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Interaction effect of plant extracts and natural ethylene sources on ripening behaviour, shelf life and quality of banana cv. Grand Naine (AAA) under ambient conditions

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Abstract

Postharvest study was done mainly for assessing the shelf life and ripening behaviour by using different plant extracts viz., aloe vera gel extract, neem leaf extract, ginger rhizome extract and natural ethylene sources viz., apple, sapota, papaya tomato, banana. The effect of different plant extracts and natural ethylene sources and their interactions were found significantly differing among the treatments. Among the different interactions treatment with combination of aloe vera gel extract and tomato showed the lowest physiological loss in weight (1.65 %), slowest change in fruit colour (1.16 %), no spoilage, highest firmness (3.49 kg/cm²), peel thickness (3.46 mm), pulp to peel ratio (1.99), highest (24.33 days) shelf life, long (11.49 days) days of ripening.

Keywords: Natural extracts, natural ethylene sources, ripening, shelf life.

1. Introduction

Banana (*Musa* spp.) belongs to the family Musaceae is one of the oldest fruits known to mankind. It is also known as Apple of Paradise and one of the most important sources of tropical fruits in the world as it is a significant staple food as well as a major export commodity (Rahman *et al.*, 2013) [5]. Banana holds a high position in fruit and food crops of the tropical and sub-tropical regions and good source of income for growers and its taste and high nutritional value keep it in high demand by consumers throughout the year. The use of various chemicals and waxing material at the pre and post-harvest stages is becoming popular among growers in order to enhance the shelf life of fruits. However, the use of these substances has their own limitations, as some of them are believed to be ecologically unsafe and economically not viable besides leaving their residue on the fruit surface, which may have the direct effect on human health. Additionally, some of them may be associated with the changes of aroma of the fruit.

Coating of plant leaf/flower extract forms a thin film around each fruit, which act as a semi-permeable membrane to regulate the diffusion of oxygen and carbon dioxide into and out of the fruit, thereby reducing the rate of metabolism and also preventing water loss (Umesh *et al.*, 2017) [9]. Post-harvest application of botanicals such as Azadirachta, Ocimum, Aloe, Tagetes, Mentha, Gingiber, Curcuma, and Eucalyptus which are known to contain higher amounts of some principle natural substances exhibiting growth regulating, fungicidal, insecticidal properties can be exploited for retaining freshness and enhancing the shelf life of horticultural crops. Successful marketing of edible cultivated bananas requires control over the ripening process to ensure predictable ripening and good quality ripe fruits.

Thus, most bananas are harvested in the unripe stage, transported to destination markets where they may be induced to ripen by exposure to ethylene prior to sale. Unripe bananas can normally be initiated to ripen by exposure to an exogenous source of ethylene (100 to 1000 µl l⁻¹ for 24 hours) under high humidity and controlled temperature conditions in specially designed ripening rooms (Soltani *et al.*, 2010) [17]. Fruits may be classified as climacteric or non-climacteric depending on its respiration rate. The level of ethylene present in ripe climacteric fruits is more than sufficient for inducing the major ripening associated events such as softening and colour changes. Fruits like avocado, banana, mango, pear and tomato produce 500, 40, 3, 40, 35 µg/l (µg l) ethylene at the climacteric peak (Belitz *et al.*, 2009) [1] while the threshold level of ethylene for fruits like avocado, banana, mango, tomato ranges from 0.1 to 0.5 ppm.

Materials and Methods

The experiment was conducted with factorial completely randomized block design with three replications with sixteen treatments. The treatment details are with different plant extracts *i.e.*, E₁-Leaf extract of Neem (*Azadirachta indica*) 20%, E₂-Aloe vera gel extract (*Aloe barbadensis*) 20%, E₃-Rhizome extract of Ginger (*Zingiber officinalis*) 20% and with different natural ethylene sources like N₁- Apple, N₂-Sapota, N₃-Papaya, N₄-Tomato, N₅-Banana and one treatment is control without imposition of any treatments.

Preparation of Extracts

Aqueous extracts of different plant materials shall be prepared under laboratory conditions on per cent weight basis as per the method described by Gakhukar (1996) [2] and Sharma *et al.* (1997) [6].

Neem leaf extract

The method consists of collection of fresh leaves, followed by shade drying and then grinding them to powder form in an electric blender. Fresh green leaves of neem were collected blended with distilled water. Then 20% neem leaf extract solution was prepared by taking 60 ml of raw neem leaf extract in 500 ml beaker with the addition of 240 ml distilled water separately to make a final volume of 300 ml (Suva laxmi and Dash 2017) [8]. Finally, the extracts solutions were filtered before use and stored in refrigerator at 5°C

Aloe vera gel extract

For preparation of aloe vera gel extract, aloe vera gel matrix was separated from the outer cortex of leaves and this colourless hydro parenchyma was ground in a blender. The resulting mixture was filtered to remove the fibre. The liquid obtained constituted fresh Aloe vera gel. It was later be stored in brown Amber bottle to prevent oxidation of the gel.

Ginger rhizome extract

In case of ginger rhizomes fresh juice was extracted and then different concentrations were prepared by dilution. The extract was stored in bottles till use. Aqueous solutions were prepared by soaking a known weight of the extract in an equal quantity of water and keeping it overnight. The extract was separated with the help of muslin cloth and it was considered to be of 100 per cent strength. It was diluted by adding appropriate quantity of distilled water to make up the desired concentration.

After harvesting 80-85% matured fruits are taken for the treatment. Ripened fruits (apple, sapota, papaya, tomato and banana) placed along with some unripe matured fruits (in a ratio of 1:100 in a closed environment (Prashanta,2014)) to initiate ripening.

Results and Discussions

Physiological loss in weight (%)

Among the different interaction treatment E₂N₄ showed the lowest (1.65) physiological loss in weight on the 3rd day which was at par with E₂N₅ (1.83) and E₂N₃ (1.83) and highest loss (4.23) recorded in E₃N₁ and in control (4.64). Whereas same increasing trend of physiological weight was observed from 6th to 18th day. On 18th day E₂N₄ showed the lowest (13.47) physiological loss in weight which was at par with E₂N₅ (13.79) and E₂N₃ (13.80) followed by E₂N₂ (14.33) and highest loss (18.93) in E₃N₁. The physiological loss of weight (14.69) was recorded in control on 12th day.

Aloe vera gel in combination with different ethylene sources has given the significant results for the main crop of banana. Among the different treatments the aloe vera gel in combination with tomatoes given the better results when compared to the combination with apples this might be due to the fact that apple is a good generator of ethylene and initiated the ripening process faster than the other fruits. The mechanism involved in the positive effect of aloe vera gel can be explained based on its hydrophobic property which enables formation of a barrier to water diffusion between the fruit and outside environment thus avoiding its external interference.

Fruit color (Score)

With respect to interaction effect there was non-significant difference observed among the treatments. The treatment E₂N₄ showed the lowest (1.16) change in fruit colour and the highest (1.29) on the 3rd day in E₃N₁ and in control (1.53). Similar increasing trend of fruit colour was observed from 6th to 18th day. On 18th day treatment E₂N₄ showed the lowest (5.71) change in fruit colour and the highest (7.95) was recorded in E₃N₁. The fruit colour (6.89) was recorded in control on 12th day.

The earliest visual sign of ripening was a change in colour primarily due to disappearance of chlorophyll at peak and post climacteric stage, higher amount of ethylene released from apples during peak climacteric period. Aloe vera coated fruits showed a lesser loss in chlorophyll, lesser development of xanthophyll and reduced rate of ripening. Many coatings have the added advantage of providing a moisture barrier that reduces dehydration in the fruit during storage. Similar results of colour retention in coated fruit had been reported in carambola fruits (Neeta *et al.*, 2013) [3]

Fruit spoilage (%)

The interaction effect also showed the significant difference among the treatments. No spoilage was seen up to 3 days of storage. Among the different interaction's treatment E₂N₄ showed the no spoilage and the highest (2.35) was noticed on in E₃N₁ and in control (3.05) on 6th day. Whereas same increasing trend of fruit spoilage was observed from 6th to 18th day and almost the results obtained in these days were found to be non-significant. On 18th day treatment E₂N₄ showed the lowest (5.26) spoilage and the highest (7.51) was recorded in E₃N₁. The spoilage (8.55) was recorded in control on 12th day. This is because aloe vera gel is not only capable of reducing the rate of respiration and ripening process but also can significantly retard the growth of bacteria, fungi and molds that is known to cause rotting in fruits. Mature fruits coated with Aloe vera showed an extended life in comparison to control, which may be attributed to its antimicrobial properties and hygroscopic properties of gel that enable the formation of a barrier to diffusion of gasses and water vapour between fruit and environment.

Fruit firmness (kg/cm²)

The interaction treatments showed the significant difference among them. Among the different interaction's treatment E₂N₄ showed the highest (3.49) firmness on the 3rd day which was at par with E₂N₅ (3.48) and E₂N₃ (3.45) followed by E₂N₂ (3.38) and lowest (2.83) in E₃N₁ and in control (2.79). Whereas same trend was observed from 6th to 18th day. On 18th day E₂N₄ showed the highest (3.20) firmness which was at par with E₂N₅ (3.14) and E₂N₃ (3.14) followed by E₂N₂ (3.06) and lowest (2.37) in E₃N₁. The fruit firmness (2.18) was

recorded in control on 12th day

Synergistic effect of Aloe vera coating experimentally noted in reduced respiratory and transpirational loss in fruit weight, maintenance of fruit texture or firmness, activity of cell wall hydrolase and reduced rate of chlorophyll degradation and thereby extending shelf life and also less release of ethylene from natural ethylene sources. Aloe vera gel has been proved to maintain the texture of fruit efficiently. This may be due to the effect of Aloe vera gel on the reduction of galactosidase, polygalacturonase, and pectinmethyl-esterase activities (Warthakar *et al.*, 2017) ^[10]

Shelf life (days)

The interaction treatments also showed the significant difference among them. Among the different interaction's treatment E₂N₄ showed the highest (24.33) shelf life which was at par with E₂N₂ (22.67), E₂N₃ (23.00) and E₂N₅ (23.00) followed by E₂N₁ (21.67) and less days (19.00) in E₃N₁. The Shelf life for the fruits in control is 13.00 days.

Shelf life of any fruits calculated from the period of harvest up to rotting. Shelf life was the period of time which started from the time of harvesting and extended up to the start of rotting of fruit and it is the basic quality of fruit as well as it is

the most important parameter in loss of reduction biochemical reaction of fruit and more release of ethylene from apples resulted in early ripening and thus resulting reducing the shelf life

Ripening days

Among the different interactions treatment E₂N₄ showed the more (11.49) days for ripening and less days (9.04) was observed in E₃N₁ and results for interaction found to be non-significant and for the control it has taken 5.04 days.

On the basis of results obtained, it can conclude that all the botanical extracts significantly reduced the ripening percentage in banana and in turn increased the shelf life of fruits. The retardation of ripening process observed in present study may be attributed to reduced ethylene production caused by the modified atmosphere and less ethylene from other climacteric fruits apart from apples. Many coatings have the added advantage of providing a moisture barrier that reduces dehydration in the fruit during storage. One advantage to the use of coatings in a fruit like bananas, is that the skin is not normally consumed, possibly providing greater flexibility in the choice of coating materials (Neeta *et al.*, 2013) ^[3].

Table 1: Effect of plant extracts and natural ethylene sources on physiological loss in weight (%) of banana main crop under conditions

Physiological loss in weight at 3 rd day							Physiological loss in weight at 6 th day							Physiological loss in weight at 9 th day						
Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean
E1	3.05	2.72	2.63	2.21	2.55	2.63	E1	4.50	4.17	4.08	3.66	4.00	4.08	E1	6.78	6.45	6.36	5.94	6.28	6.36
E2	2.06	1.95	1.83	1.65	1.83	1.86	E2	3.51	3.40	3.38	3.10	3.28	3.33	E2	5.79	5.68	5.60	5.38	5.56	5.60
E3	4.23	4.05	3.55	3.21	3.29	3.67	E3	5.68	5.50	5.00	4.66	4.17	5.00	E3	7.96	7.78	7.28	6.94	7.02	7.40
Mean	3.11	2.91	2.67	2.36	2.56		Mean	4.56	4.35	4.15	3.81	3.81		Mean	6.84	6.63	6.41	6.09	6.28	
Control	4.64						Control	8.28						Control	10.97					
	SE.m±		CD (5%)					SE.m±		CD (5%)					SE.m±		CD (5%)			
E	0.03		0.11				E	0.04		0.13				E	0.05		0.15			
N	0.05		0.14				N	0.06		0.17				N	0.06		0.19			
ExN	0.08		0.25				ExN	0.10		0.30				ExN	0.11		0.34			

Physiological loss in weight at 12 th day							Physiological loss in weight at 15 th day							Physiological loss in weight at 18 th day						
Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean
E1	9.32	9.12	8.92	8.56	8.77	8.94	E1	14.40	13.7	13.16	12.41	13.04	13.34	E1	16.49	15.76	15.22	14.84	15.03	15.47
E2	8.33	8.22	7.82	7.46	7.72	7.91	E2	12.17	11.67	10.92	10.71	10.97	11.29	E2	14.67	14.33	13.8	13.47	13.79	14.01
E3	12.16	11.41	11.06	9.56	10.48	10.93	E3	16.47	16.16	15.87	14.74	15.47	15.74	E3	18.93	18.44	18.22	17.44	17.66	18.14
Mean	9.94	9.58	9.27	8.53	8.99		Mean	14.35	13.85	13.32	12.62	13.16		Mean	16.70	16.18	15.75	15.25	15.50	
Control	14.69						Control	**						Control	**					
	SE.m±		CD (5%)					SE.m±		CD (5%)					SE.m±		CD (5%)			
E	0.05		0.15				E	0.04		0.12				E	0.05		0.16			
N	0.07		0.20				N	0.05		0.15				N	0.07		0.21			
ExN	0.12		0.35				ExN	0.09		0.26				ExN	0.12		0.36			

E-Extracts N-Natural ethylene sources (Matured fruits)

E1-Leaf extract of Neem E2-Aloe vera gel extract E3-Rhizome extract of ginger

Table 2: Effect of plant extracts and natural ethylene sources on fruit colour (score) of banana main crop under ambient conditions

Fruit colour at 3 rd day							Fruit colour at 6 th day							Fruit colour at 9 th day						
Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean
E1	1.23	1.22	1.21	1.22	1.21	1.22	E1	2.30	2.27	2.26	2.16	2.19	2.24	E1	3.31	3.21	3.11	2.75	2.95	3.07
E2	1.21	1.19	1.18	1.16	1.18	1.18	E2	2.07	2.06	2.07	1.97	2.05	2.04	E2	2.75	2.71	2.65	2.55	2.64	2.66
E3	1.29	1.28	1.26	1.24	1.25	1.26	E3	2.60	2.61	2.34	2.32	2.33	2.44	E3	4.06	3.44	3.39	3.33	3.34	3.51
Mean	1.24	1.23	1.22	1.21	1.21		Mean	2.32	2.31	2.22	2.15	2.19		Mean	3.37	3.12	3.05	2.88	2.97	
Control	1.53						Control	4.35						Control	5.82					
	SE.m±		CD (5%)					SE.m±		CD (5%)					SE.m±		CD (5%)			
E	0.03		NS				E	0.06		0.17				E	0.06		0.18			
N	0.04		NS				N	0.07		NS				N	0.08		0.23			
ExN	0.07		NS				ExN	0.13		NS				ExN	0.14		NS			

Fruit colour 12 th day							Fruit colour 15 th day							Fruit colour 18 th day						
Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean
E1	4.53	4.45	4.29	4.09	4.19	4.31	E1	5.53	5.43	5.42	4.7	4.77	5.17	E1	7.04	6.95	6.86	6.61	6.71	6.83

E2	3.65	3.62	3.61	3.33	3.53	3.55	E2	4.67	4.65	4.45	4.33	4.43	4.51	E2	6.09	6.04	5.79	5.71	5.78	5.88
E3	5.29	5.19	5.09	4.98	4.99	5.11	E3	6.53	6.43	5.73	5.61	5.73	6.01	E3	7.95	7.79	7.73	7.70	7.71	7.78
Mean	4.49	4.42	4.33	4.13	4.24		Mean	5.58	5.50	5.20	4.88	4.98		Mean	7.03	6.93	6.79	6.67	6.73	
Control	6.89						Control	**						Control	**					
	SE.m±			CD (5%)				SE.m±			CD (5%)				SE.m±			CD (5%)		
E	0.04			0.11			E	0.12			0.37			E	0.12			0.37		
N	0.05			0.15			N	0.16			0.48			N	0.16			0.48		
ExN	0.09			0.27			ExN	0.28			NS			ExN	0.28			NS		

E-Extracts N-Natural ethylene sources (Matured fruits)

E1-Leaf extract of Neem E2-Aloe vera gel extract E3 –Rhizome extract of ginger

Table 2 Effect of plant extracts and natural ethylene sources on fruit colour (score) of banana main crop under ambient conditions

E-Extracts N-Natural ethylene sources (Matured fruits)

E1-Leaf extract of Neem E2-Aloe Vera gel extract E3 –Rhizome extract of ginger

Table 3: Effect of plant extracts and natural ethylene sources on Fruit spoilage (%) of banana main crop under ambient conditions

Fruit spoilage at 6 th day							Fruit spoilage at 9 th day							Fruit spoilage at 12 th day						
Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean
E1	1.07	0.83	0.61	0.45	0.54	0.70	E1	1.25	1.13	0.85	0.73	0.84	0.96	E1	1.95	1.94	1.93	1.84	1.93	1.92
E2	0.17	0.16	0.00	0.00	0.00	0.07	E2	0.74	0.73	0.63	0.31	0.55	0.59	E2	1.75	1.73	1.75	1.14	1.74	1.62
E3	2.35	1.87	1.81	1.25	1.71	1.80	E3	2.42	2.14	1.89	1.34	1.85	1.93	E3	3.17	2.84	2.36	2.04	2.36	2.55
Mean	1.20	0.95	0.81	0.57	0.75		Mean	1.47	1.33	1.12	0.79	1.08		Mean	2.29	2.17	2.01	1.67	2.01	
Control	3.05						Control	4.37						Control	8.55					
	SE.m±			CD (5%)				SE.m±			CD (5%)				SE.m±			CD (5%)		
E	0.06			0.18			E	0.05			0.15			E	0.04			0.13		
N	0.08			0.24			N	0.06			0.19			N	0.05			0.17		
ExN	0.14			0.41			ExN	0.11			0.33			ExN	0.10			2.94		
Fruit spoilage 15 th day							Fruit spoilage at 18 th day													
Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean							
E1	3.35	3.39	3.28	3.08	3.17	3.25	E1	7.20	6.40	6.20	6.10	6.09	6.40							
E2	2.58	2.47	2.39	2.32	2.38	2.43	E2	5.90	5.80	5.79	5.26	5.31	5.61							
E3	4.24	4.17	4.15	3.39	3.98	3.99	E3	7.51	7.44	7.40	7.28	7.36	7.40							
Mean	3.39	3.34	3.27	2.93	3.18		Mean	6.87	6.55	6.46	6.21	6.25								
Control	**						Control	**												
	SE.m±			CD (5%)				SE.m±			CD (5%)									
E	0.07			0.2			E	0.11			0.32									
N	0.09			0.26			N	0.14			NS									
ExN	0.15			NS			ExN	0.25			NS									

E-Extracts N-Natural ethylene sources (Matured fruits)

E1-Leaf extract of Neem E2-Aloe Vera gel extract E3 –Rhizome extract of ginger

Table 4: Effect of plant extracts and natural ethylene sources on fruit firmness (kg/cm²) of banana main crop under ambient conditions

Fruit firmness at 3 rd day							Fruit firmness at 6 th day							Fruit firmness at 9 th day						
Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean
E1	3.15	3.22	3.25	3.27	3.26	3.23	E1	3.12	3.19	3.30	3.34	3.32	3.25	E1	3.05	3.11	3.12	3.27	3.24	3.16
E2	3.35	3.38	3.45	3.49	3.48	3.38	E2	3.30	3.34	3.41	3.43	3.42	3.43	E2	3.27	3.29	3.32	3.39	3.37	3.33
E3	2.83	2.98	2.93	3.14	3.10	2.98	E3	2.81	2.93	2.92	3.02	3.00	2.95	E3	2.77	2.78	2.88	2.95	2.89	2.85
Mean	3.09	3.16	3.19	3.28	3.26		Mean	3.10	3.18	3.23	3.28	3.27		Mean	3.03	3.06	3.11	3.2	3.17	
Control	2.79						Control	2.68						Control	2.34					
	SE.m±			CD (5%)				SE.m±			CD (5%)				SE.m±			CD (5%)		
E	0.03			0.09			E	0.03			0.10			E	0.03			NS		
N	0.04			0.12			N	0.04			0.13			N	0.04			0.13		
ExN	0.07			0.21			ExN	0.07			0.22			ExN	0.07			0.22		
Fruit firmness at 12 th day							Fruit firmness at 15 th day							Fruit firmness at 18 th day						
Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean
E1	3.02	3.09	3.11	3.26	3.22	3.14	E1	2.87	2.96	3.02	3.16	3.13	3.03	E1	2.28	2.45	2.79	2.98	2.88	2.80
E2	3.23	3.25	3.30	3.29	3.31	3.27	E2	3.22	3.24	3.29	3.28	3.26	3.26	E2	3.04	3.06	3.14	3.20	3.14	3.13
E3	2.73	2.77	2.86	2.92	2.89	2.83	E3	2.67	2.72	2.76	2.87	2.85	2.77	E3	2.37	2.38	2.40	2.68	2.49	2.46
Mean	2.99	3.04	3.09	3.16	3.14		Mean	2.92	2.97	3.02	3.10	3.08		Mean	2.69	2.70	2.78	2.97	2.84	
Control	2.18						Control	**						Control	**					
	SE.m±			CD (5%)				SE.m±			CD (5%)				SE.m±			CD (5%)		
E	0.04			NS			E	0.04			NS			E	0.05			0.16		
N	0.05			0.16			N	0.06			0.17			N	0.07			0.20		
ExN	0.10			0.29			ExN	0.10			0.30			ExN	0.12			0.36		

E-Extracts N-Natural ethylene sources (Matured fruits)

E1-Leaf extract of Neem E2-Aloe vera gel extract E3 –Rhizome extract of ginger

Table 5: Effect of plant extracts and natural ethylene sources shelf life (days) and ripening days of banana main crop under ambient conditions

Shelf life (days)							Ripening days						
Treatments	N1	N2	N3	N4	N5	Mean	Treatments	N1	N2	N3	N4	N5	Mean
E1	20.67	21.00	21.00	21.67	21.33	21.13	E1	9.77	9.78	9.86	9.89	9.86	9.83
E2	21.67	22.67	23.00	24.33	23.00	22.93	E2	10.35	10.51	10.77	11.49	10.87	10.80
E3	19.00	19.33	19.67	20.33	20.00	19.67	E3	9.04	9.51	9.53	9.60	9.55	9.45
Mean	20.45	21.00	21.22	22.11	21.44		Mean	9.72	9.93	10.05	10.33	10.09	
Control	13.00						Control	5.04					
	SE.m±		CD (5%)					SE.m±		CD (5%)			
E	0.28		0.82				E	0.15		0.44			
N	0.36		1.06				N	0.19		0.56			
Ex.N	0.63		1.85				Ex.N	0.33		NS			

E-Extracts N-Natural ethylene sources (Matured fruits)

E1-Leaf extract of Neem E2-Aloe Vera gel extract E3 –Rhizome extract of ginger

N1 –Apple N2–Sapota N3-Papaya N4- Tomato N5-Banana

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