	0.016	0.014	0.017	-	-	-	-
S.E. (D)	0.022	0.020	0.025	-	-	-	-
C.D. (P=0.05)	0.045	0.042	0.053	-	-	-	-

Initial value: 7.46 %
PE – Polyethylene, PP – Polypropylene, NP – Non-perforated, P – Perforated, G- Gauge, TLO– Turmeric leaf oil.

chemicals and wax emulsion, fruits treated with waxol 6 % + captan 0.1 %, recorded 7.326 % acidity followed by fruits treated with waxol 6 % + NaCl 2 % *viz*. 7.288 % than other treatments. The acidity was decreased during storage time, may be due to conversion of acids to sugars. Among the chemicals and waxol, fruits treated with waxol showed higher per cent of acidity was might be due to slow or decrease in respiratory process. Due to low availability of oxygen in wax-coated fruits, the organic acid involve in the respiratory process, is not oxidized. These findings are in general agreement with the results of Tarkase and Desai (1989) in oranges and Dhilon *et al.* (1977) in kinnow mandarins.

The brix/acid ratio was increased with the increase in storage period (Table 4). Minimum brix/acid ratio was recorded by fruits stored in 200-gauged perforated polypropylene bags. At the end of storage in cold storage, minimum brix/acid ratio was maintained by fruits stored in 200 gauged perforated polypropylene bags followed by 200 gauged perforated polyethylene bags. The ratio was increased with the increase in storage period may be due to increase in TSS and decrease in acidity in respective treatments.

The ascorbic acid due to various treatments during storage period was decreased regularly (Table 5). Among packaging treatments in cold storage condition, fruits stored in 200 gauged perforated polypropylene bags recorded 31.23, 31.07 and 30.91 mg/100 ml ascorbic acid at the end of 10, 20 and 30 days, respectively. Among chemicals, waxol 6 % + captan 0.1 % and waxol 6 % + NaCl 2 % recorded substantial amount of ascorbic acid at all the storage intervals. At the end of 70 days, the fruits stored in 200-gauged perforated polypropylene bags recorded ascorbic acid to the tune of 29.17 mg/100 ml. The higher ascorbic acid retained in polyethylene and polypropylene bags and fruits treated with chemicals and

Table 4 : Effect of packaging materials, chemical treatment and wax emulsion on brix /acid ratio of kagzi lime

Treatment	Brix/acid ratio/Storage period (days)						
	10	20	30	40	50	60	70
PE 100 G NP	0.958	0.961	0.968	0.985	1.003	-	-
PE 200 G NP	0.916	0.928	0.935	0.951	0.973	0.985	-
PE 300 G NP	0.992	0.978	0.990	0.998	-	-	-
PP 100 G NP	0.935	0.947	0.949	0.963	0.999	-	-
PP 200 G NP	0.898	0.914	0.921	0.93	0.947	0.961	-
PP 300 G NP	0.973	0.971	0.983	0.947	-	-	-
PE 100 G P	0.949	0.951	0.958	0.975	0.993	-	-
PE 200 G P	0.909	0.919	0.926	0.947	0.963	0.978	0.996
PE 300 G P	0.980	0.978	0.972	1.009	-	-	-
PP 100 G P	0.928	0.935	0.942	0.951	0.963	-	-
PP 200 G P	0.884	0.907	0.905	0.914	0.928	0.944	0.969
PP 300 G P	0.965	0.963	0.975	0.987	-	-	-
NaCl at 2 %	0.914	0.925	0.933	-	-	-	-
$KMnO_4$ 100 ppm	0.900	0.916	0.928	-	-	-	-
Carbendazim 500 ppm	0.919	0.94	0.947	-	-	-	-
TLO 1 %	0.930	0.951	0.958	-	-	-	-
Castor oil 1 %	0.935	0.951	0.958	-	-	-	-
Waxol 6 % + Captan 0.1 %	0.886	0.912	0.914	-	-	-	-
Waxol 6 % + NaCl 2 %	0.898	0.914	0.923	-	-	-	-
GA_3 500 ppm	0.925	0.949	0.964	-	-	-	-
Coconut water	0.938	0.959	0.983	-	-	-	-
Control	0.945	0.979	1.001	-	-	-	-
S.E. ±	.0043	.0043	.0076	-	-	-	-
S.E. (D)	.0060	.0060	0.010	-	-	-	-
C.D. (P=0.05)	0.012	0.012	0.021	-	-	-	-

Initial value 0.864
PE – Polyethylene, PP – Polypropylene, NP – Non-perforated,
P – Perforated, G- Gauge, TLO – Turmeric leaf oil.

Table 5 : Effect of packaging materials, chemical treatment and wax emulsion on ascorbic acid (mg/100 ml) of kagzi lime

Treatment	Ascorbic acid / Storage period (days)						
	10	20	30	40	50	60	70
PE 100 G NP	29.94	29.78	29.62	29.14	28.49	-	-
PE 200 G NP	30.59	30.43	30.10	29.78	29.3	28.66	-
PE 300 G NP	28.98	28.82	28.66	28.17	-	-	-
PP 100 G NP	30.26	30.10	29.94	29.30	28.66	-	-
PP 200 G NP	31.07	30.91	30.59	30.26	29.78	28.98	-
PP 300 G NP	29.46	29.14	28.82	28.33	-	-	-
PE 100 G P	30.10	29.78	29.62	29.30	28.65	-	-
PE 200 G P	30.75	30.59	30.26	29.94	29.46	29.3	28.82
PE 300 G P	29.14	28.82	28.66	28.17	-	-	-
PP 100 G P	30.43	30.10	29.78	29.46	28.82	-	-
PP 200 G P	31.23	31.07	30.91	30.59	30.10	29.62	29.17
PP 300 G P	29.62	29.46	29.14	28.66	-	-	-
NaCl at 2 %	30.75	30.43	30.10	-	-	-	-
$KMnO_4$ 100 ppm	30.91	30.59	30.26	-	-	-	-
Carbendazim 500 ppm	30.59	30.42	30.10	-	-	-	-
TLO 1 %	30.10	29.78	29.62	-	-	-	-
Castor oil 1 %	30.43	30.10	29.62	-	-	-	-
Waxol 6 % + Captan 0.1 %	31.07	30.75	30.42	-	-	-	-
Waxol 6 % + NaCl 2 %	31.09	30.91	30.42	-	-	-	-
GA_3 500 ppm	29.94	29.62	29.30	-	-	-	-
Coconut water	29.78	29.62	29.30	-	-	-	-
Control	29.62	29.3	28.98	-	-	-	-
S.E. ±	0.113	0.141	0.161	-	-	-	-
S.E. (D)	0.160	0.199	0.228	-	-	-	-
C.D. (P=0.05)	0.319	0.396	0.453	-	-	-	-

Initial value: 31.39(mg/100 ml)
PE – Polyethylene, PP – Polypropylene, NP – Non-perforated,
P – Perforated, G- Gauge, TLO – Turmeric leaf oil.

wax emulsion as compared to control and other treatment was might be due to retarded oxidation processes in these treatments and thereby lowering down the rate of conversion of ascorbic acid to the hydro-ascorbic acid. The results are in conformity with the findings of Tarkase and Desai (1989) in oranges, Rana and Singh (1992) in sweet oranges, Singh *et al*. (1978) in kinnow fruits recorded highest ascorbic acid in waxol treated fruits as compared to kinnow fruits treated with surf, mustard oil and ground nut oil.

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