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Effect of Waxing and Gum Arabic Coating on Quality and Shelf Life of Mango (*Mangifera indica* L.) Fruits

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Abstract: The effect of waxing and coating with aqueous solutions of gum Arabic on quality and shelf life of the fruits of 'Kitchner' and 'Abu-Samaka' mango fruits was evaluated. The fruits were coated with aqueous solutions of 0 %, 5 % or 10 % gum Arabic by dipping the fruits in the aqueous solution of each concentration for three minutes and air dried. In the composite treatments of gum Arabic and wax, food-grade wax was applied in a thin layer by brushing over the surface of fruits after gum Arabic treatment. The fruits were packed in carton boxes (43 x 33 x 15 cm), arranged in a completely randomized design with four replicates and stored at 18 ± 1°C and 85 % - 90 % relative humidity. Coating the fruits with gum Arabic in aqueous solutions significantly delayed the onset of the climacteric peak of respiration and fruit ripening; reduced weight loss, fruit softening, peel colour development, total soluble solids (TSS) accumulation and the drop in titratable acidity; retained ascorbic acid; maintained quality and extended shelf life of mango fruits. Waxing in addition to gum Arabic coating was more effective than gum coating alone, in all parameters studied. Gum Arabic coating at 5 % and 10 % without waxing reduced weight loss by 3.6 % and 7.7 % and peel colour development by 3.8 % and 9.6 % respectively in 'Kitchner' and 'Abu-Samaka', compared with the control. Gum Arabic coating at 5 % and 10 % with waxing reduced weight loss by 13.5 % and 19.6 % and peel colour by 10.5 % and 21.0 %, respectively, compared with the control. Ascorbic acid content was 5.5 % and 12.5 % more in fruits coated with gum Arabic at 5 % and 10 % aqueous solutions without waxing and 22.1 % and 33.4 % more in fruits coated with 5 % and 10 % gum Arabic with waxing in respectively in 'Kitchner' and 'Abu-Samaka', compared with the untreated fruits.

Key words: Mango fruit; fruit waxing; gum Arabic coating; fruit quality; shelf life.

INTRODUCTION

The mango fruit (*Mangifera indica* L.) is the most popular fruit among millions of people in many countries. It is considered as one of the best fruits in the world market, due to its excellent flavor, attractive fragrance, beautiful colour, delicious taste and health giving properties (Salunkhe and Desai 1984). In Sudan, mango is an important and popular fruit crop with an annual production of 641,728 tons, representing 60% of total Sudan exports of horticultural crops (HSA 2017).

Mango is a typical climacteric fruit that exhibits characteristic rise in ethylene production and respiration rate during ripening (Kader 2002). The high rate of respiration, which is usually associated with short shelf life, soft texture and high moisture content, makes mango a very perishable fruit that requires great care during harvesting, handling, transportation and storage.

'Abu-Gebeha' area in south-eastern Kordofan is considered as one of the most important areas in Sudan for producing low cost fruit crops, especially mango, guava and citrus, under rain-fed conditions. Although more than 100 thousand tons of good quality mango fruits are produced, only about 15 % of the produce is marketed due to poor harvesting techniques, unsatisfactory handling practices and inadequate transportation and storage facilities (RMAFNK 2008). Large number of fruits are bruised, shriveled, unattractive and with short shelf life. Post-harvest losses were estimated at 20-30 % (Tahir *et al.* 2002). These post-harvest handling practices need a lot of improvement for the development of a sound mango industry in the area.

Waxing retards the rate of moisture loss, maintains turgidity and plumpness and covers injuries on the surface of the commodity (Wills and Golding 2016). Moreover, waxing significantly alters permeability of the skin to gases. The commodity, through respiration, is used to reduce oxygen and increase carbon dioxide and a modified atmospheric condition may be generated and consequently some of the benefits of the modified atmosphere may be achieved (Kader 2002). Waxing was reported to delay fruit ripening, reduce water loss, improve quality and to extend shelf life

in mango (Mohamed and Abu-Goukh 2003), tomato (Ahmed and Abu-Goukh, 2003), grapefruit (Abu-Goukh and Elshiekh 2008), lime

(Abdallah and Abu-Goukh 2010), papaya (Abu-Goukh and Shattir 2012) and guava (Mohamed-Nour and Abu-Goukh 2013).

Coating of fruits with gum Arabic has been found to delay fruit ripening, maintain post-harvest quality and enhance shelf-life in tomato (Ali *et al.* 2010) and banana (Magbool *et al.* 2011). Gum Arabic in aqueous solution of 10 % applied as a novel edible coating to mature-green tomatoes and stored at 20 ºC and 80%-90 % relative humidity for 20 days significantly delayed changes in colour development, flesh firmness, TSS, weight loss, titratable acidity, ascorbic acid content and decay percentage, compared to uncoated control fruits (Ali *et al.* 2010). The composite edible coating of 10 % gum Arabic plus 1.0 % chitosan on bananas reduced respiration rate and ethylene production, delayed fruit ripening and maintained the overall quality of banana fruits stored at 13 ± 1ºC and 80 ± 3 % relative humidity (Magbool *et al.* 2011).

This study was carried out to evaluate the effect of waxing and gum Arabic coating in aqueous solutions on quality and shelf life of ‘Kitchner’ and ‘Abu-Samaka’ mango fruits in 'Abu-Gebeha' area, south-eastern Kordofan.

MATERIALS AND METHODS

Experimental material

Two of the most important mango cultivars grown in Sudan: an early 'Kitchener' and late maturing ‘Abu-Samaka’ were selected for this study. Mature-green fruits of the two cultivars were harvested from an orchard at ‘Abu-Gebeha’ area in south-eastern Kordofan (11o 27′ N, 31o 14′ E). The fruits were picked by a hook attached to a long bamboo pole equipped with a long cloth bag held open by a ring. When the pedicle was severed, the fruit dropped into the sleeve, and moved smoothly downwards to be received by the picker. About 900 fruits of each cultivar were selected for uniformity in size, colour and freedom from blemishes and defects. The fruits were packed in carton boxes and transported to the laboratory at the Faculty of Agriculture, University of Khartoum. The fruits were washed with tap water to remove latex and dust, and then

washed by distilled water, treated with 200 ppm sodium hypochlorite (Clorox, 5 %) as disinfectant and air dried.

Fruit treatment

The fruits were distributed among six treatments in a completely randomized design with four replicates. The treatments were: (1) control, (2) wax, (3) 5 % gum Arabic, (4) 10 % gum Arabic, (5) 5 % gum Arabic with wax, and (6) 10 % gum Arabic with wax. The fruits were treated with gum Arabic by dipping the fruits in the aqueous solution of each designated concentration for three minutes and then air dried. Food-grade wax (Flucka AG, CH-9470 Buchs) was used for wax treatment, and was applied in a thin layer by brushing over the surface of the fruits. In the composite treatments of gum Arabic and wax, the wax was applied after gum Arabic treatment. The fruits were then packed in carton boxes and stored at 18 ± 1ºC and 85 % - 90 % relative humidity.

Parameters studied

Respiration rate was determined daily during the storage period in 12 fruits from each replication. Respiration rate was determined by the total absorption method of Charlimers (1956) as modified by Mohamed-Nour and Abu-Goukh (2010) and expressed in mg CO_2 per kg-hr. Peel colour was determined daily during the storage period on the same fruits used for determination of respiration rate. The colour score used was: mature green (=0), trace yellow on skin (=1), 20% yellow (=2), 40% yellow (=3), 60% yellow (=4), 80% yellow (=5), and 100% yellow (=6). Weight loss percentage was determined daily on the same fruits used for respiration rate and peel colour determinations. Weight loss percentage was determined daily according to the formula: $W_1 = [(W_o - W_t) / W_o] \times 100$ %; where W_1 is the percentage weight loss, W_o is the initial weight of fruits at harvest and W_t is the weight of fruits at the designated time.

Flesh firmness was determined in three fruits picked randomly from each replicate, other than those used for respiration rate, peel colour and weight loss determinations, at 2- day intervals and later every day during the storage period. Flesh firmness was measured by Magness and Taylor firmness tester (D. Ballauf Meg. Co.), equipped with an 8 mm-diameter plunger tip. Two readings were taken from opposite sides of each fruit after the peel was removed, and expressed in kilogram per square

centimeter. Total soluble solids (TSS) were determined at 2- day intervals and later every day during the storage period on the same fruits used for

Flesh firmness determination. TSS was measured directly from the fruit juice extracted by pressing the fruit pulp in a garlic press, using a Kruss hand refractometer (model HRN-32). Two readings were taken from opposite sides of each fruit and the mean values were calculated and corrected according to the refractometer chart.

Thirty grams of fruit pulp of the three fruits used for flesh firmness and TSS determinations were homogenized in 100 ml of distilled water for one minute in a Sanyo Solid State blender (model SM 228P) and centrifuged at 10,000 rpm for 10 minutes using a Gallenkamp portable centrifuge (CF-400). The volume of supernatant, which constituted the pulp extract, was determined. Titratable acidity was measured every two days and later every day during the storage period according to the method described by Ranganna (1979) and expressed as percent citric acid. Thirty grams of pulp from the three fruits used for flesh firmness and TSS determinations were homogenized in 100 ml of oxalic acid for one minute in a Sanyo Solid State blender (model SM 228P) and centrifuged at 10,000 rpm for 10 minutes by a Gallenkamp portable centrifuge (CF-400). The volume of supernatant was topped to 250 ml with oxalic acid. Ascorbic acid was determined in the pulp extract at 2-day intervals and later daily using the 2,6-dichlorophenol-indophenol titration method of Ruck (1963) and expressed in mg per 100g fresh weight.

Statistical analysis

Analysis of variance (ANOVA) followed by Fisher's protected LSD test with a significance level of $P \leq 0.05$ were performed on the data (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Waxing and gum Arabic coating significantly delayed fruit ripening and senescence, retarded moisture loss, maintained quality and extended shelf-life of the two mango cultivars. Similar results with waxing were reported in mango (Mohamed and Abu-Goukh 2003), tomato (Ahmed and Abu-Goukh, 2003), grapefruit (Abu-Goukh and Elshiekh 2008), lime

(Abdallah and Abu-Goukh 2010), papaya (Abu-Goukh and Shattir 2012) and guava (Mohamed-Nour and Abu-Goukh 2013).

Coating of fruits with gum Arabic has been found to delay fruit ripening, maintain quality and enhances shelf-life in banana (Magbool *et al.* 2011) and tomato (Ali *et al.* 2010). These effects of waxing and gum Arabic coating on ripening, quality and shelf-life were reflected in changes in respiration rate, weight loss, peel colour development, flesh firmness, total soluble solids (TSS), titratable acidity and ascorbic acid content.

Effect on respiration rate

The respiration curves of the two mango cultivars exhibited a typical climacteric pattern. Respiration rate was higher in 'Kitchner' with a climacteric peak at 249 mg CO_2/kg-hr than in 'Abu-Samaka' with a climacteric peak at 153 mg CO_2/kg-hr (Fig. 1). Similar rates of respiration were observed during ripening of two mango cultivars (Mohamed and Abu-Goukh 2003). The untreated fruits had reached the climacteric peak after 8 days in 'Kitchner' and 10 days in 'Abu-Samaka' cultivars. The gum Arabic coating at 5% and 10% aqueous solutions delayed the onset of the climacteric peak by one and two days, respectively, compared with the untreated fruits. This is in line with the findings of Magbool *et al.* (2011). The wax treatment delayed the onset of the climacteric peak by two days in the two cultivars (Fig. 1). Waxing in addition to the gum Arabic coating further delayed the onset of the climacteric peak by two more days in both cultivars, compared to gum Arabic treatment. This is in agreement with previous reports in mango (Mohamed and Abu-Goukh 2003) and guava (Mohamed-Nour and Abu-Goukh 2013). Waxing has been reported to influence respiration rate by decreasing oxygen and increasing carbon dioxide content in the internal atmosphere of the fruits (Irving and Warren 1960).

Waxing and gum Arabic coating on quality and shelf-life of mangoes Abu-Goukh 2003) and guava (Mohamed-Nour and Abu-Goukh 2013). Waxing has been reported to influence respiration rate by decreasing oxygen and increasing carbon dioxide content in the internal atmosphere of the fruits (Irving and Warren 1960).

Effect on weight loss

Weight loss progressively increased with storage. Significantly lower percentages of weight loss were observed in the fruits coated with gum Arabic in aqueous solutions, with or without waxing, compared with the

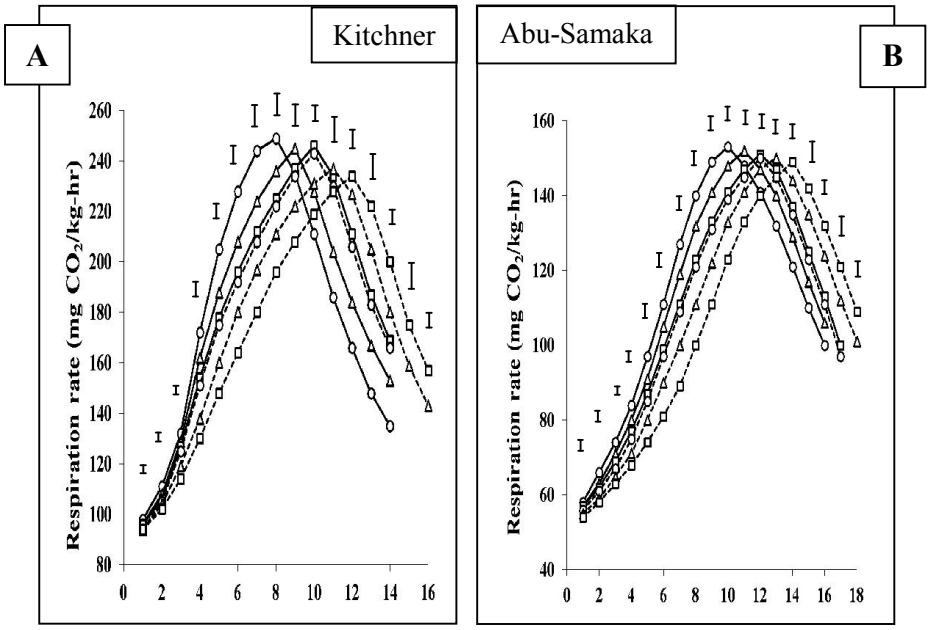

Fig. 1. Changes in respiration rate during storage of 'Kitchner' [A] and 'Abu-Samaka' [B] mango fruits treated with gum Arabic aqueous solutions at zero (o), 5% (Δ) or 10 % (□) without waxing (———) or with waxing (--------) during storage at 18 ± 1°C and 85% – 90% relative humidity. Vertical bars represent LSD (5 %).

control (Fig. 2). At the end of storage period, weight loss in the untreated fruits was 22.1 % in 'Kitchner' and 15.2 % in 'Abu-Samaka' cultivars. Weight loss was reduced by an average of 3.6% and 7.7% in the fruits coated with gum Arabic aqueous solutions at 5% and 10%, respectively, compared with the control (Fig. 2). Magbool *et al.* (2011) found that weight loss was 24% lower in banana fruits treated with 10% gum Arabic plus 1.0% Chitosan composite coating than control fruits. Similarly, 10% gum Arabic in aqueous solutions significantly reduced weight loss during storage of tomato fruits at 20oC and 80-90% relative humidity (Ali *et al.* 2010). Waxing in addition to gum Arabic coating at 5% and 10%,

decreased weight loss in both mango cultivars by an average of 13.5% and 19.6%, respectively, compared with control fruits (Fig. 2).

Waxing decreases water loss from the fruits in mango (Mohamed and Abu-Goukh 2003), grapefruit (Abu-Goukh and Elshiekh 2008), lime (Abdallah and Abu-Goukh 2010), papaya (Abu-Goukh and Shattir 2012) and guava (Mohamed-Nour and Abu-Goukh, 2013). Wills and Golding (2016) reported that the rate of water loss could be reduced by 30 % to 50 % in waxed fruits, under commercial conditions, particularly if the stem scar and other injuries are coated with wax.

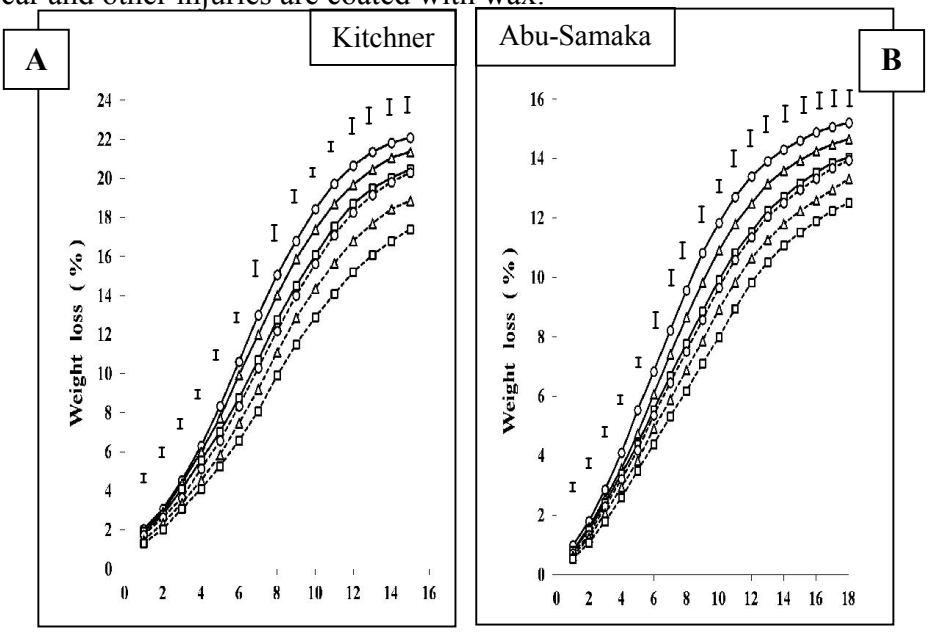

Fig. 2. Changes in weight loss during storage of 'Kitchner' [A] and 'Abu-Samaka' [B] mango fruits treated with gum Arabic aqueous solutions at zero (o), 5% (Δ) or 10 % (□) without waxing (———) or with waxing (--------) during storage at 18 ± 1°C and 85% – 90% relative humidity. Vertical bars represent LSD (5 %).

Effect on peel colour

Peel colour score continuously increased during storage of the two mango cultivars. At the end of the storage period, the untreated fruits reached the full yellow stage (colour score 6) after 10 days in 'Kitchner' and 13 days in 'Abu-Samaka' mango cultivars (Fig. 3). Gum Arabic coating at 5% and

10% aqueous solutions delayed the development of peel colour by one and two days in both cultivars, respectively, compared with the control (Fig. 3). When the untreated fruits reached the full yellow stage (colour score 6), peel colour development was reduced in both mango cultivars by an average of 3.8% and 9.6% in fruits coated with 5% and 10% gum Arabic aqueous solutions, respectively. This is in agreement with previous reports that colour development was delayed in tomatoes (Ali *et al.* 2010) and bananas (Magbool *et al.* 2011) coated with gum Arabic aqueous solutions. The wax treatment delayed peel colour development in both cultivars by two days, compared to unwaxed control fruits (Fig. 3). Waxing plus gum Arabic coating at 5% and 10% aqueous solutions, delayed peel colour development by three and five days, respectively, compared with the control fruits. When the control fruits reached the full

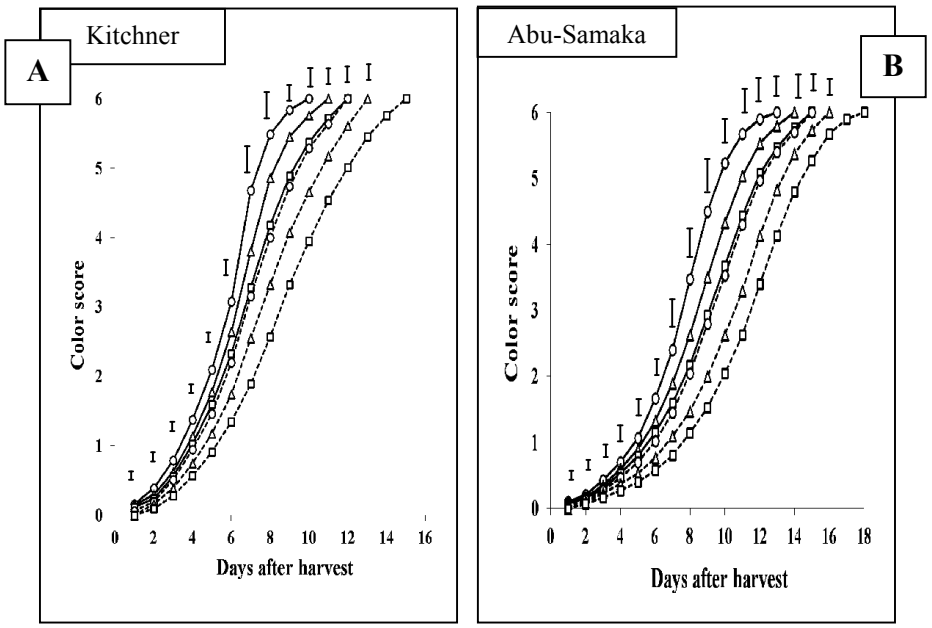

Fig. 3. Changes in peel color during storage of 'Kitchner' [A] and 'Abu-Samaka' [B] mango fruits treated with gum Arabic aqueous solutions at zero (o), 5% (Δ) or 10 % (□) without waxing (———) or with waxing (--------) during storage at 18 ± 1ºC and 85% – 90% relative humidity. Vertical bars represent LSD (5 %).

yellow stage (colour score 6), colour score was reduced in both cultivars by an average of 10.5%, 21.0% and 32.5% in fruits treated with 0, 5 and 10% aqueous solutions of gum Arabic, respectively, compared with the control (Fig. 3). The delay in colour development in the waxed fruits was due to reduced oxygen and increased carbon dioxide content in the internal atmosphere of the fruit (Kader 2002). Waxing delays peel colour development in mango (Mohamed and Abu-Goukh 2003), tomato (Ahmed and Abu-Goukh, 2003), grapefruit (Abu-Goukh and Elshiekh 2008) and lime (Abdallah and Abu-Goukh 2010) and guava (Mohamed-Nour and Abu-Goukh 2013).

Effect on fruit flesh firmness

Fruit flesh firmness decreased steadily during storage of both mango fruit cultivars (Fig. 4). The untreated fruits reached the final soft stage (0.17 kg/cm^2 shear resistance) in 12 and 16 days in 'Kitchner' and 'Abu-Samaka' cultivars, respectively. Gum Arabic and wax treatments delayed the decrease in flesh firmness during storage of both cultivars. Fruits treated with gum Arabic and/or wax were more firm than the control at any time during the storage period, but the difference diminished at the end of the storage period (Fig. 4). This is in line with previous reports that fruit firmness was higher in tomato and bananas treated with gum Arabic aqueous solution than the control (Ali *et al.* 2010; Magbool *et al.* 2011).

Effect on total soluble solids

During the storage period, total soluble solids (TSS) progressively increased in both mango cultivars. The maximum TSS value reached by the untreated fruits was 20.3% in 'Kitchner' after 11 days and 17.8% in 'Abu-Samaka' after 13 days (Fig. 5). These maximum values were reached after one and two days later in fruits coated with 5% and 10% gum Arabic without waxing and after three and five days with waxing in both cultivars, respectively, compared to the control (Fig. 5). This agrees with the reports that fruit coating with 10% gum Arabic delayed TSS changes during storage of tomato (Ali *et al.* 2010) and banana fruits (Magbool *et al.* 2011). Waxing of fruits delays changes in TSS during

storage in mango (Mohamed and Abu-Goukh, 2003), grapefruit (Abu-Goukh and Elshiekh, 2008), and guava (Mohamed-Nour and Abu-Goukh 2013).

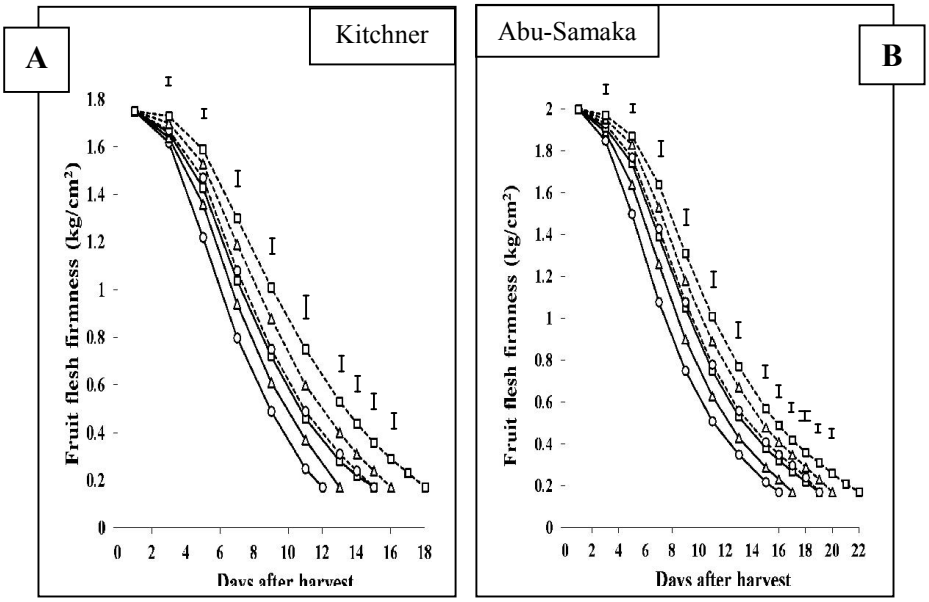

Fig. 4. Changes in fruit flesh firmness during storage of 'Kitchner' [A] and 'Abu-Samaka' [B] mango fruits treated with gum Arabic aqueous solutions at zero (o), 5% (Δ) or 10 % (□) without waxing (———) or with waxing (--------) during storage at 18 ± 1ºC and 85% – 90% relative humidity. Vertical bars represent LSD (5 %).

Effect on titratable acidity

Titratable acidity progressively decreased during storage of both mango cultivars. It decreased from 2.65% to 0.19% in 12 days in 'Kitchner' and from 3.1% to 0.2% in 14 days in 'Abu-Samaka' (Fig. 6). This is in line with earlier reports (Medlicott and Thompson 1985). These minimum values were reached one and two days later in fruits treated with gum Arabic at 5% and 10% without waxing and three and five days later with waxing in both cultivars, respectively, compared with the control. Similar results were reported in tomatoes (Ali *et al.* 2010) and bananas (Magbool *et al.* 2011) coated with gum Arabic aqueous solutions. Waxing was

repeatedly demonstrated to decrease the drop in titratable acidity during storage of tomato (Ahmed and Abu-Goukh, 2003), grapefruit (Abu-Goukh and Elshiekh 2008), lime (Abdallah and Abu-Goukh 2010) and guava (Mohamed-Nour and Abu-Goukh 2013).

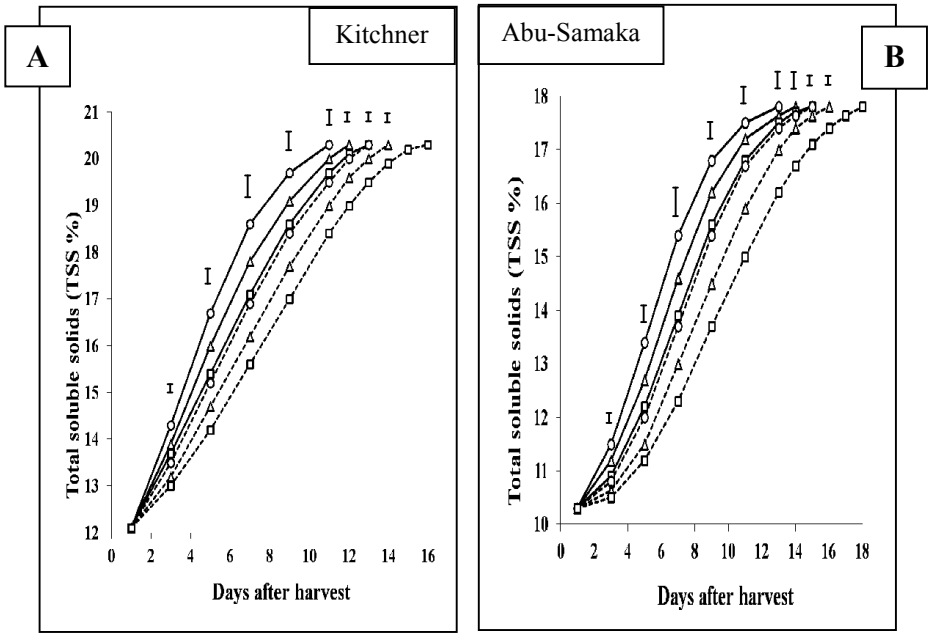

Fig. 5. Changes in total soluble solids (TSS) during storage of 'Kitchner' [A] and 'Abu-Samaka' [B] mango fruits treated with gum Arabic aqueous solutions at zero (o), 5% (Δ) or 10 % (□) without waxing (———) or with waxing (--------) during storage at 18 ± 1 ºC and 85% – 90% relative humidity. Vertical bars represent LSD (5 %).

Effect on ascorbic acid content

Ascorbic acid content showed continuous decline during storage of both mango cultivars in all treatments. It significantly decreased from 40.1 to 15.0 mg/100g fresh weight at the ripe stage after 12 days in 'Kitchner' and from 32.8 to 15.0 mg/100g fresh weight at the ripe stage after 14 days in 'Abu-Samaka' (Fig. 7). This agrees with previous reports that ascorbic acid content declined rapidly during storage of mango (Mohamed and Abu-Goukh 2003) and lime (Abdallah and Abu-Goukh 2010). The amount of ascorbic acid retained at the final ripe stage after 12 and 14

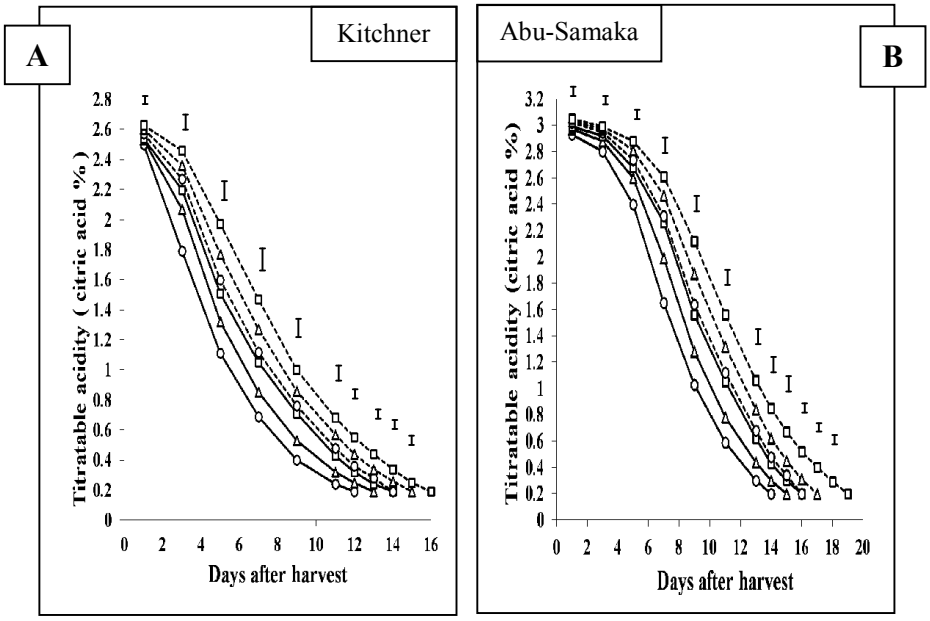

Fig. 6. Changes in titratable acidity (citric acid %) during storage of 'Kitchner' [A] and 'Abu-Samaka' [B] mango fruits treated with gum Arabic aqueous solutions at zero (o), 5% (Δ) or 10 % (□) without waxing (———) or with waxing (--------) during storage at 18 ± 1°C and 85% – 90% relative humidity. Vertical bars represent LSD (5 %).

days in 'Kitchner' and 'Abu-Samaka' was 37.4% and 45.7% of the initial amount in the two cultivars, respectively. At that time, ascorbic acid retained was on average 5.5% and 12.5% more in the fruits coated with gum Arabic at 5% and 10% aqueous solutions without waxing and 22.1% and 33.4% more in the fruits coated with gum Arabic with waxing, respectively, compared with the control (Fig. 7). Ali *et al.* (2010) reported that fruit coating with 10% gum Arabic significantly delayed changes in ascorbic acid content in tomatoes. Conditions favorable to wilting resulted in more rapid loss of vitamin C (Ezell and Wilcox. 1959). Waxing reduced water loss during storage of both mango cultivars (Fig. 2), and consequently reduced ascorbic acid losses in the waxed fruits. Waxing of fruits was reported to retain ascorbic acid content in mango (Mohamed

and Abu-Goukh 2003), tomato (Ahmed and Abu-Goukh, 2003), grapefruit (Abu-Goukh and Elsheikh 2008) and lime (Abdallah and Abu-Goukh 2010).

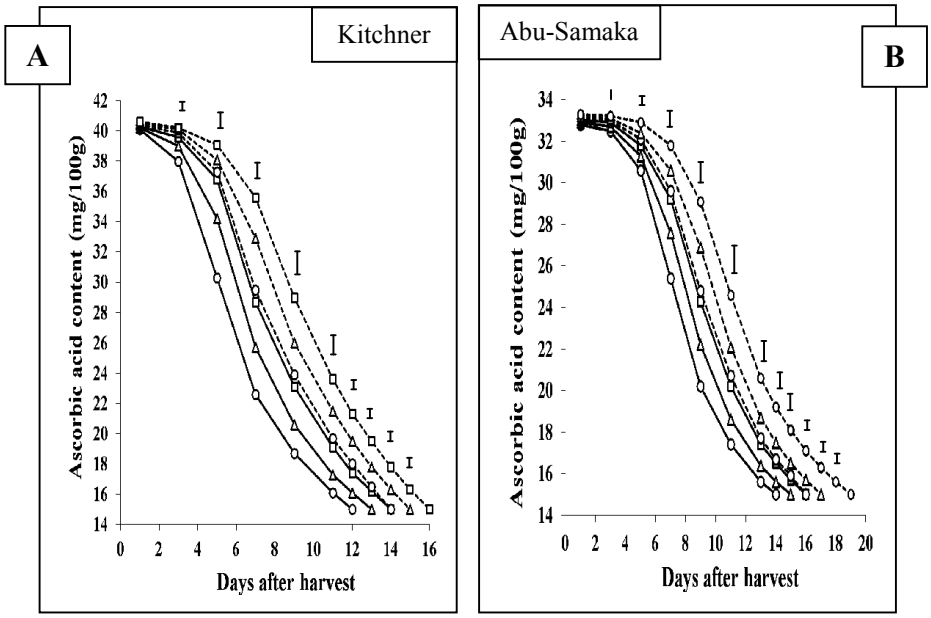

Fig. 7. Changes in ascorbic acid content during storage of 'Kitchner' [A] and 'Abu-Samaka' [B] mango fruits treated with gum Arabic aqueous solutions at zero (o), 5% (Δ) or 10 % (□) without waxing (———) or with waxing (--------) during storage at 18 ± 1°C and 85% – 90% relative humidity. Vertical bars represent LSD (5 %).

CONCLUSION

- Coating of Mango fruits with gum Arabic in aqueous solutions significantly delayed the onset of the climacteric peak of respiration and fruit ripening; reduced weight loss, fruit softening, peel colour development and total soluble solids accumulation; drop in titratable acidity; retained ascorbic acid; maintained quality and extended the shelf-life of mango fruits.
- Waxing in addition to gum Arabic coating was more effective than gum Arabic coating alone in all parameters studied.

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تأثيـر التشـميع والطـلاء بمحاليـل الصـمغ العربـى على الجـودة والعمـر التخزيني لثمـار المانجـو (*Mangifera indica* L.)

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المستخلص: تم تقويم تأثير تشميع الثمار وطلائها بمحاليل الصمغ العربى على الجودة والعمر التسويقى لصنفى ثمار المانجو "كتشنر" و"أبوسمكة" فى منطقة "أبوجبيهة" بجنوب كردفان. عوملت الثمار بغمرها فى محاليل الصمغ العربى بتركيز 0 % و 5 % و 10 % لمدة 3 دقائق ثم تجفيفها بتعريضها للهواء لإزالة الماء من أسطحها. فى معاملات الصمغ مع التشميع تم مسح الثمار بطبقة رقيقة من الشمع بعد معاملتها بمحلول الصمغ. تمت تعبئة الثمار فى صناديق كرتون (43 x 33 x 15 سم) وإستخدم التصميم كامل العشوائية بأربعة مكررات لإجراء التجربة وحفظت الثمار على درجة حرارة 1 ± 18o م ورطوبة نسبية 85% - 90%. أدى طلاء الثمار بمحاليل الصمغ العربى إلى تأخير معنوى فى وصول الثمار إلى ذروة التنفس وتأخير نضجها وتقليل فقد الوزن وليونة الثمار وتلون القشرة وزيادة تراكم المواد الصلبة الذائبة فيها والانخفاض في معدل الحموضة. كما حافظت الثمار على محتواها من حمض الأسكوربيك وعلى جودتها وإطالة عمرها التسويقى. كان تشميع الثمار إضافة لطلائها بمحاليل الصمغ العربى أكثر فاعلية من الثمار المعاملة بمحاليل الصمغ فقط فى كل الصفات التى تمت دراستها. أدى طلاء الثمار بمحاليل الصمغ العربى بتركيز 5 % و 10% بدون تشميع، إلى تقليل فقد الوزن بنسبة 3.6 % و 7.7 % ، وتلون القشرة بنسبة 3.8 % و 9.6 % ، على التوالى، مقارنة بالثمار غير المعاملة. و أدى طلاء الثمار بالصمغ بتركيز 5 % و 10 % مع التشميع إلى خفض فقد الوزن بنسبة 13.5 % و19.6 % ، وتلون قشرة الثمار بنسبة 10.5 % و 21.0 %، على التوالى، مقارنة بالثمار غير المعاملة. كان محتوى الثمار من حمض الأسكوربيك أكثر بنسبة 5.5% و 12.5% فى الثمار المعاملة بمحاليل الصمغ العربى بتركيز 5 % و 10 % بدون تشميع، وبنسبة 22.1 % و 33.4 % فى الثمار المعاملة بمحاليل الصمغ العربى مع التشميع، على التوالى، مقارنة بالثمار غير المعاملة.