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Respiratory Weight Loss in Yam (*Dioscorea rotundata* Poir) Tubers, Fruits of Valencia Oranges (*Citrus sinensis* L.) And Tomato (*Lycopersicon esculentum* Mill.) Stored Using Plant Derived Materials as Protective Coatings in Zaria, Nigeria

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Abstract: An experiment was conducted to evaluate the relative effectiveness of applying locally derived plant products, namely oil from groundnut (*Arachis hypogaea* L.) seeds and juice extracted from lime (*Citrus aurantifolia* L.) fruits on respiratory weight loss of yam (*Dioscorea rotundata* Poir) tubers and fruits of Valencia orange (*Citrus sinensis* L.) and tomato (*Lycopersicon esculentum* Mill.) during storage under ambient conditions, in the Savanna region of Nigeria. Rate of weight loss during early periods of the observation was minimal in all the three stored products when groundnut oil coating was applied and maximal in uncoated products. Mean weight loss was reduced by both lime and groundnut oil coatings, although, for yam and Valencia oranges this was significantly (p=0.05) lower for groundnut oil coatings than lime juice coatings. In tomato fruits the differences in weight loss between fruits treated with the two coating materials at the termination of observation period was not significant. Weight loss was generally attributed to respiration and transpiration and groundnut oil was seen as a possible alternative to synthetic waxes in controlling this process in stored yams, oranges and tomatoes, in rural communities under tropical savanna conditions.

Key words: Oil, limejuice, coating, weight loss, stored products

INTRODUCTION

Post harvest deterioration of agricultural produce is significantly affected by storage conditions. Two important processes that contribute to this are respiratory weight loss and dehydration[1,2]. Modern methods that enhance storage of these produce including controlled atmosphere storage, refrigeration etc. are impracticable in many developing nations due to unavailability, cost or both. Increasingly, the use of protective coating materials to reduce weight loss and desiccation in horticultural crops has been adopted. This includes use of various categories of synthetic materials[3-6].

Although, these synthetic materials have proven quite efficient at reducing weight loss and desiccation in various crops, their acceptance and widespread application is somewhat limited by an understandable reluctance of local growers to apply unfamiliar chemical treatments to edible materials. In this regard, use of edible/chemically harmless or easily degradable materials, has been on the increase. Some of such that have been used including alginate based coatings, corn-zein, shellac, chitosan and semperfresh (a fatty-acid-sucrose ester mixture) have been reported to lower respiration, delay color change, reduce loss of firmness and weight and extend the shelf life of various fruits and vegetables[7-10]. However, there still remains the fact that these formulations are rather expensive and relatively unavailable to many growers, particularly those who produce at the subsistence level. This therefore creates the need to source for cheaper and more readily available alternatives.

While the citruses are commonly cultivated in many local homesteads and orchards, the use of species such as lime (*Citrus aurantifolia* L.) is highly limited and this results in waste of produce at fruit maturity. Groundnut (*Arachis hypogaea* L.) on the other hand is widely cultivated and used in various ways particularly as a source of edible oil. This study was therefore designed to evaluate the comparative efficiency of lime juice and groundnut oil, applied as protective coating in reducing respiratory weight loss in three categories of stored food crops namely a root tuber, (yam-*Dioscorea rotundata* Poir), a fruit (Valencia orange-*Citrus sinensis* L.) and a fruiting vegetable (Tomato-*Lycopersicon esculentum* Mill.) stored under ambient conditions in Zaria, Nigeria.

MATERIALS AND METHODS

Study area: The experiment was performed over a two-month period from August-September, at the Department of Biological Sciences, Ahmadu Bello University Zaria

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(Lat. 11°11'N) in the Northern Guinea Savanna of Nigeria. Mean annual rainfall in this area is about 1020 mm, while mean relative humidity ranges from 21.6 to 78.0% and mean temperature ranges from 17 to 33.3°C.

Experimental procedure: Three batches of three medium sized yam tubers (between 2.0-2.5 kg each) were weighed and carefully cleaned to remove soil from the surface. To one set of three tubers, a thin coating of groundnut oil was evenly applied using a fine brush. To a second batch of three tubers, two films of freshly extracted limejuice was applied in the same manner. A third batch was left untreated.

This treatment was repeated for three batches of Valencia oranges weighing 30-32 g each and three batches of tomato fruits weighing 5-20 g each. Each of these batches of fruits were placed in collapsible cartons containing dry sawdust and kept on the shelf at 22-25°C. For the yams, tubers were weighed at fortnightly intervals, over a period of 98 days (3 ½ months), while for oranges and tomatoes; readings were taken at weekly intervals over a period of 49 days (7 weeks).

Results obtained were used to compute percentage weight loss and these values were subjected to Analysis of Variance (ANOVA)[11] to determine the level of significance of observed differences at 5% level of probability.

RESULTS

Rate of weight loss in yam tubers stored at ambient temperature increased significantly and steadily from 14-98 days in storage for tubers coated with both lime juice and groundnut oil as well as uncoated tubers (Table 1), weight loss at the early periods of storage was minimal in tubers coated with groundnut oil and maximal in uncoated tubers.

Mean weight loss was significantly (p=0.05) higher in uncoated tubers than in tubers coated with either limejuice or groundnut oil. Of the latter two categories, mean weight loss in tubers coated with limejuice was significantly higher in those coated with groundnut oil.

In Valencia oranges stored at ambient temperature, rate of weight loss also increased steadily from 7-49 days of storage in fruits coated with both limejuice and groundnut oil. In uncoated fruits, the rate of weight loss declined during the terminal 14 days. Weight loss at the early periods of storage was minimal in fruits coated with groundnut oil and maximal in uncoated fruits. Mean weight loss was significantly higher (p=0.05) in uncoated fruits than in fruits coated with either limejuice or groundnut oil (Table 2). Between the latter two categories, mean weight loss in fruits coated with limejuice was significantly higher than in those coated with groundnut oil.

Table 1: Weight loss (% Fresh Weight) of yam (*Dioscorea rotundata* Poir) tubers stored under ambient conditions after coating with limejuice and groundnut oil

	Days of storage							
	14	98	28	42	56	70	84	Mean
Uncoated (control)	1.38	1.68	1.68	2.53	2.89	2.98	2.25	2.57a
Lime Juice coating	0.83	1.92	1.07	1.70	1.89	2.30	2.38	2.20b
Groundnut oil coating	0.20	3.55	0.22	0.24	0.24	2.28	2.92	1.61c

Means followed by the same letter are not significantly different by Duncan's Multiple Range Test, p=0.05

Table 2: Weight loss (% fresh weight) of Valencia orange (*Citrus sinensis* L.) stored under ambient conditions after coating with limejuice and groundnut oil

	Days of storage							
	7	49	14	21	28	35	42	Mean
Uncoated (control)	2.10	3.20	2.69	4.36	5.56	5.80	3.73	4.57a
Lime Juice coating	1.38	3.01	1.80	2.69	2.98	3.79	2.92	3.10b
Groundnut oil coating	0.38	5.65	0.43	0.44	0.84	3.54	4.26	2.59c

Means followed by the same letter are not significantly different by Duncan's Multiple Range Test, p=0.05

Table 3: Weight loss (% fresh weight) of tomato (*Lycopersicon esculentum* Mill.) stored under ambient conditions after coating with limejuice and groundnut oil

	Days of storage							
	7	49	14	21	28	35	42	Mean
Uncoated (control)	1.07	1.70	1.50	3.92	2.95	2.28	1.71	2.52a
Lime Juice coating	0.81	2.07	1.01	1.25	1.29	3.00	2.29	1.95ab
Groundnut oil coating	0.04	5.18	0.06	0.11	0.27	3.42	4.41	2.25a

Means followed by the same letter(s) are not significantly different by Duncan's Multiple Range Test, p=0.05

Pattern of weight loss in tomato fruits stored at ambient temperature was variable among the treatments. While for uncoated fruits a sharp increase up to the third week was followed by a steady decline in subsequent weeks, for fruits coated with lime juice, a steady increase up to the fifth week was followed by a decline in the last two weeks (Table 3). On the other hand, weight loss in tomato fruits coated with groundnut oil increased steadily and significantly up to the end of the observation period (7th week). Weight loss during the early periods of storage was minimal in fruits coated with groundnut oil and maximal in uncoated fruits.

Mean weight loss was significantly (p=0.05) higher in uncoated fruits than in fruits coated with either limejuice or groundnut oil. The difference in mean weight loss between fruits coated with limejuice and groundnut oil was not significant.

DISCUSSION

For all stored products, protective coatings of both limejuice and groundnut oil significantly reduced rate of weight loss during storage, probably because, these coating materials reduced rate of oxygen uptake by the stored products. Protective coatings are generally known to influence the gas permeability properties of stored products[3]. In the absence of gases such as oxygen, metabolic rates will drop because the activities of oxidative and cell wall enzymes, which break down storage and structural carbohydrates, will be greatly minimized. In yam tubers stored for prolonged periods, it has been reported that respiratory weight loss is due principally to increased activities of respiratory enzymes such as phosphorylase, hexokinase, glucose-6-phosphate dehydrogenase and alcohol dehydrogenase[12]. In addition, breakdown of tuber storage proteins and lipids leading to disintegration of tuber structures also occur[13]. Coatings have been reported to reduce intensity of respiration and delayed the de-polymerization of hemi-cellulases in avocado[3]. Furthermore, protective coating materials reduce the permeability of the skin to water vapor, thereby reducing the rate of transpiration and thus the rate of water loss and dehydration of the stored products[1].

Comparisons, between the efficiency of the two types of coating materials for yam and oranges showed that groundnut oil coatings were more effective than lime juice. This could be due to several reasons. The first could be that oil coatings provided a more spreading and efficient blockage of the gas exchange channels in these two products. Secondly, oil coating would be more chemically stable and thus last longer on the stored products. For tomatoes however, these coating materials did not differ significantly in their effectiveness. Furthermore, the pattern of weight loss recorded for tomato fruits was indicative of the nature of the fruits. Tomato fruits are dominantly composed of water and very little of respiratory substrates, such as carbohydrates. It would then follow that most of the weight loss in tomato fruits was due to transpiration and subsequent drying of the fruits. In the uncoated fruits, transpiration rates were high and peaked earlier at 3 weeks and then declined as the fruits dried out. In the fruits coated with lime juice the peak of transpiration rate was delayed to the 5th week, before a decline while in the fruits coated with groundnut oil, transpiration rates were slowest and continued a gradual increase up to the end of the observation period.

CONCLUSIONS

The results of this study has shown that both lime juice and groundnut oil coatings were effective in reducing respiratory weight loss and transpiration rates in stored yam tubers, oranges and tomato fruits. Groundnut oil was more effective as a protective coating on yam tubers, oranges and tomato fruits and provides a possibility for local use in place of synthetic waxes and imported coating materials.

REFERENCES

1. Babarinsa, F.A., J.O. Williams and A. Omumukuyo, 2002. Effects of three skin- coating materials on the storage of Valencia oranges. Postharvest Sci., 1: 7-11.
2. Babarinsa, F.A. and J.O. Williams, 2002. Control of weight loss in Valencia oranges using waxed paper wrappers. Postharvest Sci., 1: 78-81.
3. Alonso, J. and R. Alique, 2004. Influence of edible coatings on shelf life of picota sweet cherries. Eur. Food Res. Technol., 218: 535-539.
4. Jeong, J., D.J. Huber and S.A. Sargent, 2002. Influence of 1-methylcyclopropene (1-MCP) on ripening and cell wall matrix polysaccharides of avocado (*Persea americana*). Postharvest Biol. Technol., 25: 241-256.
5. Tay, S.L. and C.O. Perera, 2004. Effect of 1-methylcyclopropene treatment and edible coatings on quality of minimally processed lettuce. J. Food Sci., 69: C131-C135.
6. Bai, J.H., R.D. Hagenmaier and E.A. Baldwin, 2003. Coating selection for delicious and other apples. Postharvest Biol. Tech., 28: 381-390.
7. Park, H.J., M. Chinnam and S.V. Shewfelt, 1994. Edible coating effects on storage life and quality of tomatoes. J. Food Sci., 59: 568-570.
8. Yolters, T., Y. Tiizel and A. Guil, 1994. Effects of Semperfresh application on ripening of tomato harvested at mature green stage. Acta Hortic., 366M: 469-474.
9. Kluge, R.A. and K. Minami, 1997. Effect of sucrose esters on stored santa clasa tomatoes. Sci. Agric., 54: 39-44.
10. Han, C., C. Lederer, M. McDaniel and Y. Zhao, 2005. Sensory evaluation of fresh strawberries (*Fragaria ananassa*) coated with chitosan-based edible coatings. J. Food Sci., 70: S172-S178.
11. Parker, R.E., 1980. Introductory Statistics for Biology. Edward Arnold Ltd. Southampton UK Series, 43: 122.

12. Ikediobi, C.O., 1985. Biochemistry and Physiology of Yam Storage. In: Advances in Yam Research. The Biochemistry and Technology of the Yam Tuber. G. Osuji (Ed.) (The Biochemical Society of Nigeria in Collaboration with Anambra State University of Technology), pp: 109-141.

13. Osuji, G.O., 1981. The disintegration of yam tuber y-glutamyl transpeptidase during tuber storage. Acta Biol. Med. Germ., 40: 149-150.