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Guava (*Psidium guajava* L.) fruit coating with gum arabic for quality and fruit fly control

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ABSTRACT

Guava (*Psidium guajava* L.) is a lovely tropical and subtropical fruit that originates in Mexico, Central America, and then taken to other distant and near parts around the world. In Sudan this popular fruit is produced in orchards and household and is so profitable but yet attacked by a lot of fruit fly species of the Genera *Ceratitis* and *Bactrocera* and the result is a loss of more than 70%. This research aimed at evaluating the effect of Gum Arabic coating (GAC) in extending the shelf life of guava fruit and disinfesting it from these notorious pests. Guava fruits from Kadaro orchards, Khartoum North, were tested using seven concentrations of Gum Arabic solutions. The results reflect that 1: 4 (25%) and 1: 8 (12.5%) (GA: water) concentrations attained 56 and 40% disinfestation, respectively whereas the other lower concentrations effected corresponding results in a range from 20 – 08%. The reduction in maggots per test fruit reached upto 188% as compared to the control. The highest concentrations (1: 4 & 1: 8) effected a sustainability of 52% in fruit firmness (FF) with an average of medium (3) FF compared to soft FF (4) in the control. The corresponding results in other lower concentrations (1: 16; 1: 32; 1: 64; 1: 72 & 1: 96) were 36, 24, 24, 20 and 16%, respectively. In addition to an average FF of 4 (soft) for all these concentrations and 5 (very soft) for all the corresponding controls. Nevertheless, the sustainability of fruit color (FC) effected by the test concentrations was 52, 44, 24, 22, 24, 20, and 24%, respectively. Regarding these results, the two highest test concentrations effected a sizeable disinfestation and control of fruit flies and a good extension of shelf life of guava in Khartoum State. These findings support using this treatment as an effective IPM tool to extend guava fruit shelf life and upgrading its postharvest quality.

KEYWORDS: Guava, fruit flies, shelf life, fruit firmness, color and quality.

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INTRODUCTION

Guava (*Psidium guajava* L.) center of origin is not yet assured but it is believed to be the Central America and Mexico [1]. It is distributed by man and his animals and birds spread in warm parts of America and the Island as early as 1526. Then travelled to other parts of the world such as North America, India, Malaysia, North Africa, Brazil, Australia, Japan and a lot of other areas around the globe [1]. In Sudan common guava (*P. guajava*) is cultivated for market in orchards and for domestic use in backyards [2]. The open pollination and the propagation by guava seed produce a lot of different cultivars this besides the introduction of some exotic lines by the Agricultural Research Corporation (ARC) in 1980s. There are four distinct cultivars of guava known in Sudan that include Singa (white flesh), Gunnib (red flesh), Pakistani (White flesh) and Shendi (white flesh) [3], [4]. The production of guava is not ascertained but tentative statistics reflect that the area under this tree is estimated as 6000 ha that produce 112000 tons annually with an average production of 10 – 17 tons per hectare per annum. However, the major and famous production areas include Singa, Shendi, Abujebaiha, Um Rawaba, Kassala, Rahad and Khartoum [5]. The main constraint of guava production in Sudan is fruit flies. That is, five different species attack guava that include *Ceratitis cosyra* WLK; *Ceratitis quinaria* Bez.; *Ceratitis capitata* Weid.; *Bactrocera zonata* Saunders and *Bactrocera invadens* De Trusta and White [6]. However, the infestation by *B. invadens* caused damaged to fruit hosts in a range of 30 – 80% [7].

A lot of postharvest techniques were tested to extend the shelf life of guava fruits and to control fruit flies [6]. However, coating of fruits with GA and vegetables was practiced in a lot of crops to extend shelf life. That is, coating of cucumber (*Cucumis sativus* L.) with GA resulted in reducing the tenderness, color change and sustain quality in 16 days storage [8]. GA aqueous solution at 10% was recommended for tomato coating. That is, it slowed maturity, rate of respiration and retarded ethylene formation and regulated antioxidant capacity, lycopene, phenolics and carotenoids in store as compared to untreated lots after 20 days [9]. However, an amalgam of GA (10%) and ginger oil (2%) was found successful as a storage fungicide and

a ripening retardant for papaya (*Carica papaya* L.) fruit [10]. Similar results were obtained by a combination of 10% GA and 1.0% chitosan in coating banana fruits [11]. Moreover, coating of banana with GA – starch solution resulted in dawdling ripening and sustained firmness [12]. A mixture of GA (15%), sodium caseinate (SC, 2%) and tulsi extract (TE, 5%) composite solution was used in coating guava over a week storage. An average concentration (7.5 – 12%) resulted in a far better quality indexes compared to the untreated control fruits. Optimized solution (5% GA, 1% SC and 2.5% TE) retarded ripening and reflected good results in the sensory evaluation and extended the shelf life of guava 3 days [13]. Five combinations of (1) 5% GA and 1% SC + 1% cinnamon (CE) oil; (2) 5% GA + 1% SC + 2% CE; (3) 5% GA + 1% SC + 1% lemon grass (LG); (4) 5% GA + SC 1% + 2% LG and (5) 5% GA + 1% SC + 2% LG were used to coat guava in a storage period of 7, 21, 35 and 40 days at 4 – 7 C. The results obtained revealed that the combination of No. 2 and No 4 were the top in extending the shelf life of guava [14]. This study focused on evaluating the effect of seven different concentrations of GA solution (using water as a solvent) as edible coating in improving the quality and extent the shelf life of guava fruits.

MATERIALS AND METHODS

Materials

Guava fruits were brought from orchards in Kadarao (the guava reservoir of Sudan, Khartoum North). The GA powder was supplied from Shalabi Factory, Khartoum. The cartoons for on – bench storage were made available from the Behri Central Fruits and Vegetable Market (Khartoum North). The glass ware used belong to the Canning Department of the National Food Research Center, Ministry of Agriculture and Forestry, Khartoum North. These include glass beakers, electronic sensitive balance, glass rod, spatulas, stainless steel spoons knives, needles etc… magnifying lenses, binocular, big metallic basins etc… were all used in this experimentation.

Methods

Freshly harvested guava fruits were put in big metallic basins and washed thoroughly with tap water. The test fruits used were of medium size (4 X 5 cm^2) and medium color (yellowish green). The concentrations used were prepared by weighing the calculated weight of GA powder and then put in a glass beaker with the calculated amount of water. This then stirred thoroughly by a glass rod up till the complete dissolution and a product of homogeneous solution was produced. The washed and picked guava fruits were then immersed in the set concentration for 20 seconds and put in the test cartoon lined with paper under a ceiling fan to sweep the excess moisture. The concentrations of GA used were (grams per ml of water) 1: 4, 1: 8, 1: 16, 1: 32, 1: 64, 1: 72 and 1: 96. For any of these concentration a corresponding control (treated with absolute water, 0 GA: ml water).

The readings were taken after a bench storage of 4 days. Every fruit was checked for FF, FC, the number of maggots/fruit and the infestation by worms of fruit flies.

The FF was read according to five grade tissue soundness by finger probing as follows

- Grade one, very solid.
- Grade two, solid.
- Grade three, medium.
- Grade four, soft.
- Grade five, very soft.

The FC was read by vision by giving one score for the fruit

- Yellow color (Y).
- Yellowish green (YG).
- Yellowish Brown (YB).
- Green (G).

The test fruits were then stored for 4 days on bench in a laboratory the average temperature and average relative humidity of which were 30°C and 18%, respectively. The fruits were then visualized, probed and dissected for FF, FC, insect infestation and worm count, respectively.

The analysis of the results were done by ANOVA using the mode, mean, range and percentage. However, the entomological results were corrected by eliminating the control figures [15] as follows

The corrected result = (Test result – control result/Total used) X 100

RESULTS AND DISCUSSION

The results of the insect infestation are summarized in Table 1. The infestation of fruit flies in test fruits of the 7 concentrations

Table 1: Summary table of insect infestation in gum – Arabic coated guava fruits

Concentration	Disinfestation (%)			Worms/fruit				Infestation		
	Test	Control	Corrected	Test	Control	Difference	Diff. (%)	(%)	Range	Mode
1: 4	72	16	56	5	11	6	120	28	1 – 17	1
1: 8	56	16	40	7	11	4	57	44	1 – 23	2
1: 16	32	12	20	8	23	15	188	68	1 – 20	1
1: 32	32	12	20	17	23	6	35	68	1 – 45	19
1: 64	32	12	20	25	23	2	8	68	3 – 75	7
1: 72	24	12	12	14	23	9	64	76	1 – 38	4, 7 & 14
1: 96	20	12	08	23	23	0	0	80	4 – 77	7
Contr. 1								84	3 – 57	4
Contr. 2								88	2 – 109	6

Table 2: Summary table of fruit quality results

Concentration	Sustainability of fruit color (FF) (%)			Sustainability of fruit firmness (FF) (%)			Fruit firmness average (FFA)	
	Test	Control	Corrected	Test	Control	Corrected	Treatment	Control
1: 4	60	08	52	76	24	52	3	4
1: 8	56	12	44	64	12	52	3	4
1: 16	64	40	24	48	12	36	4	4
1: 32	76	54	22	36	12	24	4	4
1: 64	28	04	24	36	12	24	4	4
1: 72	24	04	20	32	12	20	4	4
1: 96	28	04	24	28	12	16	4	4

used (1:4; 1:8; 1:16; 1:32; 1:64; 1:72 and 1:96) was 28, 44, 68, 68, 68, 76 and 80%, respectively. The corresponding infestation ranges were 1 – 17, 1 – 23, 1 – 20, 1 – 45, 3 – 75, 1 – 38, 4 – 77, 3 – 57 and then 2 – 109 whereas the corresponding modes were 1, 2, 1, 19, 7, (4, 7 and 4), 7, 4 and 6. However, the average number of maggots/fruit for the test concentrations, in order, were 5, 7, 8, 17, 25, 14 and 23. In addition the difference percentage of the number of worms/fruit as compared to the control were 120%, 57, 188, 35, 8, 64 and zero, respectively (Table1). Nevertheless, the corrected (by eliminating the disinfestation by other natural factors in the control) disinfestation values of the test concentrations, in order, were 56, 40, 20, 20, 20, 12 and 8%, respectively. All these mentioned results reflect the potency of GA to disinfest guava fruits from fruit flies and extending the shelf life consequently (Table 1). That is, the two highest concentrations used 1:4 and 1:8 effected 56% and 40% disinfestation of the test fruits which count more than half of the test fruits in the former and 2/5 of the fruits in the latter experiment. These figures attribute for an effective control of guava fruit flies in Khartoum State in particular and fruit flies in guava, generally speaking. GA is used as an edible coating in treating some fruits [17]. Moreover, coated guava with some edible coatings was reported to be disinfested from fruit flies [18]. GA was reported as the most soluble natural gum with a number of positive characteristics that include low viscosity, nontoxicity, lack of odor, color and taste [16]. The GA is also known as gum acacia which is harvested from *Acacia senegal* L. trees and 85% of it comes from Sudan. The chemical composition of which is n-galactopyranosyl, L – rhamnopyranosyl, L – arabinopyranosyl and D – glucopyranosyluronic acid units with calcium, magnesium and potassium ions [19]. All these findings support using GA as an edible coating of guava fruits.

The effect of GA coating on guava fruit quality indexes gave results summarized in Table 2. That is, the treatment of test fruits with concentrations of 1:4; 1:8; 1:16; 1:32; 1:64; 1:72 and 1:96 yielded a percentage of color sustainability of 60, 56, 64, 76, 28, 24, and 28, respectively. The corresponding corrected values (calculated by eliminating the control values) for the FF were 52, 44, 24, 22, 24, 20 and 24, respectively. These results reflect a proportionality between the test concentration and the color sustained, generally speaking. These figures infer that the highest test concentrations used succeeded in maintaining 52% and 44%, in order, whereas the lowest one used attained only 24%. The test FF was maintained by values of 76, 64, 48, 36, 36, 32 and 28%, respectively. The corresponding results of the corrected values were 52, 52, 36, 24, 24, 20 and 16%. In addition the two highest concentrations used achieved a FF average of 3 (medium) whereas all the other test concentrations yielded an average FF of 4 (soft) and failed to maintain their tissue connectivity (Table 2). Nevertheless, a lot of research done on the effect of GA coating on fruit quality. That is, GA coating of cucumber (*C. sativus*) improved the storage quality [8]. A concentration of 10% GA of tomato improved all the quality indexes of tomato (*S. lycopersicum*) [9]. It also succeeded as a postharvest treatment and quality upgrading for banana fruits [11] & [12] and for papaya fruits (*Carica papaya* L.) postharvest quality [10]. In addition good results were obtained in studies used GA coating of guava fruits as a postharvest quality treatment [13], [14]. Moreover, it was reported that 30% loss in fruit and vegetables occurred due to insect and microbial invasion and transport a fter harvest and storage. Coating with edible films allows postharvest protection of these products and is friendly to man and his environment [20]. That is, hydrocolloids were found effective in color, texture and aroma preservation and life prolongation of fruits and vegetables [20]. In addition GA coating of sweet lemon reduced fruit rot and skin color changes after 90 days storage [21]. All this mosaic of results support using GA as a fruit treatment for postharvest quality of guava

CONCLUSION

GA coating of guava fruit is a good method for fruit postharvest quality and fruit fly control but not as a mean of fruit fly disinfestation. It is known as a safe natural edible coating with no drawbacks for it has no odor, no color, no taste and low viscosity and offers a glazy attractive appearance to the fruits.

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