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RESEARCH PAPER

Effect of various pre and post harvest treatment as a ripening technique for oranges

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SUMMARY : Fruits of oranges free from any external and internal disorders harvested at physiological green mature stage were utilized for studying its ripening behaviour .Initially fruits were treated with Neem oil (1%) in order to break any pest attack and the treatments were given as foliar spray. Freshly harvested fruits were divided into different lots .The first lot of fruit was treated with ethylene gas as they were exposed to ethylene gas (150 ppm) for 24 h in ripening chamber. Similarly another lot was treated with various concentrations of ethephon (250, 500, 750, 1000 ppm) primarily in aqueous solution each for 5 min. Immediately after above referred treatments, the treated fruits were packed in sanitized plastic crates and stored in ripening chamber in which temperature and RH were maintained at 20-25^{0}C and 85-95 per cent, respectively. Treatment with ethylene gas (150 ppm) or ethephon (750 ppm) resulted in adequate ripening of fruits after 28 days with most acceptable quality attributes such as flavour , uniform colour, acceptable firmness and extended shelf-life. On the other hand the untreated lots of fruits were poor in quality attributes. It was observed that timely adopting ripening techniques with ethylene gas or ethephon are better in reducing various postharvest decay and losses and strengthening the economy of farmers all over oranges producing states of the countries.

Key Words : Oranges, Pre-harvest treatments**,** Ripening techniques, . Ethylene gas, Ethephon, Overall quality, Shelf-life

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Oranges are one of the most important fruit crop of tropical and subtropical India and world. Punjab ,UP, Maharashtra Tamil Nadu, Andhra Pradesh , and Gujrat are major states of India where oranges are produced in plenty. In India oranges are produced in an area of 515 thousand hectares with an annual production of 19.21 million tones (Annonymous, 2010). In India, oranges cultivation has resulted in better economy to growers as a result of which both acre and production has increased from the last three four years. At present to further enhance the production and quality of oranges in India an appropriate ripening techniques is urgently required to eliminate the traditional ripening method in which ripening is done through calcium carbide and the use of this chemical is prohibited due to its carcinogenic nature (PFA, 2003). Therefore, the present Investigation was done to study the ripening techniques by using ethephon and ethylene as an alternate measure for improving the ripening of oranges fruits, so that the quality fruits with uniform ripening are made available to consumers throughout the years .

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EXPERIMENTAL METHODS

The fruits of oranges were harvested at slightly green mature stage and most appropriately when the stiffness on fruit surface starts disappearing.. The fruits selected were free from any bruising and abrasion damage and were kept in easy free manner so that the abrasion can be avoided. As far as treatment is concerned , in the first lot 50 kg of fruits were subjected to ethylene gas (150 ppm) using ethylene gas generator (9002, Cavanta , California ,USA) and the Temp. and RH inside the ripening chamber were maintained at 15^{0}C and 85-90 per cent RH. Similarly in the the second treatment lot of 40 kg was directly placed in aqueous solutions of ethephon

(250, 500, 750 and 1000 ppm) each for 5-7 min. This was followed by air drying of fruits under natural air and under fan , followed by packing in sanitized plastic crates which were ultimately stored in ripening chamber (20- 25^{0}C and 90-95 per cent RH). Control fruits lot of 30 kg were also kept under room temperature condition to compare the the physio chemical changes over the stipulated period of time. There were 3 replications for each treatment and experiment was laid out in completely randomized design. A 28 -day ripening cycle was followed in which temperature was brought down from 25 to 18^{0}C in 28 days . Ripening behaviour of oranges fruits was also studied at 20-25^{0}C at well established market conditions as well as at 30-35^0 C at regular market conditions . The observations on various physicochemical attributes were monitored everyday till 28 days. The physiological loss in weight (PLW) of fruit during storage was calculated on initial weight basis and expressed in per cent. The fruit firmness was measured with the help of 'Texture analyzer (Make Stable Microsystem, UK) using stainless steel probe of 2 mm diameter and results were expressed in g-forcer. The sensory quality of fruit was determined by Hedonic scale (1-9 points) as described by Amerine *et al.* (1965). The total soluble solids were calculated with the help of a Erma Hand Refractometer, and express in per cent after making the temperature correction at 20^{o}C. Titratable acidity was estimated as per AOAC (1990). The colour of the fruit was measured with colour difference meter (Hunter Lab, USA) and expressed as L, a, b values (Hunter 1975). The ripening percentage of the fruits was estimated by counting the total number of ripened fruits on the basis of their appearance and desirable colour.

EXPERIMENTAL FINDINGS AND ANALYSIS

The results of the present study as well as relevant discussions have been presented under following sub heads:

Physiological loss in weight (PLW) :

The PLW of fruits increased during ripening process (Table 1). The highest PLW was observed with ethephon 1000 ppm (6.5%) during ripening period of 28 days, which was followed by ethephon 750 ppm (5.2%) and these treatments resulted in shriveling, softening and over-ripening of fruits

Table 1 : Effect of ethylene gas and ethephon treatments on PLW, firmness, TSS, acidity and sensory quality during ripening of oranges

Ripening period, days	Ethylene, 100 ppm	Ethephon				Control	CD, 0.05
		250	500	750	1000		
PLW, % (n=3)							
7	1.0	1.0	1.3	1.8	2.1	0.50	T = 0.3
14	1.5	2.1	2.4	2.9	3.8	1.15	S = 0.2
21	2.6	2.9	3.1	4.0	5.2	2.00	T x S = 0.6
28	3.1	3.4	3.7	5.2	6.5	2.5	
Firmness, g-force (n=3)							
7	530	580	550	510	510	660	T = 3.2
14	370	420	320	310	305	520	S = 4.0
21	120	170	105	95	80	345	T x S = 5.3
28	66	93	64	48	44	260	
TSS, % (n=3)							
7	9.6	96.2	9.4	9.4	9.6	9.2	T = 0.4
14	11.0	11.8	11.0	125.8	12.6	10.0	S = 0.2
21	14.6	13.0	15.6	15.2	15.8	11.0	T x S = 0.9
28	17.0	15.2	18.0	18.4	19.5	12.0	
Acidity, % (n=3)							
7	0.36	0.33	0.32	0.30	0.30	0.32	T = NS
14	0.40	0.36	0.38	0.34	0.32	0.35	S = 0.2
21	0.44	0.36	0.40	0.40	0.38	0.40	T x S = NS
28	0.50	0.40	0.44	0.37	0.36	0.38	
Sensory quality (n = 10 panelists)							
7	4.5	4.5	4.5	4.5	4.5	4.0	T = 0.2
14	5.0	5.0	5.0	5.0	5.0	4.0	S = 0.1
21	6.5	6.0	6.5	7.3	7.5	4.0	T x S = 0.3
28	7.5	6.0	7.4	7.0	7.0	4.0	

and found unsuiatable. Ethylene gas (100 ppm) and ethephon (500 ppm) recorded 3.1 per cent and 3.4 per cent weight loss, respectively during ripening period of 28 days leading to adequate ripening and softening of fruits. Lowest PLW (2.5%) was recorded in control fruits and these fruits were green and hard in texture. The increase in weight loss during ripening of fruits by ethephon or ethylene application may be due to upsurge in respiration rate of the fruit. Mahajan *et al.* (2008) reported an increased weight loss in guava fruits during ripening process caused by ethylene application.

Firmness:

The firmness of fruits declined during ripening period in all treatment (Table 1). Untreated control fruits were hard (260 g-force and remained unripened, while ethephon (1000 ppm) treated fruits wee least firm (44g force). The fruits treated with ethylene gas (100 ppm) and ethephon (500 ppm) registered adequate firmness of 66 and 64 g force, respectively during ripening period of 28 day (Table 1). Firmness is one of the most crucial factors in determining the post-harvest quality of fruits (Shear, 1975). The decrease in firmness, during ripening may be due to breakdown of insoluble protopectin into soluble pectin or by cellular disintegration leading to membrane permeability (Brinston *et al.,* 1988). The hard or semi hard oranges fruits are not liked by most of the consumers. Therefore, to develop desirable quality, the oranges fruits need to be ripened artificially for enhancing consumer acceptability.

Sensory quality :

Fruits treated with ethylene gas (100 ppm) recorded 7.5 score on 28th day and were rated as very much desirable and this treatment was very closely followed by ethephon 500 ppm (Table 1). The untreated control fruits were rated poor (4) in taste on 28th day. The improvement in sensory quality with ethylene gas or ethephon treatments may be due to the role of ethylene / ethephon in promoting changes which are important to flavour quality and formation of aroma volatile in climacteric fruit (Pratt and Goeschl, 1969, Medicott *et al.,* 1987, Kulkarni *et al.,* 2004).

Total soluble solids (TSS) :

The TSS content of fruits increased during ripening irrespective of treatments (Table 1). The TSS content of oranges were maximum (19.5%) with ethephon 1000 ppm and lowest (13%) in control fruits. The increase in TSS during ripening may result from an increase in concentration of organic solutes as a consequence of water loss (Ryall and Pentzer, 1982). The increase may also be possible due to numerous anabolic and catabolic processes taking place in the fruit preparing it for senescence (Smith *et al.,* 1979). Kulkarni *et al.* (2004) reported an increase in TSS and sugars in mango fruits treated with ethrel.

Titratable acidity :

The acidity values were in the narrow range of 0.3-0.45 per cent in all the treatments (Table 1) and differences were not

Table 2 : Effect of ethylene gas and ethephon treatments on development of colour and ripening of oranges

Ripening period, days	Colour value	Ethylene, 100 ppm	Ethephon				Control
			250	500	750	1000	
Hunter values							
7	L	50.2	47.8	58.4	59.6	60.2	46.7
	a	-7.2	-8.6	-6.8	-5.4	-5.2	-9.6
	b	18.0	17.2	20.2	20.0	22.4	17.2
14	L	56.4	49.4	66.7	67.8	69.2	46.9
	a	-5.0	-5.6	-4.2	-4.0	-3.6	-9.2
	b	20.6	19.8	22.4	23.6	23.0	18.0
21	L	63.8	51.6	70.3	69.5	70.8	47.0
	a	1.30	-4.2	1.5	2.3	2.0	-8.7
	b	25.2	21.5	28.6	29.2	29.8	18.7
28	L	74.0	53.3	76.0	71.5	72.0	47.6
	a	2.27	-3.8	1.7	5.3	5.4	-8.8
	b	29.7	24.5	30.2	31.8	32.1	20.8
Ripening							
7		0	0	0	0	0	0
14		0	0	0	0	0	0
21		78	30	75	83	88	0
28		100	55	100	100	100	30

statistically significant.

Fruit colour :

The fruits treated with ethylene gas or ethephon solution recorded significant improvement in yellow colour of the peel as indicated by increase in 'b' value, compared to untreated control, which remained greenish soft with dull appearance (Table 2). The fruits treated with ethylene (100 ppm) and ethephon (500 ppm) developed uniform yellow colour, whereas ethephon (750 and 1000 ppm) resulted in deep yellow colour with black spots on fruit surface leading to over-softening of fruits. Ethylene gas and ethephon are treatment are known to accelerate the chlorophyll degradationand induce yellowness in green tissues of many fruits (Reyes and Paul, 1995; Mahajan *et al.,* 2008).

Ripening :

For initial 14 days the fruits remained hard and green in all the treatments as judged by their visual appearance (Table 2). However, on 21 day there was dramatic increase in ripening of fruits and highest ripening percentage (100%) of oranges fruit was observed after 28 days with ethylene gas (100 ppm) and ethephon (500 ppm) as well as its higher doses while lowest was in control fruits (30%). The role of ethylene in hastening ripening of fruit is evident because it binds to receptor forming an activated complex which leads to a wide variety of physiological responses including ripening (Yang, 1980). The improvement in ripening of oranges fruits is due to multifunctional nature of ethylene, which triggers a dramatic change during ripening process and ensures faster and uniform ripening in many fruits (Abeles, 1973, Kadar *et al.,* 1994, Kadar and Mitcham, 1994).

Shelf-life studies :

The shelf-life studies of oranges fruit was carried out to study the post-ripening behaviour of fruit during retail marketing at 16-18^{0}C (super market condition) and 30-32^{0}C (ordinary market condition). The data on different attributes

Table 3 : Effect of ethylene gas and ethephon treatments on shelf oranges under supermarket (16-18^{o}C) and ordinary market (30-32^{o}C) conditions

Ripening period, days	Shelf life at 16-18^{o}C					Control
	Eyhylene					
	100	250	500	750	1000	
PLW, %						
7	3.5 (5.3)	3.7 (4.9)	3.9 (5.5)	5.9 (6.4)	7.3 (7.8)	3.0 (3.4)
14	3.9 (7.0)	4.0 (6.4)	4.2 (6.7)	6.3 (8.6)	8.0 (10.3)	3.3 (5.7)
21	4.2	4.2	4.6	6.5	8.4	3.7
28	4.7	4.5	4.8	6.7	9.0	4.0
Firmness, g force						
7	65 (58)	90 (84)	62 (58)	45 (43)	41 (40)	210 (140)
14	57 (46)	83 (72)	55 (40)	40 (30)	37 (30)	150 (80)
21	53	80	51	36	35	110
28	50	78	47	32	30	83
TSS, %						
7	17.4 (17.6)	15.2 (15.4)	18.4 (18.0)	18.4 (18.0)	18.6 (18.0)	13.4 (13.6)
14	18.0 (17.0)	15.6 (15.0)	18.4 (17.0)	18.0 (16.0)	18.0 (16.0)	13.8 (13.0)
21	18.2	16.0	18.6	17.6	18.0	14.0
28	18.6	15.4	19.0	17.2	17.6	14.0
Acidity, %						
7	0.46 (0.32)	0.35 (0.30)	0.40 (0.33)	0.35 (0.30)	0.30 (0.28)	0.35 (0.32)
14	0.40 (0.25)	0.31 (0.20)	0.34 (0.22)	0.31 (0.25)	0.27 (0.21)	0.30 (0.24)
21	0.33	0.28	0.30	0.30	0.22	0.30
28	0.28	0.25	0.26	0.28	0.20	0.28
Sensory quality (n = 10 panelists)						
7	7.5 (7.2)	6.5 (7.0)	7.5 (7.2)	6.8 (6.5)	6.8 (6.5)	4.5 (5.0)
14	7.8 (7.0)	7.0 (6.5)	7.5 (6.8)	6.5 (6.0)	6.5 (6.0)	5.0 (5.5)
21	7.5	6.2	7.8	6.5	6.5	5.5
28	7.0	6.0	7.2	6.0	6.0	6.0

revealed that oranges fruit treated with ethylene gas (100 ppm) or ethephon (500 ppm) can be kept for 28 days at 16-18^{0}C and 21 days at 30-32^{0}C with optimum weight loss, desirable firmness and highly acceptable colour and organoleptic quality (Table 3). The higher doses of ethephon (750 and 1000 ppm) resulted in shattering of fruits from plant, over-softening and shriveling of fruits.

Conclusion:

Exposure of green mature oranges fruits to ethylene gas (100 ppm) for 24 h or dipping in ethephon solution (500 ppm) for 5 min followed by storage at 16-18^{0}C and 90-95 per cent RH, ensures faster and uniform ripening in 28 days with development of pleasant colour and consumer acceptability.

LITERATURE CITED

Abeles (1973). *Ethylene in plant biology*. Academic Press, NEWYORK.

Amerine, M.A., Pangborn, R.M. and Roessler, E.B. (1965). *Principles of sensory evaluation of food*. Academic Press. LONDON. p. 5

AOAC (1990). *Official methods of analysis*. 12th edn. Association of Official Analytical Chemists, WASHINGTON DC (U.S.A.).

Brinston, K., Dey, P.M., John, M.A. and Pridhan, J.B. (1988). Postharvest changes in *Mangifera indica* mesocarp walls and cytoplasmic polysaccharides. *Phytochem.,* **27** : 719-723.

Hunter, S. (1975). *The measurement of appearance*, John Wiley and Sons, NEW YORK, U.S.A. pp. 304-305.

Kadar, A. and Mitcham, B. (1994). Optimum procedures for ripening mangoes. *Perishables Handlings Newsletter,* **90**: 16-17.

Kadar, A., Mitcham, B. and Pieue, B.N. (1994). Optimum procedures for ripening orangess. *Perishables Handlings Newsletter,* **90** : 12-13.

Kulkarni, S.G., Kudachikar, V.B., Vasantha, M.S., Keshava Prakash, M.N., Aravinda Prasad, B. and Ramana, K.V.R. (2004). Studies on effect of ethrel dip treatment on the ripening behaviour of mango (*Mangifera Indiaca* L.) variety 'Neelam'. *J Food Sci. Technol.,* **41** : 216-220.

Mahajan, B.V.C., Singh, G. and Dhatt, A.S. (2008). Studies on ripening behaviour and quality of winter guava with ethylene gas ethephon treatments. *J Food Sci. Technol.,* **45**: 81-84.

Medicott, A.P., Sigrist, M.M., Reynolds, S.B. and Thompson, A.K. (1987). Effect of ethylene and acetylene on mango fruit ripening. *Ann. Appl. Biol.,* **111** : 439-444.

PFA (2003). *Prevention of food adulteration act 1954 with prcvention of food adulteration rules 1955*. 19th edn, International Law Book Co., DELHI, India, p. 140.

Pratt,H.K. and Goeschl, J.D. (1969). Physiological roles of ethylene in plants. *Ann Rev Plant Physiol*., **20**: 541-584.

Reyes, M.U. and Paul, R.E. (1995). Effect of storage temperature and ethylene treatment on guava fruit ripening. *Postharvest Biol Technol.*, **6**: 357-365.

Ryall, A.L. and Pentzer, W.T. (1982). *Handling, transportation and storage of fruits and vegetables*. Vol. 2. AVI Publ. Co., Westport, Connecticut, pp. 1-40.

Shear, C.B. (1975). Calcium related disorder of fruits and vegetables. *Hort. Sci.,* **10**: 361-365.

Smith, R.B., Lougheed, E.C., Franklin, E.W. and McMillan, I. (1979). The starch iodine test for determining stage of maturation in apples. *Canadian J. Plant Sci.,* **59**: 725-735.

Yang, S.F. (1980) Regulation of ethylene biosynthesis. *Hort Sci.,* **15**: 238-243.

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