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Effects of Postharvest Treatments on the Storage Quality of Mango (*Mangifera indica* L)

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ABSTRACT: *A study was conducted in the postharvest laboratory of the Federal College of Horticulture Dadinkowa, Gombe State, Nigeria, to investigate the effects of some postharvest treatments, namely; hot water treatment, gibberellic acid, ground nut oil, extracts of garlic, extracts of neem leaves, mixture of extracts of neem leaves and garlic and distilled water (control) on the storage quality of mango fruits. The experiment was laid out in a complete randomized design (CRD) replicated three times. The results indicated that all the treatments reduced weight loss, fruit diameter, fruit decay and loss in firmness. However, gibberellic acid was found to be most effective in minimizing fruit weight loss and fruit diameter when compared with other treatments. In terms of fruit decay and fruit firmness however, mixture of extracts of neem leaves and garlic (500 ml each) performed better than all other treatments throughout the storage period of 15 days. Hence, it can be concluded that application of gibberellic acid and extracts of neem leaves and garlic enhances the shelf life of mango fruits, and can maintain good fruit quality under ambient condition for up to 15 days.*

KEY WORDS*:* mango, postharvest, extracts, treatment, fruits

INTRODUCTION

Mango (*Mangifera indica* L.) is a tropical fruit and contains vitamins, minerals, and fibre which are essential to human health and export market (Sethi, *et al.*, 2011). Mango is classified as climacteric fruit and show rapid deterioration after harvest due to ripening and senescence (Wang, *et al.*, 2006). Additionally, desiccation of mango during transportation, storage and shelf life period causes its shriveling and reduces the market value of the fruit (Rodov, *et al.*, 1997).

Mango is considered king of fruits due to its attractive colour, aroma and jelly pulp, but it is highly perishable in nature. Several environmental conditions, higher moisture content, soft textures of fruit and susceptibility to various pathogenic infections are the limiting factors to its shelf life. In this regard, development of postharvest technology related to quality maintenance and extending the postharvest life of mango are important to consumer's acceptability and marketing (Zhong, *et al*., 2006; Chien, *et al.*, 2007). Application of postharvest treatments which have non-toxic mode of action, with negligible residue, safe on humans, animals and environment has been reported to prolong the storage life of apricots (Fan, *et al*., 2000), banana (Jansasithorn and Kanlayanarat, 2006) and delayed firmness, TSS and TA on sapodilla (Zhong, *et al.*, 2006). Furthermore,

gibberellic acid is used in preservative coating for fresh fruits due to its excellent film-foaming and biochemical properties (Ali *et al.*, 2004). The coating is also safe and has prolonged storage life and controlled the decay of many fruits such as litchi (Jiang *et al*., 2005) and mango (Abbasi *et al*., 2009). Therefore, postharvest treatments of mango is crucial to extend the shelf life and maximize profit for mango storage and provide quality consumer product for export, which include reduction in postharvest loss, increase value added crop leading to better life of farmers and entrepreneurs. There is therefore the need to prolong the storability of this particular variety at ambient temperature condition by the help of various postharvest aids other than refrigeration, which has been supposed to be the principal device for achieving the same purpose.

The objective of this study is to evaluate the effects of some non-chemical approach namely: garlic extract, neem leaf extract, hot water treatment, groundnut oil and gibberellic acid on the postharvest storage and qualities of Tommy mango fruits under ambient temperature condition.

MATERIALS AND METHODS

The experiment was conducted during the month of June of the year 2018 at the Department 0f Agricultural Technology, Federal Polytechnic Mubi Adamawa state, Nigeria. Freshly harvested mango cv " Tommy Atkin" fruits were purchased from the farmer's field and brought to the laboratory. Only the firm and well developed fruits of about uniform size and maturity, free from pests and diseases, injuries, bruises and blemishes were selected for the experiment. Fruits were washed with clean water in a bucket and gently rubbed with tissue paper to remove water. The fruits were kept in a well ventilated laboratory at ambient temperature.

Preparation of aqueous extracts

Fresh neem leaves were obtained and air-dried to crispy dry condition. It was then ground into powder using a mortar and pestle (Amadioha, 2004). The powder was then sieved through a sieve of 1mm to obtain the fine powders. Then 3% extract was prepared by dissolving 30 grams of the powdered plant in 1000 ml of distilled water and soaked for 24 hours. Thereafter, the extract was filtered with a muslin cloth into clean plastic container to obtain the solution. Garlic extract was prepared by macerating the garlic cloves and soaking thirty grams in 1000 ml of distilled water for 24 hours. The extract was obtained by filtering the solution through a muslin cloth in a clean container. To prepare solution of gibberellic acid, one gram of gibberellic acid (GA_3) was dissolved in 500 ml of distilled water and allowed for 24 hours. The treatments used for this experiment are: Garlic extract (GE), Neem leaf extracts (NLE), Groundnut oil (GO), Neem leaf extract plus garlic extracts (NLE+GE) ratio 1:1, Hot water treatment (HWT) at 50^0c, Gibberellic acid (GA_3) and distilled water (control).

Treatment of mango fruits

A total of eighty-four healthy looking mango fruits were used for the experiment. The lot was divided into seven groups each consisting of twelve fruits. The treatments were administered on the seven groups as follows:

The individual mango fruits were immersed into the respective solutions for five minutes, removed and allowed to dry before storage.

Experimental design
The experiment was conducted in a single factor laid out in a completely randomized design (CRD) consisting of seven treatments replicated four times. The fruits were kept at room temperature of 28-35^{0}C.

Data collection
Periodic observations with regard to physiological loss in weight, rotting percent, reduction in diameter were recorded on 5, 10 and 15 days of storage.

Percentage weight loss
The estimation of physiological loss in weight by periodical weighing of fruits and the differential weight loss was expressed in percent with respect to storage time and pre-treatments. Mango fruits were weighed on a balance scale at the beginning of the experiment and subsequently five days intervals during the storage period. Weight loss was expressed using the following equation:

$$\% \text{ weight loss} = \frac{(\text{initial weight of fruit} - \text{weight at each specific intervals}) \times 100}{\text{Initial weight}}$$

Fruits decay:
The decayed fruits of each treatment were visually counted out of the total fruits. The weight of such discarded fruits related to initial weight of fruits per each treatment was estimated and decay percentage was calculated. A decayed fruit was calculated by dividing the number of decayed fruits by the total number of fruits as follows:

$$\text{Decayed fruits (\%)} = \frac{\text{the number of decayed fruits} \times 100}{\text{Total number of fruits}}$$

Fruit decay was scored on a scale of 1 to 9 based on the incidence of infected fruits: 9 = absence of dark spots, skin colour alterations and/or lesions; 8 = 1-3% very light dark spots; 7=4-6% of light dark spots; 6=7-10% of light dark spots, skin colour alterations and/or lesions; 3=41-60% of dark spots, severe lesions and skin colour alterations; 2=61-75% of dark spots, severe lesion and skin colour alterations and 1= more than 75% of dark spots and very severe lesion.

Reduction in diameter:
For determination of reduction in diameter, a vernier caliper was used to measure the fruit diameter from each treatment and average value calculated

Reduction in fruit firmness
Fruit firmness was measured with Effigi penetrometer (Model 327) which recorded the pressure required to force a plunger of 11 mm diameter into flesh of fruits.

Data analysis
The data collected were subjected to analysis of variance (ANOVA). Statistical analysis was carried out using the Genstat 5 system

RESULTS AND DISCUSSION

Effect of postharvest treatments on the physiological weight loss of mango fruits
The results of the experiment indicated that there was a gradual increase in percentage weight loss of fruits throughout the storage period. The highest percentage weight loss was recorded in fruits treated with distilled water (12.50%, 19.05% and 26.04% while the least percentage weight loss was recorded in fruits treated with gibberellic acid (3.38%, 9.21% and 12.41%) followed by fruits treated with extracts of GE+NlE (4.19%, 12.63% and 13.84%) at fifth, tenth and fifteenth day of storage respectively. This result is similar to the works of Sudha *et al* (2007) who found that the reduction of weight loss in fruits treated with gibberellic acid might be due to its ant senescence action. The gibberellic acid treatment causes the decrease in the tissue permeability and thereby reducing the rate of water loss of fruits.

Table 1: Effect of postharvest treatments on the weight loss (%) of mango fruits during storage

Treatment	5DOS	10DOS	15DOS
HW	10.60	16.91	25..33
GA_3	3.38	9.21	12.41
NLE	4.73	14.56	16.12
GO	6.94	18.37	24.57
GE	5.92	16.91	18.83
GE+NLE	4.19	12.63	13.84
DW	12.50	19.05	26.04
LSD	7.62	10.75	12.04

Key: HW= Hot water, GA_3= Gibberellic acid, NLE= Neem leaf extracts, GO= Groundnut oil, GE= Garlic extracts, DW= Distilled water, LSD= Least significant difference

Effect of postharvest treatments on the fruit diameter of mango during storage
The loss in fruit diameter was closely correlated with the fruit weight loss, indicating that the products were controlling both weight loss and fruit diameter. Results obtained showed a gradual decrease in fruit diameter during storage in both treated and untreated fruits (Table 2). These results are in accordance with that of Kher and Bhat (2005) who reported decreased fruit diameter with increase in storage period. However, the highest percentage reduction in fruit diameter was recorded in the control treatment of 3.59%, 10.24% and 12.51% at 5^{th}, 10^{th} and 15^{th} day of storage respectively while the least values were recorded in fruits treated with GA_3 with values of 1.54%, 4.10% and 6.44% at 5^{th}, 10^{th} and 15^{th} day of storage respectively. The possible reason for this may be that GA_3 has been known to retard ripening and senescence of fruits. Since ripening was delayed

due to GA_3 treatment, tissue permeability would be decreased and thus the rate of water loss would also be reduced (Wills *et al.*, 1998).

Table 2: Effect of postharvest treatments on the fruit diameter loss (%) of mango fruits during storage

Treatment	5DOS	10DOS	15DOS
HW	3.33	9.72	10.76
GA_3	1.54	4.10	6.44
NLE	2.25	6.39	8.93
GO	2.39	9.57	10.21
GE	2.00	9.42	10.04
GE+NLE	1.55	5.37	8.25
DW	3.59	10.24	12.51
LSD	2.67	7.62	8.84

Key: HW= Hot water, GA_3= Gibberellic acid, NLE= Neem leaf extracts, GO= Groundnut oil, GE= Garlic extracts, DW= Distilled water, LSD= Least significant difference

Effect of postharvest treatments on the fruit decay of mango

The decay in fruits increased with the increasing period of storage, regardless of the treatments. Similar increase in rotting of fruits with prolongation of storage period was also elucidated by Garg *et al*., (1971), Khader (1989) in mango. Maximum fruit decay was recorded in the untreated fruit samples. Fruits treated with GE+NLE extracts showed least values of decay (Table 3). The least decay in these fruits might be due to the combined effects of fungicidal properties of aqueous leaf extracts of these plants. This result is similar with the earlier works of Srivastava *et al* (1997) who found that aqueous extracts of *Azadirachta indica* was able to control fruit rot of pear fruit of up to 85 percent. Also, Singh *et al.,* (1993) found that treatment of infested banana with aqueous leaf extracts of *Azadirachta indica* gave good control of *Fusarium oxysporum* disease development with minimum percentage loss in weight and volume. Combined effects of *A. indica* and garlic extracts, showed better results. .

Table 3: Effect of postharvest treatments on the fruit decay (%) of mango fruits during storage

Treatment	5DOS	10DOS	15DOS
HW	0.00	13.41	20.48
GA_3	0.00	4.66	14.24
NLE	0.00	4.66	17.53
GO	0.00	11.99	18.79
GE	0.00	8.25	17.53
GE+NLE	0.00	1.36	11.55
DW	0.00	16.50	33.21
LSD	0.00	3.40	6.54

Key: HW= Hot water, GA_3= Gibberellic acid, NLE= Neem leaf extracts, GO= Groundnut oil, GE= Garlic extracts, DW= Distilled water, LSD= Least significant difference

Effect of postharvest treatments on the fruit firmness of mango

The results in Table 4 revealed that there was a decreasing trend in fruit firmness in both treated and controlled fruits during the storage period. However, the control fruits exhibited highest values of loss in firmness than the treated fruits while the decline was lowest in fruits treated with mixture of neem leaf extracts and garlic extracts. This might be due to the effect of the coating with plant extracts which delayed the softening of fruits. The results are in agreement with the works of Hagenmaier and Baker (1995) who found that coating reduces shrinkage of fruits. Also, Yaman and Bayoindirli (2002) reported that the retention of firmness in coated fruits was due to reduction in degradation of insoluble proto-pectin to more soluble pectic acid and pectin. It was found that during fruit ripening, depolymerization occurs with an increase in pectin-esterase and polygalacturonase activities. Hence, low oxygen and high carbon dioxide concentrations reduce the activities of these enzymes and allow retention of the firmness during storage (Salunkhe *et al*., 1991; Yaman and Bayoindirli, 2002; Patricia *et al*., 2005).

Table 4: Effect of postharvest treatments on the fruit firmness of mango during storage

Treatment	5DOS	10DOS	15DOS
HW	3.0	3.3	2.5
GA_3	3.5	3.3	3.0
NLE	3.6	3.4	2.8
GO	3.0	2.8	2.5
GE	3.6	3.1	2.8
GE+NLE	4.3	4.0	3.1
DW	2.7	2.6	2.0
LSD	1.56	0.91	1.16

Key: HW= Hot water, GA_3= Gibberellic acid, NLE= Neem leaf extracts, GO= Groundnut oil, GE= Garlic extracts, DW= Distilled water, LSD= Least significant difference

CONCLUSION

The results obtained indicated that gibberellic acid play a very effective role in reducing weight loss and fruit diameter of mango fruits. The shelf life of mango fruit could be extended up to 15 days without excessive deterioration in quality by treating the fruits with GA_3. From the results obtained, therefore, it is recommended that farmers should treat mango fruit with GA_3, and extracts of garlic and neem leaves for better storage of mango fruits at ambient temperatures. However, research should be carried out to determine the effects of different levels of these products and storage duration, and the possible interaction for better mango fruits storage.

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