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# Application of Gum Arabic for Coating of Dried Mango Slices

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**Abstract:** Mango (*Mangifera indica*) fruit of kitshenar variety which is grown in wide areas in Sudan was used in this study to investigate the effect of processing treatment and storage period on the quality of dried mango slices (finger). Mango fruits of kitshenar variety were washed carefully, peeled manually and then sliced into (fingers). Mango slices were divided into three portions, the first portion coated with (25% w/v) Gum Arabic purified solution plus (5% w/v) sugar, the second portion was treated with sodium metabisulphite solution 2000 p.p.m concentration and the third portion was left without any treatment (control). Mango slices of each treatment were speeded on aluminum trays with an equal distribution and dried at room temperature under moving fan for seven days and then the dried products were packed in (polythene) plastic socks then placed inside cartoons and stored at room temperature for nine months. The results showed that the treatment with sodiummetabisulphite solution was the best in keeping the nutritive value of mango slices (ascorbic acid). The results indicated that the best treatment which prevented browning was Gum Arabic addition. The study of the effect of storage periods at room temperature on some properties of mango slices (fingers) showed there was a marked loss of some nutrients (e.g. ascorbic acid, sugars).

**Key words:** Mango slices (*Mangifera indica*), Gum Arabic, coating

## INTRODUCTION

Attention of food drying as a preservative technique started earlier. It has been adopted towards the 19$^{th}$ century. The dehydrated fruits expanded to include figs, grapes, dates, prunes, bananas, pears, apricots, citrus pineapples and mangoes. The mango fruit (*Mangifera indica*) is one of the most important seasonal fruits of tropical and sub-tropical countries. It is described as the most favorite and valuable fruits in the world market (Olli *et al*., 1996). In the Sudan, mango trees are grown widely in various areas of the country, although it is seasonal but the fruits are available in small quantities almost throughout the year. The production of mango through the last three years was 602000 tons in season 2003, 603000 tons in season 2004 and 682000 tons in season 2005 (statistics of Arab Organization for Agricultural Development (AOAD, 2006). The exports of fresh mangoes to some Middle East countries were about 7143.37 tons in season 99-2000 (Ministry of Agriculture and Forests, 2001). Sudan exported 3480 tons in season 2003, 2820 tons in season 2004, 1990 tons in season 2005 (AOAD, 2006).

Gum Arabic is defined as the natural secretion from stems and branches of Hashab tree (*Acacia senegal)* var. Senegal and related trees of the *Leguminoaceae* family (JECFA, 1990). Research has shown the accumulative effect and risk of chemical preservatives. International interest has shifted toward limitation of usage of chemical preservatives.

Gum Arabic is used widely as an additive in food materials e.g. Confectionery, ice-cream industries and bakery products. It is classified as an edible coating and it is used to increase stability and shelf-life and to enhance microbial safety of fruits (Roony, 2005).

This research ultimately aims to: 1/study of the effect of coating the hydrated mango slices with a mixture of Gum Arabic and sucrose. 2/expanding the use of Gum Arabic as a natural safe substitutes of chemical conventional additives.3/Extend the shelf life of fruits using natural additives.

## MATERIALS AND METHODS

**Mango fruits:** Kitshenar variety was used in this study, free from injured or deteriorated fruits. It was collected from the following markets:

- Central market in Khartoum North.
- Local market in Khartoum.
- Martyrs market in Omdurman.
- Fruits and vegetables market in Omdurman market.
- Alshab farm at Alfaki Hashim village, 27 km North of Khartoum.

### Additives

Sugar commercial grade was brought from local market.

Gum Arabic was bought from Omdurman market.

Sodium metabisulphite ($Na_2S_2O_5$) of technical grade was used.

All other chemicals and media were provided by the Dehydration Section of Food Research Centre (FRC) and the Food Science and Technology Department (FSTD) of the Faculty of Agriculture, Khartoum University. All chemicals were of high quality and purity.

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**Preparation of raw material:** Mango fruits were washed by tap water to remove any dirt and contaminants, then washed again by distilled water and weighed.

**Peeling, slicing:** Mango fruits were peeled manually using sharp clean stainless steal knives and then the mango fruits ware sliced into fingers. The weight of peel, stone and slices were determined.

**Gum Arabic sucrose solution preparation:** A pure concentrated (25% w/v) Gum Arabic solution was prepared by dissolving gum arabic in distilled warm water (60°C). Sugar was added (5% w/v) and the solution was then purified.

**Processing treatments:** The mango fruits were divided into two portions. The first portion was treated with sodium metabisulphite solution; the second portion was coated with gum Arabic-sucrose solution by mixing. The third portion was un-treaded as a control. Triplicate samples of each treatment were prepared.

**Drying method:** Mango slices of each treatment were speeded on trays (46 cm wide, 70 cm long and about 5 cm deep). The dehydration trays were held on stands made of metal (about 82 cm high) under moving fans for 7 days.

**Storage conditions and stability:** To study the effects and changes of storage on the stability and shelf life of dried mango slices (finger), the dried product was put in the plastic socks (polythene) inside cartoons boxes and stored at room temperature for 9 months. The effect of storage was then monthly studied by physical and chemical analysis.

**Analytical methods**

**Determination of moisture content:** The moisture content of fresh and dried product (mango finger) was determined according to AOAC (1984).

**Determination of Total Soluble Solids (TSS):** The total soluble solids for fresh and dehydrated mango were determined using a hand refractometer (0-50) and expressed as degree brix (AOAC, 1984).

**Determination of pH:** The pH of fresh and dehydrated mango was measured using fisher pH meter at ambient temperature (Egan *et al*., 1981).

**Determination of Titrable Acidity (TA):** The titrable acidity was conveniently determined according to the method describe by Ranganna (1979).

**Determination of ascorbic acid content:** Vitamin C content was estimated as ascorbic acid level according to the method described by Ruck (1963).

**Determination of non-enzymatic browning:** The method commonly applied to evaluate non-enzymatic browning effect is generally known as "soluble colour". Tow grams of shredded dried mango slices were placed in a 250 mL volumetric flask containing 100 mL of 50% ethanol. The flask was then covered with a paraffin film and was left at room temperature for 24 h with occasional shaking. The solution was then filtered using a Whatman filter paper No. 2. The optical density was determined by a colorimeter (analyzer-9) at 445 nm wave length using 0.5 cm diameter tube, the difference between the optical density of the sample before and after storage was considered as a measure of the degree of browning during storage (HendeL *et al*., 1950).

**Determination of total sugars content:** Total sugars were determined according to the lane and Eynon method (AOAC, 1984).

**Determination of reducing sugars contents:** For most samples, the reducing sugars were very low, so that filtrate can be used directly for titration according to AOAC (1984).

**Statistical analysis:** The experiment was designed using completely randomized design. Data generated was subjected to Statistical Package for Social Science (SPSS). Means were tested using two factors analysis of variance and then means separated using Duncan's Multiple Range Test (DMRT) according to (Mead and Gurnow, 1981). The Least Significant Deference (LSD) at 5% level of significance was used.

## RESULTS AND DISCUSSION

**Moisture content:** The influence of storage period (shelf life) on moisture content is shown in Fig. 1. There was a significant difference in moisture content at all intervals of storage between the control sample and that one treated with Gum Arabic sucrose solution. That indicates that the sample treated with mixture of Gum Arabic and sucrose needed slightly shorter time for drying. In control sample at zero time the moisture content was (18.08%) and reach (4.675%) after 9 month of storage, while the sample which treated with gum Arabic was (17.42%) at zero time and reach (3.79%) at the ($9^{th}$ month). The loss in moisture content during storage period may be because of packaging material (polythene bags) which is reasonably effective as a moisture barrier for rather short period of storage, say up to 6 month (Mohammed, 1970). Also the loss of moisture content may also due to differences of relative humidity between the environment of storage inside (bags) and the atmosphere outside bags.

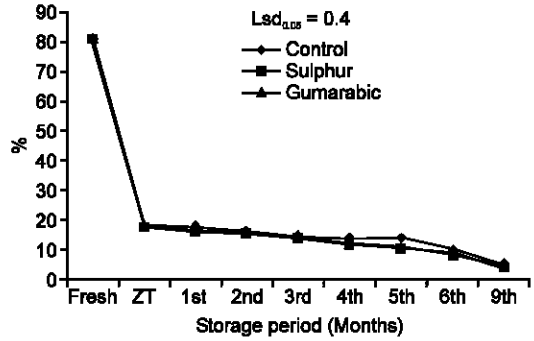


Fig. 1: Effect of treatment and storage period on moisture content of mango slices. ZT = Zero time

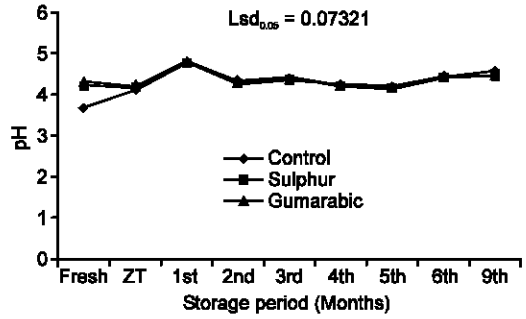


Fig. 2: pH value. ZT = Zero time

**pH:** Figure 2 shows the effect of storage period (shelf life) on pH. The general observation is that the pH was increased after one month of storage period, then decreased at the second month and increased again at the third month then decreased at the fourth month and then increased another time at fifth, sixth and ninth months. It is easy to observe that there is no difference between samples in the first month and there is no difference also between the control sample and that which treated with gum Arabic in the third month, also there is no difference between the control sample and that which treated with sodiummetabisulphite in fourth and fifth months. The same observations occurred between the sample which treated with sodiummetabisulphite and the sample treated with Gum Arabic in sixth and ninth months. The pH of control sample at zero time was (4.10) and reached to (4.54) at the end of the duration of storage. The pH of the sample treated with sulphur dioxide was (4.153) at zero time and reached (4.45) and the pH of the sample treated with gum Arabic was (4.313) at zero time and reach (4.47) at the end of storage period.

The sample treated with Gum Arabic recorded the highest result (4.470) compared to the sample treated with sodiummetabisulphite which recorded the lowest result (4.450). These results agree with those reported by Ali (2002).

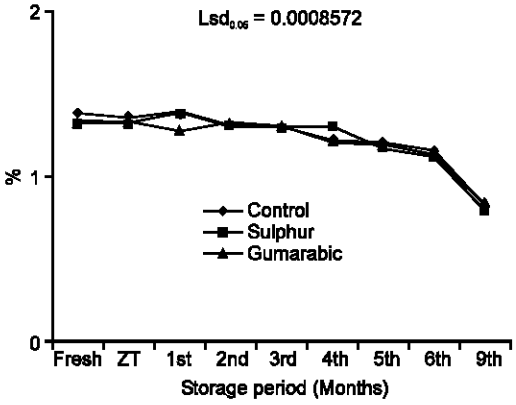


Fig. 3: Titerable acidity. ZT = Zero time

**Titrable acidity:** Referring to Fig. 3, titerable acidity was markedly decreased. These results disagree with those of Ali (2002). This could be due to the increase of pH values and the decrease of total sugars. Control sample was (1.347) at zero time and reached (0.80) at the end of storage period, while the sample treated with sodiummetabisulphite was (1.313) at zero time and reached (0.78) at 9$^{th}$ month and the sample which was treated with Gum Arabic was (1.317) at zero time and reached (0.82) at the end of the storage period. It is easy to observe that there was no difference between the sample treated with gum Arabic and the other sample treated with sodiummetabisulphite in the third, fifth and sixth month. The sample treated with Gum Arabic recorded the highest result of titerable acidity at the end of storage period which might be attributed to the encapsulation properties of Gum Arabic.

Some reports attribute reduction in citric acid of the product, during storage, to the fact that the acid could act as a catalyst to increasing the rate of oxidation of ascorbic acid (Clegg, 1966).

**Total Soluble Solids (TSS):** Data in Fig. 4, reflect the effect of treatment and storage period on total soluble solids. Total soluble solids of control sample was (19.50) at zero time and reached (20.00) at the end of the storage period. The sample which was treated with Gum Arabic recorded (15.43) at zero time and reached (23.50) at the end of the duration of storage. Small variations among all treated samples could be seen. Through all samples, one can observe that the total soluble solids were decreased at first three months of storage period then increased again up to (6) months. Gum Arabic sucrose solution sample recorded higher total soluble solids than control sample due to the addition of Gum Arabic prior to drying. These results confirmed with the findings of Mohammed (1999) and Ali (2002). In general, total soluble solids increased gradually during storage period. A positive correlation between the drying time and total concentration has been earlier established.

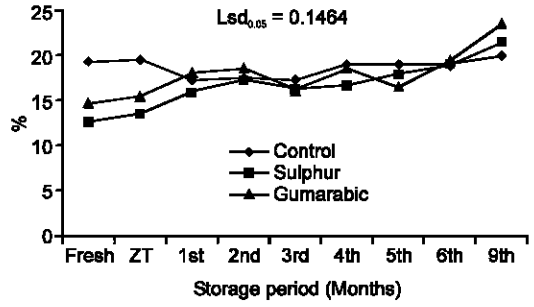


Fig. 4: Total soluble solids. ZT = Zero time

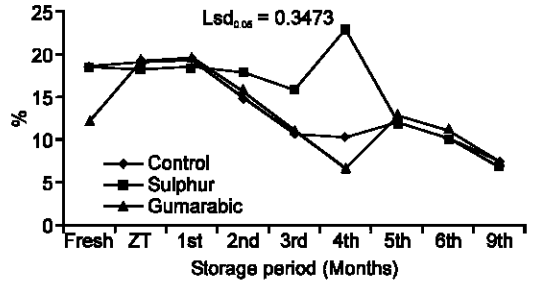


Fig. 5: Reducing sugars. ZT = Zero time

**Reducing sugars:** Figure 5 shows the effect of storage period (shelf life) on reducing sugars. It was clear that there was a large degradation of reducing sugars. This agrees with the findings of Mohammed (1999). Control sample at zero time contained (19.09%) and declined to (7.29%) at 9th month, while sodiummetabisulphite sample had (18.23%) at zero time and dropped to (6.87%) at 9th month, where Gum Arabic sample had (19.13%) at zero time and reached (7.29%) at the end of the storage period. It can well be observed that there is no change between control sample and that treated with sodiummetabisulphite at the fifth and sixth months and no change between control sample and that treated with Gum Arabic at the end of the 9th month. The sample treated with sodiummetabisulphite recorded the lowest results ranged between (18.41-6.87), while the sample which treated with Gum Arabic recorded the highest values ranged between (19.13-7.29). The decrease of reducing sugars due to the decrease of total sugars and increase of non-enzymatic browning.

**Total sugars:** Figure 6 reveals the effect of treatments and shelf life on total sugars. There was general decrease in total sugars and it agrees with the reported values of Ali (2002). Control sample contained (55.24) at zero time and decreases to (10.00) at the end of storage period, while the sample treated with sodiummetabisulphite had (83.11) at zero time and reached (14.00) at 9th month and the sample treated with Gum Arabic was (66.95) at zero time and decreased to

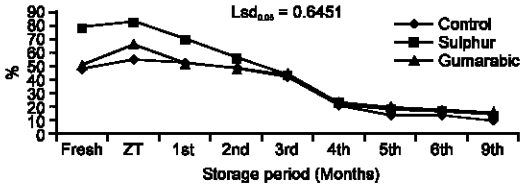


Fig. 6: Total sugars. ZT = Zero time

(15.30) at the end of storage period. It can be observed that there is no significant difference in total sugars through the third, fourth and sixth months between samples treated with sodiummetabisulphite and that treated with Gum Arabic. The sample treated with sodiummetabisulphite recorded the lowest values (14.00) while the sample treated with Gum Arabic recorded the highest values (15.30) at the end of storage period. This may be due to the encapsulation properties of Gum Arabic Bangs and Renieccius (1990). The main reason of total sugars degradation was probably the increase of non-enzymatic browning associated with the decrease of reducing sugars it may also be due to the limited contents of Total Soluble Solids (TSS).

**Ascorbic acid:** According to results shown in Fig. 7, ascorbic acid decreased rapidly during the storage period. This may be caused by the ascorbic acid oxidation, which was accelerated by the light, oxygen and storage temperature (ambient), bearing in mind that the packaging material (polythene) offers no protection against these factors. Control sample was (89.99 mg/100 g) at zero time and reached (5.273 mg/100 g) at the 9th month, while the sample which treated with sodiummetabisulphite was (105 mg/100 g) at zero time and declined to (6.703 mg/100 g) at the 9th month and the sample treated with Gum Arabic contained (96.69 mg/100 g) at zero time and dropped (5.570 mg/100 g) at the end of storage period. Compared to the sample treated with the Gum Arabic, the sample treated with sodiummetabisulphite recorded the highest levels (6.703 mg/100 g) at the end of storage period, while Gum Arabic sample recorded (5.570 mg/100 g) at the same period of storage. This results is in conformity with the finding of Bhatia and Sand (1962) who reported that sodiummetabisulphite in dried fruits was essential to protect the ascorbic acid content, also this result reflect the positive effect of Gum Arabic in keeping ascorbic acid content compared to sodiummetabisulphite. The efficiency of bee honey, bisulphate, gum arabic and sucrose to preserve vitamin C of the stored mangodeen was reported earlier (Bahatia and Sand, 1962; Mohammed, 1970; Ahmed, 1991; Mohammed, 1999).

**Non-enzymatic browning:** The result in Fig. 8 shows the effect of storage period on Non-enzymatic browning. There is a significant difference in non-enzymatic

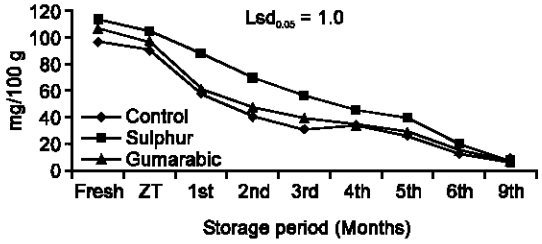


Fig. 7: Ascorbic acid. ZT = Zero time

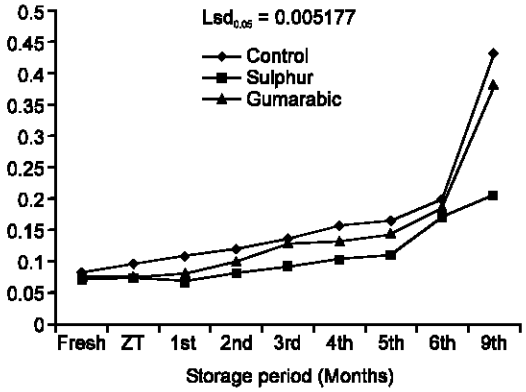


Fig. 8: Non-enzymatic browning. ZT = Zero time

browning, which increased gradually during the duration of the storage. In control sample at zero time non-enzymatic browning was (0.09667) and reach (0.4317) after 9th months of storage, while the sample treated with sodiummetabisulphite was (0.07333) at zero time and reach (0.2060) after 9th month of storage and the sample treated with Gum Arabic was (0.07533) at zero time and reach (0.38170) at the end of storage period. Untreated sample (control) recorded the highest degree of browning (0.09667-0.4317) compared to the sample treated with sodiummetabisulphite and the other one which treated with Gum Arabic, although the sample treated with the Gum Arabic recorded the highest degree compared to the sample treated with sodium-metabisulphite. The increase of the dark colour development during storage period may be due to the effect of the storage temperature. This is one of the most effective colour degradation factors. The browning is also packaging materials dependent, since polythene offers little protection against light and oxygen (Pruthy, 1978). (Hiess and Eichner, 2002) reported that non-enzymatic browning mostly occurs during storage at un favorable conditions of packaging and storage.

**Conclusion:** Kitshenar variety of mango was sliced and analyzed physically and chemically, in the fresh state. Then in another operation mango slices were processed with many treatments and dehydrated at room temperature. From the interpretation of the results and observations pertaining to the present study, conclusions may be pointed out as follow:

- The study was confined to Kitshenar variety which is one of the best varieties to produce mango slices.
- Addition of Gum Arabic for mango slices recorded a similar results compared to those which recorded by adding sodiummetabisulphite, that means Gum Arabic can be cheep, safe and natural substance instead of sodiummetabisulphite for keeping the quality of mango slices.
- Storage at room temperature beside the materials of packaging causes the deterioration of many chemical and physical characteristics of mango slices.
- These results indicate that evaluation of varieties of mango in Sudan is essential in order to determine their suitability for processing as Jam, nectar, slices, squash, mangodeen, or other dried products.

## REFERENCES

Ahmed, S.E., 1991. Harvest maturity and local preservation of mango. M.Sc. Thesis, Faculty of agriculture, University of Khartoum.

Ali, Kh.M., 2002. Factors influencing the quality and shelf life of mango pulp dehydrated in a sheet form (mangodeen). M.Sc. Thesis. Faculty of Agriculture. University of Khartoum.

AOAC, 1984. Association Official Analytical Chemists. Official methods of analysis. 14th Edn., Washington, DC.

Arab Organization for Agricultural Development (AOAD), 2006. Arab Agricultural statistic, year book. Volume 26.

Bangs, W.E. and C.A. Renieccius, 1990. Characterization of selected materials of lemon oil Encapsulation by spray drying. J. Food Sci., 55: 1356-1357.

Bhatia, B. and H.D. Sand Amin, 1962. Studies on dehydration of some tropical fruits absorption and retention of SO2 during sulphuring and sulphating. Food Sci. India, 13: 63-68.

Clegg, K.M., 1966. Citric acid and the browning of solutions containing ascorbic acid. J. Sci. Food Agri., 17: 546-549.

Egan, H., R.S. Kirk and R. Sawger, 1981. Person's chemicals analysis of foods. 8th Edn., Longman Sci. and Tech. Group.

Hendel, C.E., G.F Bailey and D.H. Taylor, 1950. Determination of non-enzymatic browning in some vegetables by spectrophotometer. J. Food Tech., 4: 344.

Hiess, R. and K. Eichner, 2002. Haltpermachen von Lebensmitteln (pp: 16-20, 196-201 and 211-222), Berlin, Springer-Verlag.

JECFA. FAO/WHO, 1990. Food and Nutrition paper No. 49: 23-25, FAO, Rome.

Mead, B. and R.W. Gurnow, 1981. Statistical Methods in Agricultural Experiment Biology, London, New York, Chapman and Hall.

Ministry of Agriculture and Forests, 2001. Management of horticulture section. Horticulture exports. Khartoum.

Mohammed, B.B., 1970. Dehydration of mango slices and pulp. Annual report FRC. Shambat, Sudan.

Mohammed, L.A., 1999. A study of factors influencing the drying characteristics and quality of mango pulps in a sheet form (mangodeen). M.Sc. Thesis, Faculty of Agriculture, University of Khartoum.

Olli, D., Y.F. Lozano and G.M. Brillouet, 1996. Isolation and characterization of (*Mangifera indica* L) soluble poly sucrids and insoluble cell wall material of the pulp from four mango cultivars. J. Agric. Food Chem., 44: 2658-2662.

Pruthy, J.S., 1978. Quality control, packaging and storage of dehydrated foods. Indian packer, (Ludhiana), pp: 7-8.

Ranganna, S., 1979. Titrable acidity in the manual of fruits and vegetables products. Mc Craw, Hill pub. co. Ltd., NewDelhi, pp: 7-8.

Roony, M.L., 2005. Introduction to Active Food Packaging Technology. In: Han JH, editor. Innovations in food packaging. San Diego, Calif: Elsevier Academic press, pp: 63-79.

Ruck, J.A., 1963. Chemical method for analysis of fruit and vegetable products. Satiation Summer Land Canadian Res. Bord Dept. Agri. Canada.