INDIAN JOURNAL OF ARID HORTICULTURE
2008, Vol. 3 (1) : 27-32

Post-harvest effect of packaging material, neem leaf extract and fumigation on colour, texture, shriveling and rotting of aonla (*Emblica officinalis*)

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Abstract

Aonla is non-climacteric fruit and each year a considerable proportion of aonla fruits are lost through spoilage mainly due to their faulty techniques of storage. Proper storage extends the period of availability of aonla by arresting the metabolic deterioration caused by fungal and microbial activities. In recent years, techniques which are commercially cheaper and require no energy have been developed to retain post-harvest quality of fruits and vegetables for longer period. Proper packaging of fruits and vegetables play a decisive role in reducing the post-harvest losses. keeping the above facts in view, present investigation entitled "Post-harvest effect of packaging material, neem leaf extract and fumigation on colour, texture, shriveling and rotting of Aonla (*Emblica officinalis*)" was undertaken. The physiological loss in colour, texture, shriveling and rotting of "Chakaiya" cultivar of aonla fruit was significantly affected by packaging materials, neem leaf extracts and diphenyl fumigation and their combinations throughout the storage period up to 21st days.

Key words: *Aonla, post harvest, packaging materials, neem leaf extracts, diphenyl fumigation.*

Introduction

Commercial cultivation of aonla is becoming important and its production is increasing rapidly in Rajasthan. The high acceptability of aonla fruit is due to their high medicinal values and the fact that they are rich source of vitamin 'C'. Aonla is non-climacteric fruit and each year a considerable proportion of aonla fruits are lost through spoilage mainly due to their faulty techniques of storage. Under ordinary room temperature conditions aonla fruits are liable to be spoiled quickly by microbial and fungal infection. Thus, the problem of post-harvest spoilage of fruits is a challenge to the scientists of the country. Dealers and consumers of aonla incur great economic losses due to improper storage conditions. Proper storage extends the period of availability of aonla by arresting the metabolic deterioration caused by fungal and microbial activities. In recent years, techniques which are commercially cheaper and require no energy have been developed to retain post-harvest quality of fruits and vegetables for longer period. Among these techniques, the use of improved packaging materials and plant extracts has been found to be quite effective and economical. However, little or no research has been done to extend post-harvest shelf life of aonla using these techniques. Proper packaging of fruits and vegetables play a decisive role in reducing the post-harvest losses. A bright possibility, therefore, exist for adoption or use of commercially cheaper techniques to extend shelf life of aonla under Rajasthan conditions. With the above facts in view, present investigation entitled "Post-harvest effect of packaging material, neem leaf extract and fumigation on colour, texture, shriveling and rotting of Anola (*Emblica officinalis*)" was undertaken.

Material and methods

Fresh and fully ripe fruits of aonla cultivar "Chakaiya" were obtained from the orchard of aonla growers, village Dabok district Udaipur and brought to the laboratory for the purpose of experiment. Bruised and immature fruits were discarded. The details of the various materials used for extending shelf-life of aonla are given below:

(A) Packaging material
Symbols
(a) Gunny bag (Control) P_0
(b) Corrugated paper boxes P_1
(c) Bamboo basket P_2

(B) Neem leaf extract:
(a) No neem leaf extract N_0
(b) Neem leaf extract 10% N_1
(c) Neem leaf extract 20% N_2

(C) Fumigation:
(a) No fumigation F_0
(b) Diphenyl (1 g) F1

randomly taken from each replication and the marks were allotted according to the category at the time of storage. Colour of the fruits was observed by panel of four judges by visual method i.e., greenish, greenish yellow, yellowish, yellow with white strips and dull green etc. Shrivelling of fruits was observed by visual method and giving marks out of 10 points.

S.No.	Shrivelling Marks (Range)	
1.	No shriveling	10.00
2.	Very low shriveling	9.99-7.5
3.	Low shriveling	7.49-5.00
4.	Medium shriveling	4.99-2.50
5.	High shriveling	Less than 2.5

Rotten fruits were usually counted out of total fruits at an interval of 7th, 14th and 21st day of storage and rotting was expressed on percentage basis. The experiment was laid out in a factorial completely randomized design (CRD). There were three replications. The analysis of

Details of treatment combination:

Treatment combinations	Symbols
Gunny bag without neem leaf extract and diphenyl fumigation (control)	P0N0F0
Gunny bag + Diphenyl fumigation (1g)	P0N0F1
Gunny bag + Diphenyl fumigation	P0N1F0
Gunny bag + Neem leaf extract (10%) + Diphenyl (1g)	P0N1F1
Gunny bag + Diphenyl fumigation (20%)	P0N2F0
Gunny bag + Neem leaf extract (20%) + Diphenyl (1g)	P0N2F1
Corrugated paper box	P1N0F0
Corrugated paper box + Diphenyl fumigation (1g)	P1N0F1
Corrugated paper box + Neem leaf extract (10%)	P1N1F0
Corrugated paper box + Neem leaf extract (10%) + Diphenyl (1g)	P1N1F1
Corrugated paper box + Neem leaf extract (20%)	P1N2F0
Corrugated paper box + Neem leaf extract (20%)+ Diphenyl (1g)	P1N2F1
Bamboo basket	P2N0F0
Bamboo basket + Diphenyl fumigation (1g)	P2N0F1
Bamboo basket + Neem leaf extract (10%)	P2N1F0
Bamboo basket + Neem leaf extract (10%)+ Diphenyl (1g)	P2N1F1
Bamboo basket + Neem leaf extract (20%)	P2N2F0
Bamboo basket + Neem leaf extract (20%) + Diphenyl (1g)	P2N2F1

Standard plant extract solution was prepared as per the method developed by Parimelazhagan and Fransis (1999). In case of diphenyl (diphenylamine) 1g was dissolved in 5ml acetone and the bloating papers were dipped in the solution and air dried. The diphenyl treated bloating papers were used for lining in the corrugated paper box and bamboo baskets. The treated fruits were stored at ambient room temperature (17 to 20°C) and subjected to various physico-chemical observations as per detail given. The texture of the aonla fruit was judged by the thumb and nail (thumb and finger) method. For this purpose fruits were

variance technique of Cochran and Cox (1950) was used to determine significance/non-significance among data of the results.

Result and discussion

Colour: The data presented in Table 1 indicate that the colour of fruit was significantly affected by packaging material, neem leaf extract and diphenyl fumigation treatments during the entire period of storage. The maximum value of colour were recorded in P_1 (5.41) and P_2 (5.4) treatments which were almost at par as compared to the mini-

mum in P_0 (3.30) at the end of the 21st days of storage. Similarly, combined application of packaging materials, neem leaf extracts and diphenyl fumigation helped in the retention of attractive light yellowish green colour of fruits. This can be seen from the fact that the maximum high colour value (5.43) was recorded in $P_1N_0F_0$ and P1N1F0 treatment as against the minimum value (Table 2). It implies that the effect of combined application of $P_1N_0F_0$ and $P_1N_1F_0$ is almost at par with individual treatments of packaging material and neem leaf extracts. Thus, it is clear from the present results that aonla fruits of "Chakaiya" cultivar packed in corrugated paper boxes/bamboo basket) and treated 10% neem leaf extract retained natural yellowish green colour for 21st days during storage.

Retardation in physiological change by treatments with plant extracts during storage has been reported by Babu and Reddy (1986). Perhaps biochemical changes in colour are slowed down by these treatments thereby resulting in retention of usual fruit colour during storage. In the present investigation, plant extracts i.e., neem leaf extract was found to affect the colour retention of fruit, during storage. Neem leaf extract might have helped indirectly in slowing down the process of change in colour. In other words, those compounds which are responsible for deterioration in fruit colour might have been reduced by plant extracts. Packaging materials were found to affect fruit colour, might have been reduced by plant extracts. Packaging materials were found to affect fruit colour. A possible reason for this could be that packaging materials form a cover over the fruits leading to reduction in oxygen concentration. As a result, the respiration in fruits may be slow down due to which the degeneration of colour in treated fruit is reduced. Packaging material prevents the fruits from the direct sun rays which may also results in less fading of colour.

Texture: The texture of the fruit was significantly affected by packaging material, neem leaf extract and diphenyl fumigation treatments during the entire period of storage (Table 1). The maximum texture value was recorded in P_2 (3.44), N_1 and N_2 (each 2.10) and F_1 (2.70) treatment 21st day of storage as compared to minimum in P_0 (1.22), N_0 (2.69) and F_0 (2.69). The combined application of packaging material, neem leaf extract and diphenyl fumigation significantly affected fruit texture during storage (Table 2). This is evident from the fact that maximum texture value (3.45) was recorded when combined application of bamboo basket +20% neem leaf extract with or without diphenyl ($P_2N_2F_1$, P2N2F0) was applied. It implies that the effect of combined application ($P_2N_2F_1$, $P_2N_2F_0$) was almost at par with the individual treatment of packaging material, neem leaf exracts and diphenyl fumigation. Thus, it is clear from the present result that Chakaiya aonla fruits packed in bamboo/corrugated paper boxes with or without 20% neem leaf extract can retain natural texture of fruits for 21st days during storage. Retardation in physiological changes by treatments with plant extracts during storage has been reported by several researchers (Khanna, and Chandra, 1989,

Table 1. Effect of packaging material, neem leaf extract and dipehnyl fumigation on reduction in fruit colour and texture.

Treatments	Colour* loss (%)			Texture loss (%)		
	Storage days			Storage days		
	7	14	21	7	14	21
Packaging material						
P_0	8.02	5.28	3.30	3.47	3.42	1.22
P_1	8.73	7.43	5.41	8.72	6.22	3.43
P_2	8.73	7.43	5.40	8.69	6.22	3.44
SEm±	0.009	0.014	0.019	0.007	0.007	0.008
CD at 5%	0.026	0.039	0.057	0.021	0.022	0.024
Neem Leaf Extracts						
N_0	8.49	6.61	4.43	6.95	5.28	2.69
N_1	8.50	6.76	4.84	6.96	5.29	2.70
N_2	8.50	6.76	4.83	6.96	5.29	2.7
SEm±	0.007	0.014	0.019	0.007	0.007	0.008
CD at 5%	NS	0.039	0.057	NS	NS	NS
Fumigation						
F_0	8.49	6.66	4.57	6.96	5.28	2.69
F_1	8.50	6.76	4.83	6.96	5.29	2.70
SEm±	0.007	0.011	0.016	0.006	0.006	0.007
CD at 5%	NS	0.032	0.047	NS	NS	NS

Initial Colour Value = 10

*Values derived from 0-10 point scale.

Table 2. Effect of combined application of packaging material, neem leaf extract and fumigation on reduction in fruit colour and texture.

Treatments	Colour Loss (%)			Texture loss(%)		
	Storage days			Storage days		
	7	14	21	7	14	21
$P_0N_0F_0$	24.0	4.53	1.29	3.46	3.42	1.21
$P_0N_0F_1$	24.1	5.43	3.71	3.47	3.42	1.22
$P_0N_1F_0$	24.1	5.43	3.71	3.47	3.43	1.23
$P_0N_1F_1$	24.1	5.43	3.71	3.47	3.43	1.23
$P_0N_2F_0$	24.1	5.43	3.71	3.47	3.43	1.22
$P_0N_2F_1$	24.1	5.43	3.71	3.47	3.43	1.22
$P_1N_0F_0$	26.2	7.43	5.43	8.71	3.51	3.43
$P_1N_0F_1$	26.2	7.43	5.40	8.72	6.22	3.43
$P_1N_1F_0$	26.2	7.43	5.40	8.72	6.22	3.43
$P_1N_1F_1$	26.2	7.43	5.40	8.72	6.22	3.44
$P_1N_2F_0$	26.2	7.43	5.40	8.71	6.22	3.43
$P_1N_2F_1$	26.2	7.43	5.40	8.68	6.22	3.44
$P_2N_0F_0$	26.2	7.43	5.40	8.68	6.22	3.44
$P_2N_0F_1$	26.2	7.43	5.40	8.68	6.21	3.44
$P_2N_1F_0$	26.2	7.43	5.40	8.68	6.21	3.44
$P_2N_1F_1$	26.2	7.43	5.40	8.71	6.22	3.44
$P_2N_2F_0$	26.2	7.43	5.40	8.71	6.21	3.45
$P_2N_2F_1$	26.2	7.43	5.40	8.71	6.23	3.45
SEm±	0.022	0.033	0.049	0.018	0.019	0.021
CD at 5%	NS	0.096	0.140	NS	NS	NS

Initial Colour Value = 10

* Values derived from 0-10 point scale.

Purohit, 2000 and Rameshwar 2000).

Shrivelling: Shrivelling of fruits is also directly related to the moisture loss and thus affects the physical appearance. Shriveling of fruits was significantly affected as a result of packaging material, neem leaf extract and diphenyl fumigation treatment from 0-21st day of storage (Table 3). The mean minimum shriveling value was found in fruits packed in bamboo basket at various storage intervals. The treatments with bamboo basket packaging had significantly less shriveling as compared to P_0 (control). It is clear that after 14th days of storage bamboo basket packaging was more effective in retarding the shriveling of aonla, followed by neem leaf extracts 10% and 20%, respectively. Very high shriveling was found in P_0 packaging material (3.13) and in combined treatment only value was (1.28) in $P_0N_0F_0$ (Table 4). Shrivelling of aonla increased with the advancement of storage days. Very low shriveling was observed on the 7th day of storage as against the medium shriveling which occurred at the end of 21st days of storage. Sharma, *et al.*, (1991) reported that shriveling was reduced by HDPE bag and diphenyl fumigation in okra during storage and thus supports to some extent the present findings. It is likely that moisture escapes through the cell wall during storage by the process of evapo-transpiration and shriveling of fruits occurs. Furthermore, at room temperature, respiration rate of aonla fruits is very high hence better results in terms of low shriveling with bamboo baskets and neem leaf extract treatments may be attributed to their effectiveness in reducing PLW.

Rotting: Rotting of fruits was significantly affected as a result of packaging material, neem leaf extract and diphenyl fumigation treatments from 0-21st days of storage (Table 3). Among the effects of individual treatments, minimum rotting was recorded with bamboo basket packaging material (28.80%) followed by 20% neem leaf extracts as compared to the maximum rotting (39.53%) in control. When main treatments were combined together, the rotting of fruits was further reduced. Only 28.36 per cent rotting was recorded at bamboo basket 20% neem leaf extract+1 g diphenyl fumigation treatment followed by 28.45 per cent rotting at corrugated paper box + 20% neem leaf extract+1 g diphenyl fumigation treatment as compared to control (39.53%) at the end of 21st days of storage (Table 4). Chopra *et al.* (1965) reported the therapeutic use of a number of plant extracts and suggested that plant extracts alter the metabolism and physiology of fruits. Moreover, growth, sporulation and spore germination of rot causing fungus is also inhibited by the plant extracts. (Bhowmick and

Table 3. Effect of packaging material, neem leaf extract and fumigation on rotting and shriveling of fruit.

Treatments	Shrivelling* Storage days			Rotting		
Packaging material	7	14	21	7	14	21
P_0	7.87	5.44	3.13	5.41(0.80)	24.09(16.66)	31.11(26.70)
P_1	7.87	7.28	5.29	4.23(0.54)	21.62(13.58)	29.30(23.95)
P_2	7.87	7.33	5.77	4.84(0.71)	21.42(13.34)	28.80(23.21)
SEm±	0.008	0.020	0.098	0.004	0.038	0.030
CD at 5%	NS	0.058	0.282	0.074	0.111	0.087
Neem Leaf Extracts						
N_0	6.16	5.62	3.58	5.28(0.86)	23.76(16.24)	50.96(26.46)
N_1	8.73	7.22	5.30	4.67(0.66)	22.20(14.23)	29.38(24.70)
N_2	8.73	7.22	5.30	4.54(0.63)	21.18(13.60)	28.88(23.23)
SEm±	0.080	0.020	0.098	0.004	0.038	0.030
CD at 5%	0.023	0.058	0.282	0.074	0.111	0.087
Fumigation						
F_0	7.87	6.57	4.31	9.67(2.82)	23.40(15.68)	30.65(25.19)
F_1	7.87	6.79	5.15	0.00(0.00)	21.36(13.26)	28.83(23.24)
SEm±	0.006	0.016	0.080	0.003	0.031	0.024
CD at 5%	NS	0.047	0.230	0.071	0.070	0.071

Initial Colour Value = 10

*Values derived from 0-10 point scale.

Table 4. Effect of combined application of packaging material, neem leaf extract and fumigation on rotting and shriveling of fruits.

Treatments	Shrivelling* Storage days			Rotting Storage days		
	7	14	21	7	14	21
$P_0N_0F_0$	6.16	3.72	1.28	13.56(5.50)	33.49(30.28)	39.53(40.52)
$P_0N_0F_1$	6.16	5.72	2.63	0.00(0.00)	22.05(14.09)	29.62(24.43)
$P_0N_1F_0$	8.73	5.80	3.72	10.77(3.49)	23.84(16.34)	30.87(31.07)
$P_0N_1F_1$	8.73	5.80	3.72	0.00(0.00)	21.53(13.46)	28.93(23.00)
$P_0N_2F_0$	8.73	5.80	3.72	8.16(2.02)	22.10(14.15)	29.19(23.80)
$P_0N_2F_1$	8.73	5.80	3.72	0.00(0.00)	21.53(13.46)	28.52(22.80)
$P_1N_0F_0$	6.16	6.00	1.25	8.15(2.02)	22.38(14.50)	29.73(24.60)
$P_1N_0F_1$	6.16	6.00	6.00	0.00(0.00)	21.55(13.49)	28.99(23.49)
$P_1N_1F_0$	8.73	7.93	6.13	8.14(2.01)	22.61(14.78)	29.73(24.60)
$P_1N_1F_1$	8.73	7.93	6.13	0.00(0.00)	21.64(13.60)	29.41(24.12)
$P_1N_2F_0$	8.73	7.93	6.13	9.12(2.51)	21.21(13.10)	29.53(24.30)
$P_1N_2F_1$	8.73	7.93	6.13	0.00(0.00)	20.35(12.10)	28.45(29.70)
$P_2N_0F_0$	8.73	6.13	4.42	9.69(2.43)	21.55(13.49)	29.40(24.00)
$P_2N_0F_1$	8.73	6.13	5.93	0.00(0.00)	21.35	28.47
$P_2N_1F_0$	8.73	7.93	6.06	9.12(2.51)	21.89(13.90)	28.63(22.94)
$P_2N_1F_1$	8.73	7.93	6.06	0.00(0.00)	21.69(13.66)	28.72(23.10)
$P_2N_2F_0$	8.73	7.93	6.06	9.98(3.00)	21.53	29.24
$P_2N_2F_1$	8.73	7.93	6.06	0.00(0.00)	20.35(12.10)	28.36(22.48)
SEm±	0.020	0.049	0.241	0.011	0.094	0.074
CD at 5%	NS	0.143	0.692	0.034	0.271	0.213

Initial Colour Value = 10

Values derived from 0-10 point scale.

Figures in parentheses are retransformed values.

Vardhan, 1981). Effectiveness of packaging materials in reducing the rotting and prolonging the shelf life of fruits in comparison to FONOFO treatment as found in the present study can be corroborated by the findings of other researchers (Sharma, *et al*.,1991). From the present result it is clear that 20% neem leaf extract seems to be effective for this diphenyl fumigation in reducing rotting of fruits. Singh, et al., (1993) also reported that diphenyl 0.50 g/box is effective in reducing the decay loss of aonla fruits cv. Chakaiya. The present findings are also supported by the results obtained by several another researchers who have also found reduction in the loss of fruit by rotting by diphenyl fumigation (Singh, *et al*.,1993 and Sharma, *et al*., 1992).

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