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Ripening regulation and post-harvest life improvement of banana cv. MALBHOG using plant extracts and modified atmosphere package

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ABSTRACT : A study on ripening regulation and post-harvest life improvement of banana cv. MALBHOG using different plant extracts and modified atmosphere package was under taken to assess the effect of plant extracts and modified atmosphere package on banana fruit ripening and quality parameters after harvest under ordinary room condition. The experiment was conducted at Central laboratory of Post-Harvest Horticulture of Agriculture and Forestry University, Rampur, Chitwan, Nepal from 3rd May to 31st May 2016. The experiment consisted of eight treatments, control, garlic extracts, *Neem* extracts, onion extracts, sesamum oil, ginger extract, unperforated low density poly ethylene (50 µm) containing cotton soaked with $KMnO_4$ and perforated low density polyethylene (50 µm) containing cotton soaked with $KMnO_4$, respectively that were replicated thrice. Different post-harvest parameters were recorded in two days interval for 15 days in the second experiment. In this experiment, the minimum physiological loss in weight on the final day of storage was observed in fruits kept inside the unperforated low density polyethylene containing cotton soaked with $KMnO_4$ (7.46 %). The highest colour score (7.00) and the lowest firmness were noted with control (0.467 kg/cm^2). The highest pulp to peel ratio was recovered with control (4.075) and the lowest with unperforated low density polyethylene containing cotton soaked in $KMnO_4$ (3.007) followed by *Neem* extracts (3.087). The highest TSS content was noticed in control (19.37ºBrix) on 15th DAS while the highest titratable acidity was obtained with neem extract. The maximum vitamin C content (6.633 mg/100 g) was recorded with neem extract. The unperforated LDPE containing cotton dipped in $KMnO_4$ resulted in longer shelf-life (27 days).The minimum disease incidence was noticed with the unperforated LDPE containing $KMnO_4$ (25 %) followed by neem extracts.

KEY WORDS : Banana, Plant extract, Modified atmosphere package, Postharvest

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Banana (*Musa* spp.) is one of the cheapest, most plentiful and nourishing of all fruits (Khader *et al*., 1995). In Nepal banana is regarded as high value commodity and thus, it can play a significant role in the upliftment of the economy of poor farmers. Among the major fruit crop growing area in Nepal banana stands 4th position after citrus, mango and apple. In Nepalese geophysical situation, it can be grown from 75 m of Terai to 1500 m altitude of mid hills, where frost does not occur usually (Gautam and Dhakal, 1993). A variety known as Jhapali Malbhog is commercially grown in Jhapa, Morang, Sunsari, Chitwan and Nawalparasi district. This variety probably belongs to Cavendish type and resembles to the William Hybrid phenotypically and is widely adapted in Chitwan and Nawalparasi. Malbhog is one of the most common local cultivar which is superior in its quality, storability and taste and has got higher demand (Basnyat *et al.*,1996).

Banana being a climacteric fruit can ripe in the plant itself as well as after harvesting by the application of various chemicals and plant materials. Ethylene is commonly practiced in commercial banana ripening in developed countries (Gautam and Dhakal, 1993). Nepalese farmers are using their indigenous knowledge in ripening of banana since time immemorial. In many places the bunch of banana after wrapping with jute bag are hanged over fire so as to meet the optimum desired temperature (Gautam and Dhakal, 1993). The banana traders are facing the problems related to ripening of bananas. Due to the massive use of chemicals like ethephon and calcium carbide in banana ripening, there is threat of health hazards. So the alternatives for banana ripening *i.e.* plant extracts and modified atmosphere package (MAP) may be useful. Any success in improving postharvest quality by extending shelf-life or preventing postharvest decay is advantageous in enlarging markets and broadening consumer appeal (Paul and Chen, 2002). The postharvest losses of banana can be reduced considerably by applying improved technologies. Efforts should be made to optimize or develop suitable alternatives such as application of different plant extracts for postharvest loss reduction, shelf-life extension along with quality retention.Thus, this research was conducted to find out the appropriate use of different plant extracts for the prolongation of post-harvest life and to discover effective, safe and economical treatments to reduce the postharvest fruit losses of banana.

RESEARCH METHODS

The banana fingers were brought from Mangalpur10 km South from Narayangadh, Chitwan for the post-harvest treatment of banana. The cultivar selected for the research is Malbhog which is one of the most popular and cultivated variety in that locality. The post-harvest analysis was carried out in post-harvest horticulture laboratory, AFU, Rampur, Chitwan, Nepal. This experiment was conducted from 3rd May to 31st June 2016. The bunch was dehanded and divided into fingers with a help of knife. The fruits were selected for uniformity of size and freedom from blemishes. Fruits were washed with tap water to remove latex and dust to reduce fungal infection and then air dried.The experiment consisted of eight treatments, control, garlic extracts, *Neem* extracts, onion extracts, sesamum oil, ginger extract, unperforated low density poly ethylene (50 μm) containing cotton soaked with $KMnO_4$ and perforated low density polyethylene (50 μm) containing cotton soaked with $KMnO_4$, respectively that were replicated thrice in Completely Randomized Design. In the experiments eight banana fingers were used as non-destructive sample and ten fruits were used as destructive sample. Analysis of variance for all parameters was carried out as per the procedures given in MSTATC (Version 1.2) (MSTATC, 1986). Duncan's multiple range test (DMRT) for mean separations was done from the reference of Gomez and Gomez (1984).

RESEARCH FINDINGS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Physiological loss in weight (PLW):

The PLW was significantly increased in all the treatments with the advancement of the storage period. The trend of weight loss was found maximum in the control upto the 15th DAS. All the plant extracts and MAP performed better in comparison to control treatments. At the end of the storage period, the maximum percentage of physiological loss in weight was observed with control fruits (39.70 %) followed by onion extract (39.33 %) and sesamum oil (36.36 %), respectively and the minimum PLW was observed with unperforated low density polyethylene containing cotton soaked with $KMnO_4$ (7.46 %) followed by perforated low density polyethylene with $KMnO_4$ (18.59 %) (Table 1).

This result is in accordance with the reports of Islam and Rul (2014) and Melbratie *et al.* (2015) reported that the fastest rate of weight loss was observed in untreated banana and the minimum weight loss was found in banana held in LDPE bags contained $KMnO_4$ soaked in 2 g cotton at the 25th DAS. The reduced weight loss of bananas in LDPE plastic might be due to lower transpiration rate in a higher relative humidity environment as well as reduced respiration due to gradual decline in O_2 and increase of CO_2 in the plastic. However, the enhanced water loss in control as a result of increased transpiration and respiration rate.

Change in peel colour:

The present study of postharvest treatments showed significant effect on the change of peel colour during storage. The peel colour of banana changed irrespective of treatment with the advancement of storage period but at varying rates (Fig. 1). The fastest rate of peel colour changes was observed with the control fruits, whereas the low density poly ethylene plastic with $KMnO_4$ treatments greatly arrested the peel colour development. On the 15[th] DAS, the highest colour score

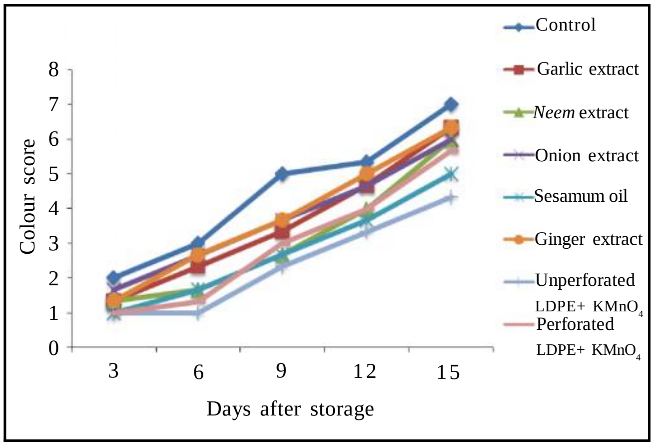

Fig. 1 : Colour score of banana fruit under different post harvest treatments during storage at ambient room temperature (30±5° C), Rampur, Chitwan, 2016

Table 1 : Physiological weight loss of banana fruit under different post-harvest treatments during storage at ambient room temperature (30±5°C), Rampur, Chitwan, 2016

Treatments	Physiological loss in weight (%) on days indicated				
	3	6	9	12	15
Control	6.911 [a]	16.24 [a]	24.43 [a]	32.86 [a]	39.70 [a]
Garlic extract	6.17 [a]	13.84 [a]	20.72 [a]	28.79 [a]	31.83 [ab]
Neem extract	5.62 [a]	14.24 [a]	21.21 [a]	28.57 [a]	32.81 [a]
Onion extract	6.31 [a]	14.90 [a]	21.76 [a]	30.74 [a]	39.33 [a]
Sesamum oil	6.85 [a]	15.19 [a]	22.22 [a]	31.86 [a]	36.36 [a]
Ginger extract	6.57 [a]	13.11 [a]	19.41 [a]	26.50 [a]	31.00 [ab]
Unperforated LDPE+$KMnO_4$	1.71 [b]	3.44 [b]	3.82 [b]	4.44 [c]	7.46 [c]
Perforated LDPE+$KMnO_4$	0.59 [b]	4.00 [b]	5.68 [b]	14.68 [b]	18.59 [bc]
Grand mean	5.10	11.87	17.41	24.8	29.4
LSD (5%)	1.81	0.64	5.99	9.01	13.08
S.E.±	0.60	0.22	1.99	3.01	4.36
CV (%)	20.5	18.6	19.9	21	25.7

Means within the same column followed by same letter do not differ significantly at 5 % level by DMRT

Table 2 : Total soluble solids of banana fruit under different post harvest treatments during storage at ambient room temperature (30±5°C), Rampur, Chitwan, 2016

Treatments	TSS of the pulp (°Brix) on days indicated				
	3	6	9	12	15
Control	4.67 [a]	7.23 [a]	10.23 [a]	14.93 [ab]	19.37 [a]
Garlic extract	4.32 [ab]	6.50 [ab]	10.47 [a]	13.37 [ab]	17.57 [ab]
Neem extract	4.32 [ab]	6.51 [ab]	10.13 [a]	13.87 [ab]	16.67 [b]
Onion extract	4.33 [ab]	6.73 [ab]	10.90 [a]	13.60 [ab]	16.33 [bc]
Sesamum oil	4.333 [ab]	6.43 [b]	10.40 [b]	12.87 [ab]	15.33 [bc]
Ginger extract	4.33 [ab]	6.63 [ab]	10.42 [a]	13.07 [ab]	17.43 [b]
Unperforated LDPE+$KMnO_4$	4.23 [ab]	6.60 [ab]	10.23 [a]	12.47 [b]	14.67 [c]
Perforated LDPE+$KMnO_4$	4.10 [b]	6.86 [abc]	11.17 [a]	15.67 [a]	16.87 [b]
Grand mean	4.30	6.68	10.58	13.73	16.80
LSD (5%)	0.29	0.67	1.80	2.75	1.82
S.E.±	0.10	0.22	0.60	0.91	0.61
CV (%)	4.0	5.9	9.9	11.6	6.3

was obtained by control treatment with the colour score of 7.00 and the minimum colour score was scored by unperforated LDEP containing cotton soaked in $KMnO_4$ with the colour score of 4.30.

The reduced change in colour development of bananas in LDPE plastic might be due to the modified atmosphere and the higher humidity created resulting delay in the ripening rate. Polyethylene plastics are noted to have the effect of reducing water loss, reducing O_2 concentration and increasing CO_2, all of which extend the pre-climacteric life of fruits (Robinson and Sauco, 2010). This finding is in line with the experiment conducted by Islam and Rul (2014) who reported that the highest rate of peel colour change was observed with control at the 20th DAS and the lowest rate with bananas held in modified atmosphere packaging with $KMnO_4$ (1 g cotton soaked with saturated solution of $KMnO_4$).

Total soluble solids of pulp:

Analysis of variance of data on the effect of different plant extracts and MAP as postharvest treatments showed significant effect on total soluble solids various DAS (Table 2). Significant differences were seen among the treatments on TSS content of the banana from the 3rd DAS. On the 15th DAS the control fruits exhibits the highest TSS content (19.37 °Brix) followed garlic extract (17.57 °Brix) ginger extract (17.43° Brix) and the lowest TSS content with unperforated LDPE containing cotton soaked with $KMnO_4$ (14.67 °Brix).

This increase in TSS might be due to the conversion of complex carbohydrates into simple sugars. This is correlated with hydrolytic changes in starch and conversion of starch to sugar being an important index of ripening process in banana and other climacteric fruits and further hydrolysis decreased the TSS during storage (Kittur *et al.*, 2001). This study is in accordance with the reports of Rob (2012) who stated thatthe highest TSS content was recorded in control treatment while the lowest with $KMnO_4$ treated banana.

Titratable acidity :

The TA content of banana fingers during experimental period under the influence of different post-harvest treatments of banana stored for different days and their mean values expressed in percentage is displayed in the Table 3. On the 15th DAS, the highest acidity (0.51 %) was observed with *Neem* extract and lowest with control fruits (0.31 %).

The decrease titratable acidity during storage may be attributed to the utilization of organic acids in respiration process and other bio-degradable reactions (Ulrich, 1974).

Shelf- life:

Shelf-life of banana differs significantly among various plant postharvest treatments (Fig. 2). These results revealed that the longest shelf-life (27.00 days) of banana was recorded with unperforated LDPE containing cotton soaked with $KMnO_4$ followed by perforated LDPE containing cotton soaked with $KMnO_4$

Table 3: Titratable acidity of banana fruits under different post-harvest treatments during storage at ambient room temperature (30±5°C), Rampur, Chitwan, 2016

Treatments	TA of the banana juice (%) on days indicated				
	3	6	9	12	15
Control	0.537 a	0.517 c	0.420 b	0.373 c	0.313 d
Garlic extract	0.532 b	0.583 b	0.447 b	0.417 b	0.327 cd
Neem extract	0.532 b	0.687 a	0.620 a	0.543 a	0.5167 a
Onion extract	0.532 b	0.583 b	0.487 b	0.432 b	0.447ab
Sesamum oil	0.531 b	0.537 bc	0.417 b	0.424 b	0.390bc
Ginger extract	0.533 b	0.543 bc	0.442 b	0.418 b	0.410 b
Unperforated LDPE+$KMnO_4$	0.531 b	0.550 bc	0.477 b	0.431 b	0.437 b
Perforated LDPE+$KMnO_4$	0.535 ab	0.563bc	0.409 b	0.420 b	0.407 b
Grand mean	0.5327	0.570	0.465	0.432	0.406
LSD (5%)	0.004	0.056	0.077	0.0344	0.070
S.E.±	0.0012	0.018	0.025	0.011	0.023
CV (%)	0.4	5.7	9.6	4.6	10.0

Means with in the same column followed by same letter do not differ significantly at 5 % level by DMRT

(20.00 days). Plant extracts of sesamum oil and ginger also showed statistically similar result on shelf-life (19.00 and 18.67 days), respectively. The shortest shelf-life of banana (16.00 days) was observed with the untreated fruits.

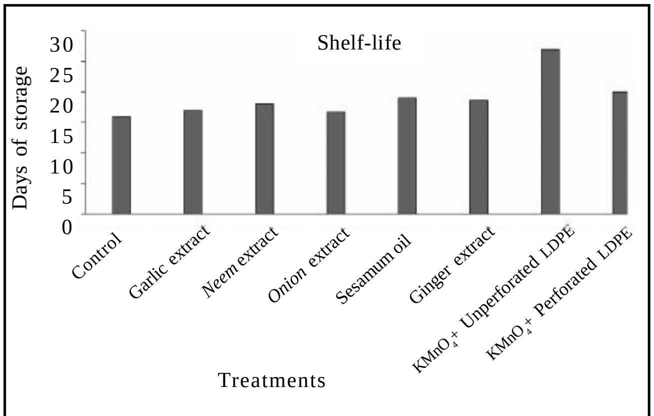

Fig. 2 : Shelf-life of banana fruit under different post harvest treatments during storage at ordinary room temperature (30±5°C), Rampur, Chitwan, 2016

This finding is in line with the finding of (Mebrite *et al.*, 2015) who reported that the longer shelf-life of bananas in LDPE plastic might be due to the delayed ripening process as a result of a relatively higher humidity in the plastic and change in composition of air which is responsible for reduced ripening and increased shelf-life of bananas kept in a higher relative humidity environment (Ahmad *et al.*, 2006 and Pendharkar *et al*., 2011).

Conclusion:

Plant extracts and modified atmospheric package can be beneficial for the prolongation of post-harvest fruit quality of banana. The *Neem* extracts and the unperforated low density polyethylene plastic containing cotton soaked in $KMnO_4$ was found to be more promising improving the shelf-life and low disease incidence.

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