Effects of Local Storage Practices on Deterioration of African Eggplant *(Solanum aethiopicum L.)* fruits

Majubwa, R.O.[1], T.J. Msogoya*[1] and A.P. Maerere[1]

[1]Department of Crop Science and Production, Sokoine University of Agriculture, P.O. Box 3005, Morogoro. Tanzania.

*Corresponding author: *tjmsogoya@yahoo.com* + 255(0) 783 172544

Abstract

The objective of this study was to evaluate the influence of postharvest storage practices on shelf life of African eggplant fruits based on decay and water losses. A laboratory experiment was laid out in a split plot arrangement following a complete randomized block design with three replications. Three African eggplant cultivars (Tengeru white, Manyire green and AB2) and four post-harvest storage practices (perforated polyethylene bags, woven polypropene bags, closed paper boxes and on-bench storage) were used as main plot and sub-plot factors, respectively. Data were subjected to analysis of variance and means separation was conducted based on Student-Newman Keuls at P<0.05 using MSTAT-C statistical software. Results indicated that fruits stored in perforated polyethylene bags had significantly (p=0.001) the lowest water loss and longest shelf life though they suffered the highest incidence of decays. The decay and shelf life varied with African eggplant cultivars where cv. AB2 had significantly (P=0.001) the lowest decay incidence and longest shelf compared with cv. Tengeru white and Manyire green. Further studies are required to evaluate the effect of fruit disinfection prior to storage in perforated polyethylene bags on the shelf life of eggplant fruits.

Key words: Modified atmosphere, Storage practices, African eggplant cultivars

Introduction

African eggplant *(Solanum aethiopicum* L.) is one of the indigenous vegetables playing a significant role in both subsistence production and income generation among rural and urban poor groups in Tanzania (Chadha, 2006). The crop is notable for high yield of about 10 kg per plant (66.67 tons per hectare) and high market potential (National Research Council, 2006). Colour, shape, size and flavour are the most perceivable quality attributes of African eggplant fruits (Hornal *et al.,* 2007) and important determinant of purchase decision-making (Kays, 1999). In Tanzania, African eggplant is grown in almost every region and is one of the most traded indigenous vegetables in local markets (Chadha, 2006). African eggplant fruits have relatively higher carbohydrate (7.2 g/100g), fibers (2.0g/100g), calcium (28 mg/100g), iron (1.5 mg/100g) and considerable amount of beta carotene (0.35 mg/100g), ascorbic acid (8 mg/100g), riboflavin (0.06 mg/100g) and thiamin (0.07 mg/100g) (Hornal *et al.,* 2007).

The production of African eggplant in Tanzania is characterized by poor post-harvest handling practices (Chadha, 2006) and short shelf life of about three to four days (Hornal *et al.,* 2007). Lack of appropriate postharvest storage management practices are reported to cause up to 50 % of yield losses of vegetable crops between harvesting and consumption (Lumpkin *et al.,* 2009). Poor harvest and storage practices are the most critical problem affecting the quantity, quality and hence the market value of fruits (Bachmann and Earles, 2000). Postharvest losses of most horticultural produces are stated to be 20-50 % in developing countries and 5-25 % in developed countries (Abbas *et al.,* 2011). About 40 – 50 % of total world fresh horticultural produce is lost before being consumed due to high rates of bruising, water loss, decays and decreased nutritional quality during postharvest handling (Kader, 2005).

Maturity stage at harvest is rated as the second most important factor after genotype that influences flavour and shelf-life qualities of fruits (Kader, 1986; Kader, 2008). African eggplant fruit spoilage losses are estimated at 25 % depending on fruit harvesting stage and storage environment (Kader, 1986; Hornal, 2007). African eggplant fruits are very sensitive to inappropriate postharvest handling for they can easily undergo colour change, shriveling and bruising (Kader, 1996). Fruit skin bruising accelerates water loss, shriveling and decays (Hornal *et al.,* 2007; Kader, 1996). Delayed harvest makes fruits mature on the plants and develop colour that results in faster and high fruit postharvest losses (Hornal *et al.,* 2007; Kader, 1996) whereas fruit harvest at early stage of maturity accelerates fruit shriveling and susceptibility to mechanical injuries and decays (Kader, 1999).

Several attempts have been made to improve shelf-life of fresh fruits and vegetables, including fruit storage under modified environment through bagging (Weor, 2007). Modified environment delays fruit peel degreening and prolongs storage life of non-climacteric fruits (Ke and Kader, 1990), retards fruit senescence, lowers respiration rates, slows down the rate of tissue softening and reduces texture loss (Irtwange, 2006; Jayas and Jeyamkondan, 2002). Nevertheless, modified environment poses challenge on getting the right gaseous composition suitable for targeted produce (Irtwange, 2006) and such situation can lead to undesirable fermenting odour in some fruit varieties (Weor, 2007). Farmers and traders in Tanzania have reported high postharvest losses of African eggplant fruits characterized by fast fruit shriveling and browning. There is limited information about the effect of bag storage using locally available materials on deterioration of African eggplant fruits. The objective of this study was to evaluate the effect of bag storage on deterioration of African eggplant fruits.

Materials and Methods

African eggplant varieties Tengeru white, Manyire green and AB2 were collected from Asian Vegetable Research Development Centre – Regional Center for Africa (AVRDC-RCA) in Arusha, Tanzania. Manyire green is a commercial local cultivars developed by AVRDC from the local African eggplant cultivar commonly cultivated at Manyire village in Arumeru district, Arusha. Tengeru white and AB2 varieties were developed by AVRDC and Tengeru Horticultural Research and Training Institute (HORTI - Tengeru) in Arusha, respectively for early bearing and maturity (Chadha, 2006).

The experiment was set as a split plot in a complete randomized block design with three replications each consisting of 30 fruits. Three African eggplant cultivars (Tengeru white, AB-2 and Manyire green) were used as main factor while four storage practices (on-bench storage (control), transparent perforated polyethylene bags, polypropene bags and paper boxes) were used as sub factor. A digital hygrometer-thermometer gauge (Dickson TH550, The Dickson Company, USA) was used for recording of temperature and relative humidity. Fruits were hand-picked with their stalk intact in the morning at stage two of maturity when they had fully expanded shoulder and shiny peel color (Figure 1).

Figure 1: Stage of maturity of African eggplant fruits: Left - cv. Tengeru white, Middle - cv. AB2 and Right - cv. Manyire green

The harvested fruits were packed in large plastic bags and carried to the Horticulture postharvest laboratory of Sokoine University of Agriculture. Fruits were individually numbered and weighed using an analytical balance (Sartorius AG Gottingen BP121S, Germany). Data on fruit water weight loss was estimated as the difference between the individual fruit initial and final weights. Final fruit weight was measured when 50 % of the fruits showed shriveling. Data on fruit decay was recorded a number of fruits with decay symptom converted into percentage. Shelf life was estimated as the number of days when 50 % of the fruits reached unmarketable level due to shriveling, decay or a combination of both. Percentage data were subjected to square root transformation prior to analysis of variance using MSTA-C statistical software (Bricker, 1991). Mean separation was carried out based on Student-Newman-Keuls test at P< 0.05.

Results

African eggplant cultivars had a significant (P = 0.01) influence on the fruit decays and shelf life. Cultivars AB2 had significantly (P = 0.01) the lowest fruit decay incidence followed by Manyire green and Tengeru white. Consequently, cv. AB2 had significantly (P = 0.02) the longest shelf life than cv. Manyire green and Tengeru white (Table 1).

Table 1: Effect of cultivars on postharvest deterioration of African eggplant fruits

Cultivars	Decay incidence (%)	Water loss (%)	Shelf life (days)
Tengeru white	10.3a	11.5	4.5b
AB2	0.9c	10.8	5.3a
Manyire green	7.0b	10.3	4.6b
P-value	0.01	0.7	0.02

Means bearing the same letter(s) within the column are insignificantly (P<0.05) different according to Student-Newman-Keuls.

Storage practices had a significant (P = 0.001) influence on decay, weight loss and shelf life of African eggplant fruits. Fruit decay incidence was the highest on perforated polyethylene bags followed by paper box, woven polypropene bags and on-bench storage (Table 2). On the contrary, fruit weight loss was the lowest on fruits stored on perforated polyethylene bags followed by woven polypropene bag, paper box and on-bench storage. Fruits stored in perforated polyethylene had statistically (P = 0.001) the longest shelf life compared to those stored on benches and closed paper box.

Cultivar-storage practice interaction had a significant (P < 0.05) influence on fruit decays and shelf life (Table 3). Cultivar Tengeru white had significantly (P = 0.001) the highest incidence of decays in perforated polyethylene bag while cv. AB2 had significantly (P = 0.001) the longest shelf life when stored in perforated polyethylene bag.

Discussion

In this study cv. AB2 had the lowest incidence of fruit decay in comparison to cv. Tengeru white and Manyire green. This low fruit decay was due to differences in genetic make-up among the cultivars. Previous studies have also associated the reduction in fruit decay with fruit epicuticular wax, which acts as a barrier for entrance of decay microorganisms (Karbulkova *et al.,* 2008). Similarly, epicuticular wax content has been linked to difference in fruit shelf life among crop varieties due to its influence on fruit water loss and mechanical damage. According

Table 2: Influence of storage practices on deterioration of African eggplant fruits

Fruit storage practices	Fruit decay (%)	Fruit weight loss (%)	Shelf life (days)
Fruit on-bench storage	0.4c	16.6a	4.1c
Woven polypropene bags	4.3b	11.4b	4.9ab
Perforated polyethylene bags	14.8a	2.8c	5.3a
Closed paper boxes	4.8b	12.7b	4.7b
P-value	0.001	0.001	0.001

Means bearing the same letter(s) within the column are insignificantly (P<0.05) different according to Student-Newman-Keuls.

Table 3: Interaction effect of cultivar–storage practices on deterioration of African eggplant fruits

Cultivars x Storage practices	Decay (%)	Water loss (%)	Shelf life (days)
Tengeru white x On-Bench (control)	0.7d	16.8	4.0b
Tengeru white x Polypropene	5.8cd	11.0	5.1b
Tengeru white x Perforated polyethylene bag	24.6a	2.8	4.2b
Tengeru white x Box storage	10.1c	12.6	4.7b
AB2 v On-bench (control)	0.0d	16.5	4.3b
AB2 x Polypropene	0.0d	12.5	5.1b
AB2 x Perforated polyethylene bag	3.2cd	3.4	7.0a
AB2 x Box storage	0.4d	13.6	4.8b
Manyire green x On-bench (control)	0.4d	16.4	4.1b
Manyire green x Polypropene	7.1cd	10.7	4.6b
Manyire green x Perforated polyethylene bag	16.7b	2.3	4.8b
Manyire green x Box storage	4.1cd	11.7	4.7b
P-value	< 0.001	0.9871	< 0.001

Means bearing the same letter(s) within the column are insignificantly ($P<0.05$) different according to Student-Newman-Keuls.

to Smith *et al.* (2006) the shelf life of bell pepper fruits was influenced by fruit epicutilar wax content and stomata density. An increase in epicuticular wax content on citrus fruits also reduced fruit water loss and respiration as the wax layer plays part in altering fruit cuticular permeability and internal gaseous concentration (Moon *et al.,* 2003).

The low decays of fruits stored on benches reported in this study was due to the low relative humidity of 65 % compared with relative humidity of 83.5, 85.8 and 90.2 % in woven polypropene bags, closed paper boxes and perforated polyethylene bags, respectively. Kaynas *et al.* (1995) also reported higher and rapid fruit decay on eggplant fruits stored in polyethylene wrappers due to higher relative humidity. Fruits stored on benches were exposed to higher oxygen gas and low carbon dioxide levels than those stored on bags and boxes. High oxygen levels in fruit storage units reduce fruit decay (Banks *et al.,* 1999) while high carbon dioxide levels increase fruit decays (Ke and Kader, 1990).

The lowest postharvest water loss observed on fruits stored under perforated polyethylene bags in this study was due to the reduction in water vapour pressure deficit caused by high relative humidity in the package. High relative humidity was reported to reduce water loss on stored peach fruits (Paull, 1998). Moreover, polyethylene bag storage has been reported to reduce water loss by 90 % in orange fruits (Ben-Yohoshua, 1985) as a result of reduction in water vapour pressure deficit between fruit surface and the surrounding air (Diaz-Perez *et al.,* 2007; Paul *et al.,* 1998).

Storage of eggplant fruits in perforated polyethylene bags increased the average fruit shelf life (5.7 days) compared with closed paper boxes (4.7 days) and on-bench storage (4.1 days). Hornal *et al.* (2007) also reported an average shelf life of African eggplant fruits of 3-4 days. The shelf life of fresh harvested fruits depends on complex interaction between genetic, physiological status, postharvest physiochemical activities, storage environment and spoilage organisms (De Ketelaere *et al.,* 2004). Optimization of storage temperature and relative humidity are however, described as the best tool for improving the shelf life of fresh fruits (Kader, 2003).

It is concluded that the shelf life varies with African eggplant cultivars with cv. AB2 having the longest shelf life when stored in perforated polyethylene bags. Perforated polyethylene bags increases fruit freshness (low shriveling) and shelf life. However, perforated polyethylene bags increase fruit decay though this does not lead to reduction of fruit shelf life. Further studies are required to evaluate the effect of fruit disinfection prior to storage in perforated polyethylene bags on the shelf life of African eggplant fruits.

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References

Abbasi, K. S., Anjum, N., Sammi, S., Masud, T. and Ali, S. (2011). Effect of coatings and Packaging materials on the keeping quality of Mangoes *(Mangifera indica L.)* stored at low Temperature. Pakistan Journal of Nutrition 10 (2): 129 - 138.

Bachmann, J. and Earles, R. (2000). *Postharvest handling of fruits and vegetables.* [http://attra.ncat.org/attra-pub/PDF/postharvest.pdf] site visited on 17/05/2010.

Banks, N. H., Dadzie, B. K. and Cleland, D. J. (1999). Reducing gas exchange of fruits with surface coatings. Postharvest Biology and Technology 3: 269 - 284.

Ben-Yohoshua, S., Burg, S. P. and Young, R. (1985). Resistance of fruits to mass transport of water vapour and other gases. Journal of Plant physiology 79: 1048 - 1053.

Bricker, B. (1991). MSTAT-C: A microcomputer program for the design, management, and analysis of agronomic research experiments. Michigan State University, Plant and Soil Sciences, East Lansing, Michigan. [http://www.underutilizedspecies.org/Documents/PUBLICATIONS/iv_chadha_paper.pdf] site visited on 01/06/2010.

Chadha, M. L. (2006). *AVRDC's experiences within Marketing of Indigenous Vegetables – A Case Study on Commercialization of African Eggplant.* AVRDC, Tanzania.

De Ketelaere, B., Lammertyn, J., Molenberghs, G., Desmet, M., Nicolai, B. and De-Baerdemaeker, J. (2004). Tomato cultivar grouping based on firmness change, shelf life and variance during postharvest storage. Postharvest Biology and Technology 34: 187 - 201.

Diaz-Perez, J. C., Muyu-Rangel, M. D. and Mascorro, A. G. (2007). Fruit size and stage of ripeness after postharvest water loss in bell pepper fruit (Capsicum annum L.). Journal of the Science of food and Agriculture 87: 68 - 73.

Hornal, D., Timpo, S. and Guillaume, G. (2007). *Marketing of Underutilized crops: The case of the African egg (Solanum aethiopium) in Ghana.* [http://www.underutilizedspecies.org/Documents/PUBLICATIONS/african_garden_egg.pdf] site visited on 21/02/2010.

Irtwange, S. V. (2006). Keeping freshness in fresh-cut horticultural produce. *CIGR* Ejournal (8). 12pp.

Jayas, D. S. and Jeyamkonda, S. (2002). Modified Atmosphere storage of grain, meat, fruits and vegetables. Biosystems Engineering 82 (3): 235 - 251.

Kader, A. A. (1986). Effect of postharvest handling procedures on tomato quality. *Acta Hort culture* 190: 209 - 221.

Kader, A. A. (1996). Maturity, ripening, and quality relationships of fruit vegetables. Acta Hort culturae 439: 249 - 255.

Kader, A. A. (1999). Fruit maturity, ripening and quality relationships. Act Horticulturae 485: 203 – 208.

Kader, A. A. (2005). Increasing food availability by reducing postharvest loss of fresh produce. Acta Horticulturae 682: 2169 - 2176.

Kader, A. A. (2008). Perspective flavor quality of fruits and vegetables. Journal of the Science of Food and Agriculture 88: 1963 - 1868.

Karbulkova, J., Schreiber L., Macek, P. and Santrucek, J. (2008). Differences between water permeability of astomatous and stomatous cuticular membranes: Effect of air humidity in two species of contrasting drought-resistance strategy. Journal of

Experimental Botany 15: 3987 - 3995.

Kays, S. J. (1999). Quality maintenance of fresh produces. Acta Horticulturae 875: 27 - 32.

Ke, D. and Kadar, A. A. (1990). Tolerance of Valencia orange to controlled atmosphere as determined by physiological responses and quality attributes. Journal of American Society of Horticultural Science 115 (5): 779 – 783.

Lumpkin, T. A. (2009). Perspective from the World Vegetable Center: Human health effects of fruits and vegetables. Acta Hortculturae 841: 254 - 248.

Moon, D., Cho, Y., Mizutani, F., Rutto, K. L. and Bhusal, R. C. (2003). Wax deposition on the fruit surface of Satsuma mandarin as affected by water Stress. Asian Journal of Plant Science 2: 1138 - 1141.

National Research Council (2006). *Lost crops of Africa- Volume II Vegetables*. National Academic of Science. National academies Press., Washington. 352pp.

Paull, R. E. (1998). Effect of Temperature and relative humidity on fresh comodity quality. Postharvest Biology and Technology 15: 263 - 277.

Smith, D. L., Stommel, J. R., Fung, R. W. M., Wang, C. Y. and Whitaker, B. D. (2006). Influence of cultivar and harvest method on postharvest storage quality of pepper *(Capsicum annum L.)* fruits. Biology and Technology 42: 243 - 247.

Weor, D. V. (2007). Effect of harvesting methods and storage environments on storability of Peter Mango fruits in Gboko, Benue state. Journal of sustainable Development in Agriculture and Environment 3: 81 - 88.