American Journal of Food Technology

ISSN 1557-4571

Academic Journals Inc.

www.academicjournals.com

OPEN ACCESS American Journal of Food Technology

ISSN 1557-4571
DOI: 10.3923/ajft.2017.186.192

Research Article
Retrospective Analysis of *Moringa* Leaf as a Substitute to Ethylene Gas in Hastening Ripening of Banana Fruit

[1]Betewulign Eshetu Ademe and [2]Agena Anjulo Tanga

[1]Department of Horticulture, College of Agricultural Sciences, Arba Minch University, P.O. Box 21, Arba Minch, Ethiopia
[2]Ethiopian Environment and Forest Research Institute, P.O. Box 24536, Code 1000, Addis Ababa, Ethiopia

Abstract

Objective: The objective of this experiment was to study the knowledge, skills and traditional experiences of the farmers on the post harvest handling and management of Giant Cavendish banana fruit. The study further studied the effects of *Moringa* leaves in ripening and associated post harvest characters of Giant Cavendish banana fruits. **Methodology:** A questionnaire survey was conducted to assess the traditional experience of the farmers in Arba Minch Zuria Woreda in post harvest management of banana fruits. The survey further assessed the experience of the farmers in using *Moringa* leaves and other materials to hasten banana ripening. Moreover, the survey generated scientific information from 140 farmers from the entire Woreda of which 79 are males and 61 are females. The study had another part involving a laboratory experiment to further investigate the role of *Moringa* leaves in substituting ethylene gas to hasten ripening in banana. Fully matured banana bunches of Giant Cavendish variety were collected from the three representative kebeles. Eight banana fingers were detached from the bunch and used for further ripening and associated post harvest characters analysis. The banana fingers from each variety were subjected to different levels of *Moringa* leaves (0, 50, 100, 150, 200 and 250 g) and kept sealed inside a paper cartoon for 24 h following the conventional banana ripening procedure. **Results:** The observed result showed that differences in the level of *Moringa* leaves had statistically significant effect on the fruit firmness and non significant effect on the physiological weight loss and total soluble solids. Though the analysis was statistically non significant in the latter two parameters, there was a considerable difference among the means. **Conclusion:** Moreover, in this study, the effect of *Moringa* leaves on the ripening, physical and physico-chemical characteristics of banana fruits was evidently demonstrated.

Key words: *Moringa* leaves, Giant Cavendish, ripening, fingers, fruit firmness, total soluble solids, physico-chemical

Received: July 13, 2016 Accepted: January 05, 2017 Published: April 15, 2017

Citation: Betewulign Eshetu Ademe and Agena Anjulo Tanga, 2017. Retrospective analysis of *Moringa* leaf as a substitute to ethylene gas in hastening ripening of banana fruit. Am. J. Food Technol., 12: 186-192.

Corresponding Author: Betewulign Eshetu Ademe, Department of Horticulture, College of Agricultural Sciences, Arba Minch University, P.O. Box 21, Arba Minch, Ethiopia

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Banana (*Musa* spp.) was introduced to East Africa and to the Mediterranean region about 650 AD and its cultivation is distributed throughout the warm countries situated in the region between 30°N and 30°S of the equator. The largest consumption of banana is in Africa where they are considered as a source of starchy food. India is the largest producer of banana in the world. Banana contains vitamins, minerals and has several medicinal properties[1]. It is a rich source of energy, low in protein and fat contents and provides a banana diet. Banana breeding is difficult and complicated due to presence of parthenocarpy, sterility, polyploidy and vegetative propagation. These are the main reasons for the existence of natural hybrid either diploid or triploid. Banana is a humid tropical plant and is well suited for cultivation from humid tropics to semi-arid sub tropics. It propagates vegetative through suckers or whole bits of rhizomes of parent plant. Fresh fruit and vegetable have been part of human diets since the down of history. Although most scientists have tended to value foods from animal source more highly scientist with largely or totally vegetation diet for religious or economic reasons have a greater dependency on fruit and vegetables. With the assistance of modern nutritional science, the profile of fruit and vegetables has considerably improved. Particularly in developed countries, fruits and vegetables are merely recommended for increased consumption.

Fruits, vegetables and ornamentals are ideally harvested at optimum eating or visual quality[2]. However, since they are living biological systems, they deteriorate just after harvest. The rate of deterioration varies greatly between individual products depending on the overall rate of metabolism[3]. But for many, it can be ripped either during the chains where produce is transferred from farmer to end user within a short period of time[4]. The rate of post harvest deterioration is a little consequence. However, with the increasing remoteness of production areas from a population centers in both developing and developed countries, extending the post harvest life of horticultural produces requires knowledge of the entire factor[5]. Carelessness in doing so can lead to loss of quality or generation of unsellable material. The actual cause of post harvest loss are many but, they can be classified in to two main categories, the first one is physical loss, the physical loss can arise from mechanical damage or pest and disease damage resulting in produce tissue being disrupted to a stage where it is not acceptable for fresh consumption or processing[6]. Physical loss can also arise from evaporation of intercellular water, which leads to a direct loss in weight. The second causes of post-harvest loss is due to physiological and compositional changes that alter the appearance, test or texture and make produce less aesthetically desirable to end user[6].

The contribution of horticulture remains extremely important for ensuring food and nutritional security in Ethiopia but the desired level of development in horticulture has not yet been achieved because of a number of constraints. Due to absence of proper post harvest management system, a bulk of the harvested produce is damaged every year. Arba Minch is the well known potential area in production of banana contributing significant quantity of banana fruits to the domestic and Saudi markets. Moreover, the economic, knowledge and skill level of the farmers in Ethiopia and hence in Arba Minch Zuria Woreda in using ethylene gas for ripening banana is quite low. Hence, the post harvest handling and management of banana in the area remains to be quite traditional and insufficient to meet the consumer standard in spite of the abundance of the fruit production and productivity. The objectives of the study was following:

- To asses and evaluate the effects of different post-harvest factors and handling mechanisms on the shelf life of banana fruit in Arba Minch Zuria Woreda
- To evaluate the role of *Moringa* leaves in substituting ethylene gas in ripening banana fruit

MATERIALS AND METHODS

Description of the study area: The study was conducted in Arba Minch Zuria Woreda. It is found 495 km to the South of Addis Abeba. The area is characterized by mountain hills escarpment and narrow valley. The slope of this land lies between 4-100% and its altitude lies between 1100-1600 m a.s.l. The South East of the Woreda is characterized by flat and gentle topography and its altitude lies between 1100-500 m a.s.l., this is where banana grows abundantly. The climatic condition of Arba Minch Zuria Woreda is Dega (10%), Woinadega (60%) and Kola (30%). The specific climate at the study area is 100% Kola. Also the experiment was conducted in the laboratory of Horticulture Department, College of Agricultural Sciences of Arba Minch University.

Sampling techniques: There are several kebeles in the woreda known for abundant production of banana. However, only 3 kebeles were selected purposively for our study based on potential of banana production and accessibility. A total of 140 households were selected for the questionnaire survey using structured questionnaire and random sampling technique.

Methods of data collection: The experimental study was bidirectional, one of the experiments was field based on the farmer's garden of the three kebele administrations and the other part was laboratory based where we conducted a ripening and shelf life study in line with analyzing the physical and biochemical properties of the banana fruits.

The study was conducted during 2016 season at the selected kebeles namely Chano, Sille-Sera and Shara. Semi structured questionnaire survey was designed to address specific objectives of the study. The approach had enabled the collection of both qualitative and quantitative information on the different aspects of the crop from the respondents. The questionnaire was divided in two parts, section A (personal information) and section B (information on the post handling and management practices of the banana fruit). The laboratory based experiment was carried out with the intention of checking the following quality parameters.

Physiological weight loss (%): The weight of the banana fruit was measured during storage period using sensitive beam balance. The loss in weight was expressed as percentage of the original fresh weight of the fruit. The weight loss of banana fruit was calculated as the difference between initial weight and final weight divided by initial weight multiplied by 100%. The weight loss of the fruit was measured regularly at 24 h interval during the storage period.

Fruit firmness: The fruit firmness was determined by using digital hand held penetrometre by taking five reading per fruit on opposite sides along the fruit's equatorial section. Finally the fruit firminess was expressed in terms of pascal ($N\ m^{-2}$).

Total soluble solid (^{0}Brix): The TSS level of the fruit was determined by using hand held refractometer. An appropriate quantity of banana finger was placed on prism-plate of the refractometer. The reading on the lens screen was recorded as Total Soluble Solid (TSS) and the result was expressed in ^{0}Brix.

Experimental treatments: The experiment was conducted inside a sealed paper cartoon. The banana fingers together with the *Moringa* leaves were kept inside a cartoon as a packaging material. The banana fingers were kept inside the paper cartoon for 6 days till the final data recording.

Experimental design: The experiment was laid out in Complete Randomized Design (CRD) in the laboratory with three replication and six treatments. Each treatment received 8 banana fingers.

Experimental materials: Experiment used fingers of banana variety named, Giant Cavendish. Different level of *Moringa* leaves, cartoons, refractometer, penetrometer, double distilled water, juicing machines, beakers and measuring cylinders were used. Matured light green, non-injured banana fingers were harvested and also *Moringa* leaves were also were used to check the effect on the ripening of the bananas.

Method of data analysis: The data that was collected from the laboratory was analyzed using JMP statistical software version 12. The means, standard deviations, standard error of the means and p-values were used to discuss on the statistical results.

The significant means was further separated using Duncan's multiple range test. The data that was collected from the questionnaire survey was presented by using simple descriptive statistics: Means, percentage, frequency were used to discuss on the descriptive results.

RESULTS AND DISCUSSION

Results from survey questionnaires: To our knowledge, so far, there is no even a single research attempt in assessing and evaluating the effect of different doses of *Moringa* leaves in the ripening, physical, physico-chemical and fruit firmness of Giant Cavendish banana fruits. We hence would like to declare that this is a retrospective study conducted to investigate the presumptive effect of *Moringa* leaves in hastening ripening and associated changes in Giant Cavendish banana fruits. Moreover, questionnaire was prepared to conduct a preliminary assessment on the effects of different traditional post harvest handling technologies on the shelf life of banana fruit. There were 140 respondents of which 79 were male and the remaining 61 were females. The results are showed below in line with the respective questions (Table 1).

The researcher conducted the questionnaire interview using a structured questionnaire consent form. The information was gathered from three kebeles of Arba Minch Zuria Woreda. One hundred forty respondents were interviewed to generate the information. Of the interviewed respondents, 56.42% (79) were males and the rest 43.58% (61) were females. Again out of the interviewed farmers, 93.5% owe a farm land that is 1-10 ha in size. The 96.43% of the farmers produce Giant Cavendish variety of banana whereas; 1.43% of the farmers produce Dwarf Cavendish and the rest 2.14% of the farmers produce both varieties in a mixed approach. From the interviewed farmers, only 2.86% have taken training on harvesting and post harvest handling of

Table 1: Survey result on the traditional post harvest handling of banana fruits in and around Arba Minch Zuria Woreda

Questionnaire character raised	Frequency	Percentage/(100%)
Average size of the land owned by banana		
1-10 ha	131	93.50
11-20 ha	4	3.00
Above 20	5	3.50
Banana variety planted on the land		
Giant Cavendish	135	96.43
Giant Cavendish	2	1.43
Mixed	3	2.14
Previous exposure to any form of training		
Yes	4	2.86
No	136	97.14
Maturity indices used to determine maturity		
Colour	7	5.00
Size/shape	130	92.86
No. of days after bloom	3	2.14
Time of harvesting		
Early morning	127	90.71
Late in the morning	10	7.15
Mid-day	3	2.14
Harvesting frequency in a season		
Twice	15	10.71
Thrice	8	5.72
Above thrice	117	83.57
Duration length it takes for banana to ripe		
1-2 days	132	94.30
4-6 days	8	5.70
Material used for ripening of banana		
Moringa leaf	129	92.16
Wrapping with teff straw	8	5.70
Wrapping with news paper	3	2.14
Container used for packaging		
Baskets	117	83.57
Paper carton	12	8.57
Wooden crates	11	7.86
Stages during which maximum losses of banana is encountered		
During harvesting	12	8.58
During transportation	8	5.71
During storage	120	85.71
Major constraints of banana storage and post harvest handling		
Lack of awareness	125	89.28
Unfavorable weather condition	9	6.43
Mechanical injury	6	4.29

Source: Own survey data

banana fruit and the rest 97.14% of the farmers did not take any training with regards to harvesting and post harvest handling of banana. The most frequent and effective method that the farmers use to determine maturity of the fingers is the physical indices which entails the size and shape of the fruits. Among the interviewed farmers, 92.86% use the size and shape maturity indices to determine whether to harvest or not the banana bunch.

From the respondents, 90.71% harvest the banana bunch during the early morning hours of the day. According to the finding, 83.57% of the farmers harvest more than three times per season per cluster of banana. Of the interviewed farmers, 94.3 get their banana ripe in less than two days whereas, 5.7% get it ripe in 4-6 days. Most of the farmers in the area (92.16%) use *Moringa* leaves to ripe their banana whereas, 5.7% of the farmers use teff straw to ripe banana and the rest 2.14% of the farmers use news paper to ripe their banana. Of the total respondents, 83.57 use banana leaf for packing the ripe banana whereas, 8.57 and 7.86% of the respondents use baskets and paper cartoon respectively. Among the respondents, 85.71% encounter the maximum loss of banana fruit during storage.

Lack of awareness is the most frequently reported (89.28%) cause of post harvest loss in banana. Some other farmers (6.43%) reported that unfavorable weather condition is the other major cause of post harvest loss in banana whereas, the rest 4.29% of the farmers reported mechanical injury either during or post harvest as the major cause of post harvest loss of banana.

Physico-chemical properties of banana fruit: The same study had another experiment to investigate the effect of *Moringa* leaf on the ripening and post harvest life of banana fruits. The effect was variable across the treatments and replications. The flesh firmness (Pa), total soluble solids (^{0}Brix) and physiological weight losses were the parameters checked in response to different levels of *Moringa* leaf.

Total Soluble Solid (TSS): The effect of different levels of *Moringa* leaf on ripening time and TSS of banana fruit was presented in graph1. Results indicated that the maximum TSS value (20 and 19 ^{0}Brix) was recorded for the banana fruits ripe with 150 and 200 g level of *Moringa* leaves. The minimum TSS was recorded with treatment-one which did not receive any *Moringa* leaves. Higher rates of starch hydrolysis might have occurred in the fruits ripe with *Moringa* leaves compared to the one which did not receive *Moringa* leaves(control): This might have accelerated the ripening process of the banana fruits with the *Moringa* leaves. The TSS of fruits which were ripe with small amount of *Moringa* leaves significantly increased with an increase in storage time: This can apparently be due to slow action of the less *Moringa* leaves. This demonstrates that the less the amount of *Moringa* leaves, the slower the rate of starch and chlorophyll hydrolysis and in to sugar and anthocyanin respectively. On the other hand, higher TSS vales of fruit indicate rapid degree of ripeness of fruit, the rise in TSS in the banana fruits shows the rise of sugar content due to degradation of starch by different factor but, mainly due to rise in respiration rate.

The increase in TSS during ripening may result from an increase in concentration of organic solutes as a consequence

of water loss[7]. An increase in TSS can be possible due to numerous anabolic and catabolic processes taking place in the fruit preparing it for senescence[8]. Furthermore, Kulkarni *et al.*[9] reported an increase in TSS and sugars in mango fruits treated with an increased concentration of ethrel (another ripening agent) (Fig. 1a).

Weight loss (%): Weight loss, decay and rapid deterioration are often major factors that determine the storage and marketability duration of banana fruit. The mean value for the weight loss of banana fruit was presented in Fig. 1b. The mean values showed that weight loss is significantly greater in all treatments that received *Moringa stenopetala* leaf compared to the control. The banana fruit ripe with 200 g *Moringa stenopetala* leaf showed absolute weight loss (8.95%) on the 3rd day, this absolute weight loss could be due to higher respiration rates triggered by the phytochemicals released from the *Moringa* leaf. In contrary, at the end of the experiment, the smallest weight loss was recorded with the fruits that received 200 g *Moringa* leaf: The less reduction of weight in the fruits with 200 g *Moringa* leaf could be due to the deposition of the decomposed *Moringa* leaves on the surface of the banana fruit which in turn blocked the stomata which ultimately retards respiration and other metabolic processes in the fruit. On the other hand, the banana fruit that received 150 g *Moringa* leaf showed the highest weight loss compared to the others at 0, 50, 100, 200 and 250 g. This can be explained by the fact that the high *Moringa* leaves (200 and 250 g) could have been decomposed eventually block the normal respiration due to closing the stomata on the banana fruits: The more apertures are closed, the lesser the tendency of the fruits to respire and the slower the rate of respiration which ultimately attributes to the reduced weight loss. The less *Moringa* leaves (control, 50 and 100 g) might have not significantly affected the respiration of banana fruit and hence the weight in response to the less respiration rate has reduced. A study was conducted by Mahajan *et al.*[10] using ethylene gas and ethephon as a ripening agent. These authors recorded an increased during physiological weight loss in response to the banana ripening process. The same researchers compared the efficiency and effectiveness of ethylene gas (100 ppm) with levels of ethephon (250, 500, 750 and 1000 ppm) in terms of hastening banana ripening associated changes. Their finding demonstrates the effectiveness of ethylene gas at 100 ppm in a similar degree to 250 ppm ethephon across the days of post harvest though the maximum physiological weight loss was achieved with an ethephon at 1000 ppm on the day 7 after treatment.

Fruit firmness: The effect of different *Moringa* leaf levels on the flesh firmness was investigated. The effect of the various *Moringa* levels on the fruit firmness of banana fruit is presented in Fig. 1c. The findings showed that the banana fruit which received 250 g *Moringa* leaf has the highest fruit firmness, this could be attributed to the lower chemical reactions associated to respiration that eventually led to less

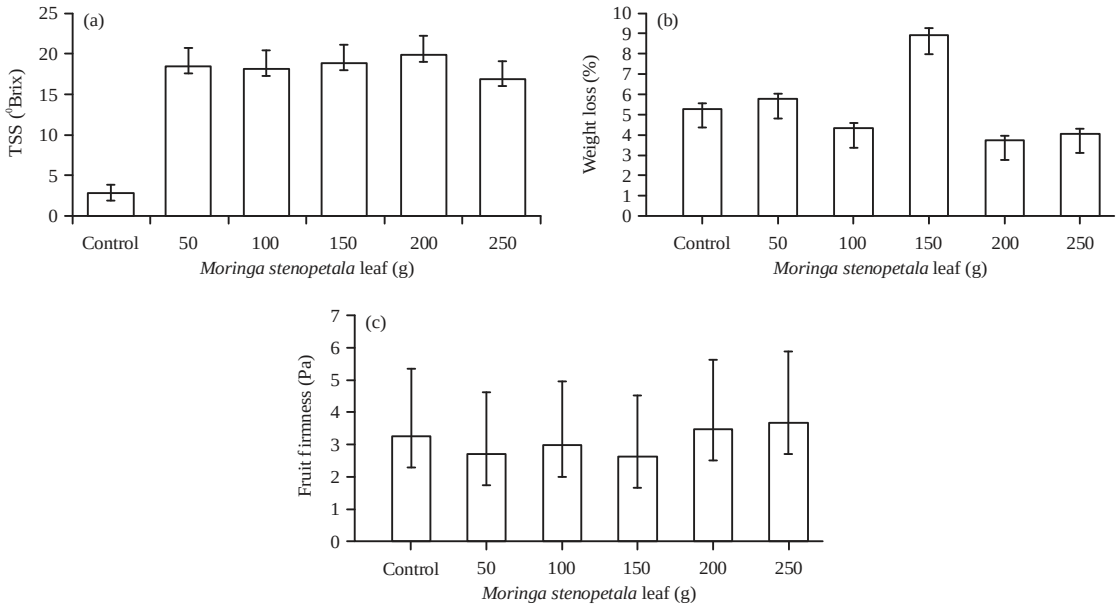

Fig. 1(a-c): Mean (a) Total soluble solid, (b) Weight loss and (c) Fruit firmness of banana fruits in response to differences in the levels of *Moringa* Leaf. Data are Mean±Standard Error of the mean

disintegration of the epidermal cells of the banana fruit whereas, in the 150 g *Moringa* leaf, the lowest firmness was recorded, this is because firmness has a direct relationship with weight loss in banana ripening process. The chemical reactions that reduced the weight of the fruit can reduce the firmness as the ripe fruit is less firm. The overall effect of *Moringa* leaf on the fruit firmness was statistically non significant though difference was observed among the means across the treatments. Another study conducted by Brinson *et al*.[11] stated that the decrease in firmness, during ripening is due to breakdown of insoluble protopectin into soluble pectin or by cellular disintegration leading to membrane permeability. Firmness is one of the most crucial factors in determining the post-harvest quality of fruits[8].

CONCLUSION AND FUTURE RECOMMENDATIONS

The objective of present study was to assess and evaluate the different traditional post harvest handling methods used by the local banana growers in and around Arba Minch in association with the physical, chemical and physico-chemical properties of banana fruit. The laboratory experiment involved of six different levels of *Moringa* leaves and storage period. The treatment had the following *Moring* levels as a treatment 0, 50, 100, 150, 200 and 250 g, respectively. Data was taken on the basis of the Total Souble Solid (TSS), fruit firmness and physiological weight loss (%). The observed result showed that differences in the level of *Moringa* had statistically significant effect on the fruit firmness and non significant effect on the the physiological weight loss and total soluble solids. Though the analysis was statistically non significant in the latter two parameters, there was a considerable differences among the means. Moreover, in this experiment, the effect of *Moringa* leaves on the ripening, physical and physico-chemical characteristics of banana fruits was evidently demonstrated.

Banana is one of the perishable tropical fruits in nature. Therefore, it requires suitable storage and packaging material to improve the shelf-life. The farmers hence, must be given training on the harvesting and post harvest handling technologies of banana fruits so as to ascertain the keeping quality and increased quantity of banana fruit which would in turn align with the country's growth and transformation plan-two plan. The other basic point is, the farmers have to use the *Moringa* material leaves for ripening than other products as it has revealed the most effective and efficient finding in hastening respiration and the transpiration rate of the banana fruit.

SIGNIFICANCE STATEMENTS

The study is intended to produce a scientific and working document on the effect of *Moringa* leaves in ripening banana fruit. Likewise, this study involves demonstration of the prominence and pronounced tendency of *Moringa* leaves in substituting ethylene gas which is not allowed by many airlines to transport as it is a potentially flammable gas. Next to that substitution of ethylene gas by *Moringa* leaves tends to minimize the cost incurred to ethylene gas for ripening both at commercial and small holder farmer level. Furthermore, this study output can be used to produce policy briefs for the policy making bodies of the government, NGOs, Private investors and other stake holders to consider while planning to engage in banana production, processing and marketing.

REFERENCES

1. Iqbal, M., 1996. Type and extent of postharvest losses in horticultural commodities in Pakistan. Proceedings of the National Conference on Postharvest Technology of Horticulture Commodities, September 10-12, 1996, Quetta, pp: 33-42.
2. Hofman, P.J. and L.G. Smith, 1993. Preharvest effects on postharvest quality of subtropical and tropical fruit. Proceedings of the International Conference on Postharvest Handling of Tropical Fruits, July 19-23, 1993, Chang Mai, Thailand.
3. Irtwange, S.V., 2006. Application of modified atmosphere packaging and related technology in postharvest handling of fresh fruits and vegetables. Agric. Eng. Int.: CIGR EJ., 8: 1-13.
4. Hassan, A., 2004. Technologies developed for postharvest handling of Malaysian bananas. Proceedings of the 1st International Congress on Musa: Harnessing Research to Improve Livelihoods, July 6-9, 2004, Penang, Malaysia, pp: 31.
5. Fallik, E. and Y. Aharoni, 2004. Postharvest physiology, pathology and handling of fresh produce. Lecture Notes, International Research and Development Course on Postharvest Biology and Technology, The Volcani Centre, Isreal, pp: 30.
6. Burdon, J.N., 1997. Postharvest Handling of Tropical and Subtropical Fruit for Export. In: Postharvest Physiology and Storage of Tropical and Subtropical Fruits, Mitra, S. (Ed.). CAB International, Wallingford, UK., pp: 1-19.
7. Ryall, A.L. and W.T. Pentzer, 1982. Handling, Transportation and Storage of Fruits and Vegetables. Vol. 2, AVI Publ Co., Westport, Connecticut, pp: 1-40.

8. Smith, R.B., E.C. Lougheed, E.W. Franklin and I. McMillan, 1979. The starch iodine test for determining stage of maturation in apples. Can. J. Plant Sci., 59: 725-735.
9. Kulkarni, G., V.B. Kudachikar, M.S. Vasantha, K. Prakash, B.A. Prasad and K.V.R. Ramana, 2004. Studies on effect of ethrel dip treatment on the ripening behaviour of mango (*Mangifera indica* L.) variety 'Neelum'. J. Food Sci. Technol., 41: 216-220.
10. Mahajan, B.V.C., T. Kaur, M.I.S. Gill, H.S. Dhaliwal, B.S. Ghuman and B.S. Chahil, 2010. Studies on optimization of ripening techniques for banana. J. Food Sci. Technol., 47: 315-319.
11. Brinson, K., P.M. Dey, M.A. John and J.B. Pridham, 1988. Post-harvest changes in *Mangifera indica* mesocarp cell walls and cytoplasmic polysaccharides. Phytochemistry, 27: 719-723.