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Role of ethylene on ripening of Kesar mango fruits

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Abstract
Mango fruit Cv. Kesar were exposed to ethylene gas (100 ppm) for 12, 18 and 24 h in fruit ripening chamber (29.4-31.9 ^{0}C. with 65-84 % R.H.) and the untreated fruit was kept at ambient temperature (26-30 ^{0}C with 54-62% R.H.). The fruits were then removed from the ripening chamber at the end of exposure period, packed in corrugated fibreboard boxes and then kept at ambient condition to study the ripening behaviour. In ethephon dip treatments, mango fruits were treated with ethephon at the concentration of 500,750 and 1000 ppm for five minutes, drained, packed in corrugated fibreboard boxes and then kept at ambient condition. It was found that Kesar mango fruits exposed to the ethylene gas in the ripening chamber and ethephon dip treatment triggered the ripening process. It was observed that Kesar mango fruits ripened by exposing them to 100 ppm ethylene gas in ripening chamber for 18 hrs and storage at ambient condition recorded the maximum shelf life of 6 days and showed better results in respect of high overall acceptability score of 8.77. Similarly, mango fruits ripened by ethephon dip treatment of 750 ppm for 5 minutes and storage at ambient condition recorded the maximum shelf life of 8 days and showed better results in respect of high overall acceptability score of 8.66, respectively.

Keywords: Mango, Ripening, Ethylene, Ethephon, Physiological changes

Introduction
Mango (*Mangifera indica* L.) belongs to family anacardiaceae is the national fruit of India and rightly known as the 'King of fruits' owing to its attractive colour, excellent taste, excellent flavour, exemplary nutritive value, processing qualities and its delicacy for the table which provides employment to the millions of poor people during summer.

The research efforts have helped to increase the production of mango fruits but the purpose of obtaining maximum profit will not be served unless the increased production is supplemented with similar efforts to minimize their post harvest losses, which range between 25-30 per cent. World scenario indicate that mango is grown in an area of 5.60 million hectares with total annual production of 48.09 million tonnes and average productivity is 8.6 tonnes/ha. India ranks first in the world with total production of 18.31 million tonnes from about 2.5 million hectares and productivity is 7.3tonnes/ha [1]. Mango is one of the most popular subtropical fruits and belongs to the climacteric category. Its ripening is characterized by the sharp increase in ethylene production and a respiratory climacteric, followed by a series of biochemical changes. Progression in ripening resulted in degradation of cell wall component along with structural changes [11]. Artificial ripening of mango is very recent concept in post harvest technology but it has great importance especially in export of mango. The ripening with ethylene gas or ethephon treatment seems to hold promise to get good and uniform quality. In this technique, the fruits are exposed to low level of ethylene gas in a ripening chamber for particular period to induce the fruits to ripen. The most important thing in this technique is temperature and relative humidity control inside the ripening chamber which should range between 16-25^{0}C and 90-95% RH, depending upon the fruit type [9]. Therefore, the present investigation was carried out with the objective to study the effect of ethylene on physiological changes during ripening behaviour of mango Cv. Kesar.

Materials and methods
The present research entitled "Effect of ethylene on physiological and qualitative changes during ripening of mango (*Mangifera indica* L.) Cv. Kesar" was carried out in the Post Harvest Technology Centre, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri during the year 2014 - 2015. Physiologically mature, healthy green fruits at optimum

maturity of mango Cv. Kesar were collected from mango orchard, of Horticultural Department. Harvested fruits were washed, treated and packed in CFB and were used for further investigation. The ripening chamber made up of polypropelene with a dimension of 7 x 7 x 7 ' having capacity to hold 500-800 kg of mango fruits supported with a frame of 1.5 " PVC pipes with a thickness of 0.33 mm. Ethylene is a natural ripening hormone used for mango ripening in low cost ripening chamber. Ethylene gas cylinder of (100ppm) was used. Secondly, Ethephon 39% SL for dip treatment was used under the brand name ethefol.

Post harvest treatments

Ethylene gas

The selected mango fruits Cv. Kesar were kept in low cost fruit ripening chamber in the Post Harvest Technology Centre, Department of Horticulture, MPKV, Rahuri. The concentration of ethylene gas in the ripening chamber for each treatment was kept as 100 ppm, as per method developed by [12]. The mango fruits were exposed to the ethylene gas in ripening chamber (29.4-31.9^{0}C with 65-84 % R.H) for certain period as per treatment and untreated fruits were kept at ambient temperature. The fruits were then removed from the ripening chamber at the end of exposure period and then kept at ambient condition (26.8-30.6^{0}C with 54.0- 62.6% R.H) for studying of ripening behaviour of mango fruits.

Ethephon dip treatment

The selected mango fruits were treated with ethephon 5 minutes at different concentrations as given in Table 1. The treated fruits were then drained, packed in corrugated fibreboard boxes and kept at ambient condition (26.8-30.6^{o}C with 54.0- 62.6% R.H) for further study.

The treatment details are as below.

Treatment Details

T_1	Control (Without any treatments).
T_2	12 hrs exposure to ethylene gas 100 ppm in ripening chamber
T_3	18 hrs exposure to ethylene gas 100 ppm in ripening chamber
T_4	24 hrs exposure to ethylene gas 100 ppm in ripening chamber
T_5	500 ppm dip in ethephon for 5 minutes
T_6	750 ppm dip in ethephon for 5 minutes
T_7	1000 ppm dip in ethephon for 5 minutes

Statistical analysis

The data obtained in the present investigation was analyzed for the statistical significance as suggested by Panse and Sukhatme (1995) [10].

Results and Discussion

Physical characteristics of fresh mango fruit

The results for physical properties of fresh (unripe) mango fruit Cv. Kesar are presented in Table 1. The data revealed that the fresh (unripe) mango had 16.18 N firmness and L*, a*, b* values of colour for unripe mango were 36.50, -11.12, 25.45, respectively. The research findings are comparable with the observations reported by Daware (2012) [2] and Gill *et al. (*2015) [6] in the mango fruit. The firmness was found to be decreased statistically whereas L*, a*, b* values of colour, PLW and rotting of mango was found to be statistically increased in all the treatments during the advancement of storage period. The rate of decrease was faster in ethylene gas exposure treatment in the ripening chamber as compared to ethephon dip treatments.

Firmness (N)

At the initial stage, the firmness of mango fruit was found to be 16.18 N. At the end of 2nd, 4th, 6th and 8th day of storage, treatment T_4 recorded minimum firmness (11.36, 7.94, 2.05 and 1.85 N) followed by treatment T_3 (13.43, 11.02, 8.45 and 3.21N) in ethylene gas exposure treatment in the ripening chamber. At the end of 2nd day of storage, treatment T_6 recorded minimum firmness (12.37 N) followed by treatment T_7 (12.43 N) in ethephon dip treatments. At the end of 4th, 6th and 8th day of storage, treatment T_7 recorded minimum firmness (8.78, 2.79 and 2.28 N) followed by treatment T_6 (9.63, 6.15 and 4.04 N) in ethephon dip treatments. At the end of 8th day of storage treatment T_2 and T_6 (4.15 and 4.04 N) recorded at par with each other. It is also observed that the higher firmness was recorded in untreated fruits i.e. treatment T_1 in all days. This is due to ethylene effects, the tissue becomes softer as the dose increases and cell-wall integrity due to breakdown of pectic substances leading to an increase in soluble pectin and decrease in fruit firmness. As Pectic substances are structural polysaccharides responsible for the firmness of fruits and softening of fruit occurs when these pectin polymers become less tightly bound in the cell wall during ripening. Similar results were reported by William *et al*. (2009) [14], Deepa and Preetha (2014) [3], Venkatram and Pandiarajan (2014) [13] in mango fruit.

L* value for colour (Lightness)

At the initial stage, the L* value of mango fruit was found to be 36.50. At the end of 2nd, 4th, 6th and 8th day of storage, treatment T4 recorded maximum L* value (53.31, 55.79, 58.50 and 62.17) followed by treatment T_3 (48.74, 50.84, 53.17 and 59.73) in ethylene gas exposure treatment in the ripening chamber. Whereas, the lowest L* value was recorded in treatment T_1(49.37) i.e. control. At the end of 2nd, 4th, 6th and 8th day of storage, treatment T_7 recorded highest L* value (51.63, 52.82, 55.20 and 60.34) followed by treatment T_6 (47.59, 48.92, 51.15 and 57.45) in ethephon dip treatments. It is also observed that L* values for colour were less in untreated fruits i.e. treatment T_1 in all days. This is because of fact that ethylene effects on the tissue and degreening of fruits. As the ethylene triggered the ripening process, there is rapid change in the colour from dark (green) to lightness (yellow) and it increased during the period of storage. Those fruit which were not exposed to ethylene gas and ethephon dip showed low L* value. Similar findings were reported by Daware (2012) [2], Deepa and Preetha (2014) [3], and Gill *et al.* (2015) [6] in Dusehari mango fruits.

a* value for colour (Redness)

At initial stage, the a* value of mango fruit was found to be -11.12. At the end of 2nd, 4th, 6th and 8th day of storage, treatment T_4 recorded the highest a* value (1.06, 5.20, 13.43 and 26.08) followed by treatment T_3 (-2.33, 2.72, 11.23 and 24.53) in ethylene gas exposure treatment in the ripening chamber. At the end of 2nd, 4th, 6th and 8th day of storage, treatment T_7 recorded highest a* value (-1.25, 4.63, 11.23 and 24.82) followed by treatment T_6 (-3.23, 1.82, 9.06 and 22.28) in ethephon dip treatments. It is also observed that a* values for colour were less in untreated fruits i.e. treatment T_1in all days. This might be due to the breakdown of chlorophyll leading to disappearance of green colour. During ripening, the peel colour changed from dark green to bright yellow and this is due to the change in chlorophyll which gradually unmasked the carotenoid pigments present in unripe mango fruits. As the ethylene triggered the ripening process, there was rapid

change in the colour from dark (green) to redness and it increased during the period of storage. Those fruit which were not exposed to ethylene gas and ethephon dip showed low a* value. Similar findings were also reported by Daware (2012) [2], Deepa and Preetha (2014) [3], Gill *et al*. (2015) [6] in mango fruit.

b* value for colour (Yellowness)

At initial stage, the b*value of mango fruit was found to be 25.45. At the end of 2nd, 4th, 6th and 8th day of storage, treatment T_4 recorded the highest b* value (40.55, 45.32, 50.43 and 57.15) followed by treatment T_3 (38.08, 42.42, 47.60 and 55.04) in ethylene gas exposure treatment in the ripening chamber. Whereas, the lowest b* value was recorded in treatment T_1 (39.23) i.e. control. At the end of 2nd, 4th, 6th and 8th day of storage, treatment T_7 recorded highest b* value (39.15, 43.25, 48.22 and 55.75) followed by treatment T_6 (36.37, 40.20, 44.60 and 53.62) in ethephon dip treatments. It is also observed that the b* values for colour were lower in untreated fruits i.e. treatment T_1 at all days. This might be due to changes during ripening period (loss of greenness, increase in redness and yellowness) occurred as a result of the breakdown of the chlorophyll in the peel. As the ethylene triggered the ripening process, there was rapid change in the colour from redness to yellowness and it increased during the period of storage. Similar findings were also reported by Daware (2012) [2], Deepa and Preetha (2014) [3], Gill *et al.* (2015) [6] in mango fruits.

Physiological loss in weight (%)

At the end of 2nd, 4th, 6th and 8th day of storage, treatment T_4 recorded maximum physiological loss in weight (5.20, 8.67,13.82 and 19.57%) followed by treatment T_3 (4.63, 7.33, 9.68 and 13.20%) in ethylene gas exposure treatment in the ripening chamber. It is also observed minimum physiological loss in weight was recorded in untreated fruits i.e. treatment T_1in all days. At the end of 2nd, 4th, 6th and 8th day of storage, treatment T_7 recorded maximum physiological loss in weight (4.68, 7.83, 12.63 and 18.44%) followed by treatment T_6 (3.40, 6.32, 9.05 and 12.68%) in ethephon dip treatments. It is also observed that the minimum physiological loss in weight was recorded in untreated fruit i.e. treatment T_1 in all days.This might be due to the fact that higher ethylene concentration promoted the physiological process such as respiration, transpiration which resulted into more physiological loss in weight due to moisture loss. Similar findings were also reported by Dhemre (2001) [4], Lagunes *et al.* (2007) [8], Dhillon and Mahajan (2011) [5], Daware (2012) [2], Venkatram and Pandiarajan (2014) [13] in mango fruits.

Rotting (%)

At the end of 4th day of storage, treatment T_7 recorded the maximum rotting (5%) in the ethephon dip treatment. Whereas on 6th day of storage, T_7 recorded the maximum rotting (15%) followed by T_6 (5%) in the ethephon dip treatment and T_4 (5%) in the ethylene gas exposure in ripening chamber. At the end of 8th day of storage, treatment T_7 recorded maximum rotting per cent (20%) followed by treatment T_6 (10%) in the ethephon dip treatments. However, Treatment T_4 recorded the maximum rotting (10%) followed by treatment T_3 (5%) in ethylene gas exposure in the ripening chamber. While, no rotting was recorded in treatment T_2 and T_1 i.e. control.

Ripening pattern (%)

The data on effect of ethylene gas exposure treatments in the ripening chamber as compared to ethephon dip treatments on changes in ripening pattern are presented in Table 2. The ripening of mango Cv. Kesar was significantly increased in all the treatments during the advancement of storage period. The rate of increase was faster in ethylene gas exposure treatment in the ripening chamber as compared to ethephon dip treatments.

Initially, the mango fruits were green in colour. At 6th day of storage, treatment T_4 recorded 100 per cent ripe mango followed by treatment T_3 which recorded 10 per cent half ripe and 90 per cent ripe mango in ethylene gas exposure treatment in the ripening chamber. At 8th day of storage, treatment T_4 recorded 95 per cent ripe mangoes and 5 per cent over ripe mango fruits followed by treatment T_3 which recorded 5 per cent half ripe and 95 per cent ripe mangoes in ethylene gas exposure treatment in the ripening chamber.On 8th day of storage, treatment T_7 recorded 100 per cent ripe mangoes followed by treatment T_6 which recorded 10 per cent half ripe and 90 per cent ripe mangoes in ethephon dip treatments. However, only 40 per cent and 60 per cent of mango fruits were at half ripe and ripe stage on 8th day of storage in treatment T_1 i.e. control.

Sensory quality

The data on effect of ethylene gas exposure treatment in the ripening chamber as compared to ethephon dip treatments on changes in sensory quality are presented in Table 3.The organoleptic rating of mango Cv. Kesar in terms of overall acceptability on 6th day of storage was found to be maximum in the treatment T_3 (8.77) followed by the treatment T_4 (8.46) and treatment T_2 (8.37) in ethylene gas exposure treatments in ripening chamber. Whereas the mango fruits treated with ethephon dip treatments recorded the highest overall acceptability in treatment T_7 (8.25) followed by treatments T_6 (8.06) and T_5 (7.93).The lowest sensory score was recorded in the treatment T_1 (6.50) i.e. control. The organoleptic rating of mango Cv. Kesar in terms of overall acceptability on 8th day of storage was found to be maximum in the treatment T_6 (8.66) followed by the treatment T_5 (8.18) and treatment T_7 (7.91) in ethephon dip treatments. Whereas the mango fruits treated in ethylene gas exposure treatments in ripening chamber recorded the maximum sensory score in treatment T_2 (8.40) followed by treatments T_3 (8.10) and T_4 (7.85).The lowest sensory score was recorded in the T_1 (7.22) i.e. control. The uniform and sustainable colour development of the fruit during ripening may be associated with faster degradation of chlorophyll and functional activity of ethylene as a degreening agent. Generally the distinct flavor development is function of adequate sugar acid blend coupled with suitable combination of other bio-chemicals and volatiles, which might have developed adequately during the ethylene, induced ripening of fruits. Similar findings were recorded by Kulkarni *et al.* (2004) [7] in mango Cv. Neelum, Dhemre (2001) [4] in mango Cv. Kesar, Daware (2012) [2], Zagade and Relekar (2014) [15], Venkatram and Pandiarajan (2014) [13] in mango Cv. Alphonso.

Table 1: Effect of various treatments on physiological properties of mango during ripening.

Particulars	Storage period (days)	Treatments								
		Control	Ripening chamber			Ethephon dip				
		T_1	T_2	T_3	T_4	T_5	T_6	T_7	SE±	C.D. at 5 %
Firmness (N)										
	0	16.18	16.18	16.18	16.18	16.18	16.18	16.18	-	-
	2	14.37	13.66	13.43	11.36	13.33	12.37	12.43	0.06	0.19
	4	12.32	11.29	11.02	7.94	10.75	9.63	8.78	0.03	0.11
	6	10.20	9.60	8.45	2.05	7.94	6.15	2.79	0.03	0.11
	8	7.15	4.15	3.21	1.85	4.27	4.04	2.28	0.05	0.15
L* value for colour										
	0	36.50	36.50	36.50	36.50	36.50	36.50	36.50	-	-
	2	42.17	44.81	48.74	53.31	44.89	47.59	51.63	0.10	0.32
	4	44.77	46.43	50.84	55.79	46.76	48.92	52.82	0.04	0.14
	6	47.35	48.66	53.17	58.50	49.56	51.15	55.20	0.06	0.19
	8	49.37	55.80	59.73	62.17	53.74	57.45	60.34	0.03	0.09
a* value for colour										
	0	-11.12	-11.12	-11.12	-11.12	11.12	-11.12	-11.12	-	-
	2	-6.83	-4.30	-2.33	1.06	-4.60	-3.23	-1.25	0.06	0.21
	4	0.29	1.23	2.72	5.20	0.90	1.82	4.63	0.04	0.14
	6	4.82	8.75	11.23	13.43	6.37	9.06	11.23	0.07	0.22
	8	16.42	21.87	24.53	26.08	19.62	22.28	24.82	0.08	0.24
b* value for colour										
	0	25.45	25.45	25.45	25.45	25.45	25.45	25.45	-	-
	2	31.22	35.37	38.08	40.55	33.32	36.37	39.15	0.08	0.24
	4	32.72	39.33	42.42	45.32	37.53	40.20	43.25	0.11	0.35
	6	36.88	44.30	47.60	50.43	42.33	44.60	48.22	0.40	1.22
	8	39.23	52.73	55.04	57.15	50.23	53.62	55.75	0.07	0.21
PLW (%)										
	2	1.83	3.71	4.63	5.20	3.13	3.40	4.68	0.07	0.22
	4	4.22	6.37	7.33	8.67	5.68	6.32	7.83	0.09	0.30
	6	6.33	9.35	9.68	13.82	8.62	9.05	12.63	0.07	0.24
	8	9.57	12.47	13.20	19.57	11.68	12.68	18.44	0.12	0.37
Rotting (%)										
	4	-	-	-	-	-	-	5	-	-
	6	-	-	-	5	-	5	15	-	-
	8	-	-	5	10	5	10	20	-	-

Table 2: Effect of ethylene gas and ethephon on ripening pattern of mango Cv. Kesar during storage

Treatments	Ripening Pattern (%)																	
	Days of storage																	
	B	1st day after treatment				4th day after treatment				6th day after treatment				8th day after treatment				
	G	G	T	H	R	G	T	H	R	G	T	H	R	G	T	H	R	OR
Control																		
T1	100	100	-	-	-	80	10	10	-	-	-	50	50	-	-	40	60	-
Ripening chamber																		
T2	100	80	20	-	-	20	65	15	-	-	-	15	25	-	-	10	90	-
T3	100	70	30	-	-	10	60	20	10	-	-	10	90	-	-	5	95	-
T4	100	55	45	-	-	-	25	60	15	-	-		100	-	-	-	95	05
Ethephon dip																		
T5	100	85	15	-	-	25	55	20		-	-	25	75	-	-	15	85	-
T6	100	75	25	-	-	15	60	20	05	-	-	20	80	-	-	10	90	-
T7	100	60	40	-	-	-	30	55	15	-	-	15	85	-	-		100	-

B: Before treatment, G:-Green, T:-Turning, H:-Half ripe, R:-Ripe, OR:-Over ripe

Table 3: Effect of ethylene gas and ethephon on organoleptic score of mango Cv. Kesar during 6th day of storage.

Treatments	Organoleptic score				
	Colour	Flavour	Taste	Texture	Overall acceptability
Control					
T_1	7.00	7.00	6.00	6.00	6.50
Ripening chamber					
T_2	8.50	8.50	8.00	8.50	8.37
T_3	8.80	8.75	8.75	8.80	8.77
T_4	8.50	8.75	8.20	8.40	8.46
Ethephon dip					
T_5	8.00	8.00	7.75	8.00	7.93
T_6	8.50	8.50	7.25	8.00	8.06
T_7	8.25	8.50	8.25	8.00	8.25

Table 4: Effect of ethylene gas and ethephon on organoleptic score of mango Cv. Kesar during 8th day of storage.

Treatments	Organoleptic score				
	Colour	Flavour	Taste	Texture	Overall acceptability
Control					
T_1	7.20	7.45	7.00	7.25	7.22
Ripening chamber					
T_2	8.40	8.50	8.25	8.50	8.40
T_3	8.30	8.10	8.00	8.00	8.10
T_4	8.00	7.50	7.75	8.20	7.85
Ethephon dip					
T_5	8.25	8.00	8.50	8.00	8.18
T_6	8.70	8.60	8.75	8.60	8.66
T_7	8.00	8.10	7.75	7.80	7.91

Conclusion

It was found that mango Cv. Kesar exposed to the ethylene gas in the ripening chamber and ethephon dip treatment triggered the ripening process. It was also noticed that more the period of exposure to ethylene gas and more the concentration of ethephon, faster was the ripening process and showed the significant increasing trends in L*, a*, b* values of colour, ripening pattern, PLW (%) and rotting (%) and decreasing trends in firmness (N) in all the treatment combinations during advancement of storage period in ambient condition. It was also observed that mango fruits Cv. Kesar ripened by exposing them to 100 ppm ethylene gas in ripening chamber for 18 hrs and storage at ambient condition recorded the maximum shelf life of 6 days and showed better results in respect of high overall acceptability score of 8.77. Similarly, mango fruits Cv. Kesar ripened by ethephon dip treatment of 750 ppm for 5 minutes and storage at ambient condition recorded the maximum shelf life of 8 days and showed better results in respect of high overall acceptability score of 8.66, respectively.

References

1. Anonymous. Indian Horticulture Database -2016. National Horticulture Board, Ministry of Agriculture, Government of India, Gurgaon, India. 2016, 2-3.
2. Daware PM. M.Sc. Thesis submitted on Studies on period of exposure to ethylene gas in KKV fruit ripening chamber on storage behavior of mango (*Mangifera indica* L.) Cv. Alphonso. Dr. Balasaheb Sawant Konkan KrishiVidyapeeth, Dapoli. 2012.
3. Deepa J, Preetha P. Influence of exposure time, temperature and ethylene concentration on the ripening of mango fruits. Trends in Biosciences. 2014; 7(20): 3260-3267.
4. Dhemre JK. Ph.D. Thesis submitted on Studies on extending the shelf life of mango (*Mangifera indica* L.) Cv. Kesar. Mahatma Phule Krishi Vidyapeeth, Rahuri. 2001.
5. Dhillon WS, Mahajan BVC. Ethylene and ethephon inducing fruit ripening in pear. J. of Stored Products and Postharvest Research. 2011; 2(3):51-54.
6. Gill PS, Jawandha SK, Kaur N, Verma A. Changes in fruit colour of Dushehari mangoes during ethephon induced ripening. Int. J. of Agri. Envr. And Biotehnol. 2015; 8(1):97-101.
7. Kulkarni SG, Kudachikar VB, Vasantha MS, Keshava PMN, Arvinda PB, Ramana KVR. Studies on ethrel dip treatment on the ripening behaviour of mango (*Mangifera indica* L.) variety 'Neelam'. J. Food Sci. Technol. 2004; 41:12-13.
8. Lagunes L, Tovar M, Mata M, Vadillo JC, Cruz JDL, Garcia HS. Effect of exogenous ethylene on ACC content and ACC oxidase activity during ripening of Manila Mango subjected to hot water treatment, Springer Science + Business Media. 2007.
9. Mahajan BVC, Ghuman BS. Safe method of fruit ripening. http://editorialsamarth.blogspot.com. 2010.
10. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. 4th Edn. I.C.A.R., New Delhi. 1995, 58-152.
11. Parikh HR, Nair GM, Modi VV. Some structural changes during ripening of mangoes (*Mangifera indica* L.) Cv. Alphonso by abscisic acid treatment. Ann. Bot., 1990; 65:121-127.
12. Pujari KH, Mehta VB. Low cost ripening chamber for mango. A paper presented in International mango symposium 2010 held at Sanya china. 2010.
13. Venkatram P, Pandiarajan T. Optimization of ethylene concentration and exposure time for the ripening of mango var. Alphonso in Farm Level Ripening Chamber. Trends in Biosciences, 2014; 7(24):4259-4263.
14. William OA, Ibok O, William OE. Effect of Ethy-Gen II® ripening concentrate on ripening and sensory properties of mangoes (*Mangifera indica* L.). Pakistan Journal Nutrition. 2009; 8(10):1641-1644.
15. Zagade VV, Ralekar PP. Chemical composition ripening behavior and organoleptic quality of mango Cv. Alphonso as influenced by period of maturity. Plant Archives. 2014; 14(2):751-756.