# Effect of Sucrose Levels on Drying Rate and Some Quality Characteristics of Tamarind (*Tamarindus indica)* leathers

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**Abstract:** The objective of this study was to investigate the use of three levels of sucrose in drying rate and development of good quality tamarind leathers. Tamarind fruits were sorted, washed, soaked in water and then pulped. Three levels of sucrose were added to the tamarind puree (5, 10 and 15%) and a tamarind puree without sucrose as control. Tamarind puree was spread on trays and dried in cabinet drier (70ºC) and solar drier (54±4 ºC) to get thin sheets of leathers. The products were evaluated for drying behavior and physico-chemical properties. The tamarind leather (without sucrose) has the highest drying rate whereas tamarind leather containing 15 % sucrose has the lowest drying rate. There was a significant difference among tamarind leathers in terms of rehydartion ratio, drying ratio, texture, pH, titratable acidity and total soluble solids. The tamarind leather containing 15% sucrose showed the best quality performance among the rest three levels of sucrose.

**Key words**: Tamarind leather, Sucrose, Drying, Quality.

## Introduction

The unique climatic conditions prevailing in Sudan encourage a huge production of different fruits and vegetables in addition to various forest fruits, where the post-harvest losses account as high as 20% for fruits and vegetables (Kader,2002 ) and infestation of forests fruits by insects and pests (NFC, 2007).

With a new understanding of the value of indigenous fruit trees in providing food security and meeting nutritional needs, these trees received increased attention, especially in semi-arid areas (El amine, 1990).

Only a few indigenous species have been promoted or researched and are under production in the field. Little attention has been paid to minor or under-utilized crop species like wild fruit trees in Sudan (Gebauer *et al.*, 2002). One of these trees is tamarind (*Tamarindus indica)* which grows wild in most States of the country especially South Kordofan and South Darfur where the conditions are more favorable for the growth of the species. When the famine occurred in the eighties, the tamarind fruit had been eaten as a famine food in both States (Abdelmuti, 1991).

There are several different ways of utilization of tamarind plant as a food, for instance, green leaves were mixed with ground sesame or ground nut and used as a salad while fruit pulp was mixed with porridge. The fruit pulp was also employed to make a refreshing drink which is good for reducing fevers and also as laxative (Gunasena and Hughes, 2000). Unripe fruits were boiled and eaten as a salad (Abdelmuti, 1991). Tamarind pulp is rich in minerals, high in potassium (62-570 mg/100g); phosphorus (190 mg/100g); calcium (81-466 mg/100g) and a fair amount of iron (Saka and Msonthi, 1994). The ascorbic acid content in tamarind pulp is very small, varies from 2-20 mg/100 g (Ishola *et al.,* 1990).

Fruit leather is a traditional product which refers to fruit puree of sound ripe fruit or a mixture of fruit juice concentrate and other ingredients like sucrose, skim milk and soybean….etc. Fruit puree or the mixture are cooked, dried on a non-sticky surface and rolled, traditionally, sun drying is employed (Okilya *et al*., 2010).Usually fruit leathers were consumed as snack or rehydrated to make fruit juice (Henriette *et al*., 2006).

Sucrose is added to fruit puree as sweetening agent and as preservative (Gujral and Khanna, 2002; Jain and Nema, 2007).Therefore the objectives of this study were to assess the effect of sucrose level on drying rate and the quality characteristics of tamarind leathers. Texture, rehydration ratio, pH, titratable acidity, and total soluble solids will be evaluated since they are the most important quality parameters of fruit leathers that are usually affected by the level of sucrose.

## Materials and Methods

### Samples preparation

Fully ripe tamarind fruits were procured from the local market (Khartoum). Sorted, washed and soaked in distilled water (the ratio of water to tamarind fruits was 1: 4) for two hours and then passed through a pulper ( Model: Reeves, size :IVIF-18) to get tamarind pulp. The recovered pulp was cooked in an open double jacketed kettle till it became puree (Mircea, 1995).The tamarind puree was then divided into four portions, three of them were treated using 3 levels of sucrose (5, 10 and 15%) and the fourth portion was left as control.

### Drying of leathers

One kilogram of the treated purees was loaded on fabricated stainless steel drying trays with a solid base (51cm length x 39 x cm width x 3 cm depth). The tamarind leathers were dried in solar dryer and cabinet dryer. Solar drying was carried out using a prototype solar cabinet dryer (average drying temperature was 54±4°C). Drying in the cabinet dryer (Gallenkamp, Model, O. V – 160) was done at 70°C.

### Physico-chemical analyses

Texture, pH, total soluble solids and rehydration ratio of tamarind leathers were determined according to A.O.A.C, (2003) methods. While titratable acidity and drying ratio were determined according to Ranganna (1977).

### Statistical analysis

The data was statistically analyzed as for complete randomized design. The significance of mean differences was determined by the Duncan Multiple Range Test (DMRT) at $P \leq 0.05$ significance level as described by (Mead and Gurnow, 1983).

## Results and Discussion

### Drying behavior

Figures 1 and 2 show the drying rate of tamarind pulp as affected by sucrose level using solar and cabinet driers respectively. The drying rate decreased with increase in sucrose level. The tamarind pulp without sucrose (control) had the highest drying rate whereas tamarind pulp containing 15 % sucrose had the lowest drying rate with the two drying systems used. Regarding the drying rate of control sample dried by solar drier, the initial drying rate was 628.48 g moisture /100 g dry matter/ h and it decreased to 8.53 g moisture /100 g dry matter\h after 48 hours. The same trend was observed for tamarind pulp containing 15% sucrose, the initial drying rate was 261.4 g moisture /100 g dry matter / h and it decreased to 13.59 g moisture /100 g dry matter / h after 96 hours. The same was observed for tamarind pulp dried by cabinet that as sucrose level increased in tamarind pulp, the drying rate decreased. This may be due to the presence of high level of sucrose which tends to create leathery layers on the surface of the puree (case hardening) decreasing its vapor pressure (Van Arsdel *et al.,* 1973; Felllows, 2000; Brennan *et al*., 2006; Toledo, 2006 and Wang and Brennan, 2006). Jain and Nema (2007) reported that addition of 30% sugar to guava pulp decreased its drying rate.

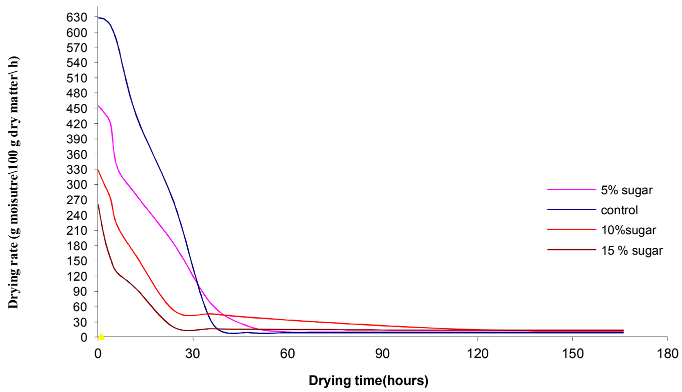


Fig. 1 Drying rate of tamarind pulp as affected by sucrose level using solar drier

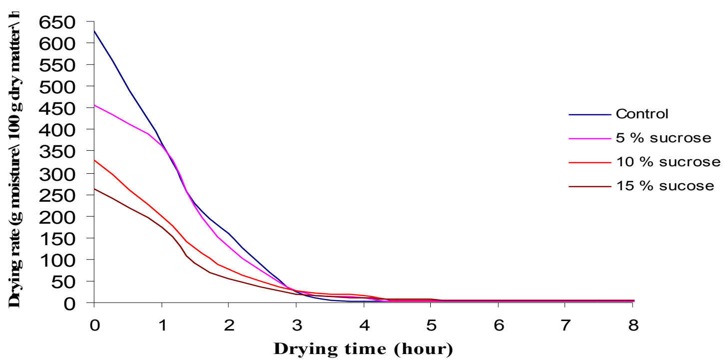


**Fig.2 Drying rate of tamarind pulp as affected by sucrose level using cabinet drier**

**Physico-chemical analysis**

Table 1 shows, that there were significant variations ($P \leq 0.05$) in texture of the different tamarind leathers produced. A significant improvement ($P \leq 0.05$) in texture of tamarind leather containing 15 % sucrose compared to tamarind leather without sucrose dried using cabinet drier (3.29 and 10.34 kg / N respectively). The same improvement was observed in the texture of tamarind leathers dried using solar drier, the texture of tamarind leather containing 15 % Sucrose was (2.52 kg/ N), whereas the texture of tamarind leather without sucrose was (12.14 kg/ N). It was clear that the texture of the different tamarind leathers dried by the two drying systems became tender as the level of sucrose increased, i.e. the addition of sucrose to tamarind pulp improved the tenderness of tamarind leathers. This seems to be associated with the moisture content of the end product**,** since more sugar in fruit leathers improves the water retention of these products (Irwandi *et al.,* 1998).

**Table 1. Effect of sucrose levels on texture (Kg/ N) of tamarind leathers dried by two systems**

| Treatment | Texture – Drying system: Cabinet | Texture – Drying system: Solar |
|---|---|---|
| Control | 10.34±2.25$^{a}$ | 12.14±1.69$^{a}$ |
| 5% sucros | 7.96±0.92$^{b}$ | 6.77±0.48$^{b}$ |
| 10% sucrose | 5.56±0.05$^{c}$ | 3.60±0.41$^{c}$ |
| 15% sucrose | 3.29±0.31$^{d}$ | 2.52±0.36$^{d}$ |
| $sd_{0.05}$ | 1.5247$^{**}$ | 0.9547$^{**}$ |
| SE± | 0.8257 | 0.7067 |

Mean ± SD value(s) bearing different superscript letter(s) within columns are significantly different (P≤0.05).

Table 2 shows, that there was significant decrease ($P \leq 0.05$) in rehydation ratio (RR) of the different tamarind leathers produced, although there was no significant difference (P≤0.05) between the tamarind leather without sucrose and the one containing 5 % sucrose when dried using cabinet drier (2.43 and 2.26, respectively), and no significant difference ($P \leq 0.05$) between tamarind leather containing 10 and 15 % sucrose (1.51 and 1.44 respectively).

**Table 2. Effect of sucrose levels on rehydration ratio of tamarind leathers dried by two systems**

| Treatment | Rehydration ratio – Drying system: Cabinet | Rehydration ratio – Drying system: Solar |
|---|---|---|
| Contr | 2.43±0.16$^{a}$ | 2.78±0.16$^{a}$ |
| 5% sucros | 2.26±0.18$^{ab}$ | 2.66±0.24$^{a}$ |
| 10% sucrose | 1.51±0.05$^{b}$ | 2.27±0.08$^{b}$ |
| 15% sucros | 1.44±0.16$^{b}$ | 1.78±0.26$^{c}$ |
| $Lsd_{0.05}$ | 0.8256$^{*}$ | 0.7520$^{*}$ |
| SE± | 0.0274 | 0.0185 |

Mean ± SD value(s) bearing different superscript letter(s) within columns are significantly different ($P \leq 0.05$).

In contrast, there was a significant decrease ($P \leq 0.05$) in RR of the different tamarind leathers dried using solar drier, although there was no significant difference ($P \leq 0.05$) in RR of tamarind leather without sucrose and tamarind leather containing 5 % sucrose (2.78 and 2.66 respec-tively). Whereas, there was significant decrease ($P \leq 0.05$) in RR of tamarind leather containing 10 and 15 % sucrose (2.72 and 1.78, respectively). Such variations in RR of fruit leathers with sucrose level endorsed earlier work reported by Mohamed (1999) for mango leather. It was clear that as the sucrose level in tamarind pulp increases, the RR decreases. Such phenomenon is due to migration of soluble solids to the surface during drying of the material (Brennan *et al.,* 2006).

Table 3 shows, a significant decrease (P≤0.05) in drying ratio (DR) of all tamarind leathers dried using the two drying systems. Tamarind leather without sucrose dried using cabinet drier gave the highest DR (7.00), whereas tamarind leather containing 15 % sucrose gave the lowest DR (3.50). Also, there was a significant decrease ($P \leq 0.05$) in DR of tamarind leathers dried using solar drier, where tamarind leather without sucrose gave the highest DR (6.96), and tamarind leather containing 15% sucrose gave the lowest DR (3.25).

It was clear that, DR of different tamarind leathers dried in each drying system decreased as the level of sucrose increased.

Addition of sucrose was reported earlier to increase the final dry weight of tamarind leather which characterized by retention of water during drying (Van Arsdel *et al*., 1973; Mohamed, 1999).

**Table 3. Effect of sucrose levels on drying ratio of tamarind leathers dried by two systems**

| Treatment | Drying ratio | |
|---|---|---|
| | Drying system | |
| | Cabinet | Solar |
| Control | 7.00±0.00[a] | 6.96±0.02[a] |
| 5% sucrose | 5.38±0.00[b] | 4.94±0.06[b] |
| 10% sucrose | 4.12±0.00[c] | 3.98±0.02[c] |
| 15% sucrose | 3.50±0.00[d] | 3.25±0.06[cd] |
| $Lsd_{0.05}$ | 1.3782* | 0.6841* |
| SE± | 0.8547 | 0.0596 |

Mean ± SD value(s) bearing different superscript letter(s) within columns are significantly different ($P \leq 0.05$).

There were no significant differences ($P \leq 0.05$) in pH values of different tamarind leathers dried using cabinet drier. Tamarind leathers dried using the solar drier showed slight significant increase ($P \leq 0.05$) in pH values (Table 4).

There was no significant increase ($P \leq 0.05$) in pH values among tamarind leather without sucrose, tamarind leather containing 5 % sucrose and tamarind leather containing 10 % sucrose (2.29, 2.44 and 2.52, respectively), while tamarind leather containing 15 % sucrose was significantly different ($P \leq 0.05$) from the rest tamarind leathers (2.81) using solar drier.

**Table 4. Effect of sucrose levels on pH values of tamarind leathers dried by two systems**

| Treatment | pH value, Drying system: Cabinet | pH value, Drying system: Solar |
|---|---|---|
| Control | $2.51 \pm 0.08^{ab}$ | $2.29 \pm 0.16^{c}$ |
| 5% sucrose | $2.61 \pm 0.01^{ab}$ | $2.44 \pm 0.14^{bc}$ |
| 10% sucrose | $2.66 \pm 0.04^{a}$ | $2.52 \pm 0.02^{b}$ |
| 15% sucrose | $2.78 \pm 0.03^{a}$ | $2.81 \pm 0.03^{a}$ |
| $Lsd_{0.05}$ | $0.0762^{*}$ | $0.0598^{*}$ |
| SE± | 0.0194 | 0.0073 |

Mean ± SD value(s) bearing different superscript letter(s) within columns are significantly different ($P \leq 0.05$).

There was a significant decrease ($P \leq 0.05$) in titratable acidity (TA) of the different tamarind leathers dried by different drying systems (Table 5). The highest TA value was recorded by tamarind leather without sucrose (18.82%) and lowest TA value was recorded by tamarind leather containing 15% sucrose (6.86). The same trend was also observed for tamarind leathers dried using solar drier, the highest TA value was recorded by tamarind leather without sucrose (15.35 %) and lowest TA value was recorded by tamarind leather containing 15% sucrose (7.83). Sucrose is reported to reduce TA in food systems, therefore the pH of food increased and TA decreased (Jain and Nema, 2007).

**Table 5. Effect of sucrose levels on titratable acidity (as tartaric acid %) of tamarind leathers dried by two systems**

| Treatment | Titratable acidity – Drying system: Cabinet | Solar |
|---|---|---|
| Contro | 18.82±0.27$^{a}$ | 15.35±0.45$^{a}$ |
| 5% sucrose | 12.02±0.21$^{b}$ | 13.19±0.08$^{b}$ |
| 10% sucrose | 8.43±0.14$^{c}$ | 10.48±0.24$^{c}$ |
| 15% sucrose | 6.86±0.03$^{d}$ | 7.83±0.39$^{d}$ |
| $Lsd_{0.05}$ | 1.2349$^{**}$ | 1.9661$^{**}$ |
| SE± | 0.8264 | 0.7548 |

Mean±SD value(s) bearing different superscript letter(s) within columns are significantly different ($P \leq 0.05$).

With regard to the total soluble solids (TSS) of tamarind leathers dried in cabinet and solar drier, table 6 shows that there was a significant increase ($P \leq 0.05$) in TSS % among different tamarind leathers in each drying system. Tamarind leather without sucrose dried using cabinet drier gave the lowest value of TSS % (5.19) and the one containing 15% sucrose gave the highest value of TSS % (8.30).Tamarind leather dried using the solar drier has adopted the same approach that, tamarind without sucrose gave the lowest value of TSS % (6.15) and the one containing 15% sucrose gave the highest value of TSS % (7.93).

From quality characteristics point of view, tamarind leathers containing 15% sucrose dried in the two drying systems gave superior quality.

Although the drying rate of tamarind leather contained 15 % sucrose was low, addition of high level of sucrose to tamarind pulp was done intentionally to improve the end product texture, retain its flavor, reduce the acidity of tamarind pulp, in addition to the sweetening and preser-vative action of sucrose for using and during storage ( Harrison and Andress, 2000). Naikare *et al*., (1998) recommended addition of 20% sugar to fruit pulp for the manufacture of fruit leather of good storage quality. This finding similar is to results of Ekanayake and Banadara (2002) who reported that 15% sugar level for banana leather was found the best and having satisfactory texture and palatability. Jain and Nema recommended addition of 20% sugar to guava pulp to improve the quality of guava leat(2007) reported that addition of 30% sugar to guava pulp decreased its drying rate, and texture of guava leather was viscous and hence her

**Table 6. Effect of sucrose levels on total soluble solids of tamarind leathers dried by two systems**

| Treatment | Total soluble solids<br>Drying system<br>Cabinet | <br><br>Solar |
|---|---|---|
| Control | 5.19±0.07$^{d}$ | 6.15±0.14$^{bc}$ |
| 5% sucrose | 6.27±0.25$^{c}$ | 6.73±0.02$^{b}$ |
| 10% sucrose | 7.49±0.39$^{b}$ | 7.24±0.25$^{ab}$ |
| 15% sucrose | 8.03±0.01$^{a}$ | 7.93±0.04$^{a}$ |
| $Lsd_{0.05}$ | 0.8257$^{*}$ | 0.4339$^{*}$ |
| SE± | 0.0469 | 0.0327 |

Mean±SD value(s) bearing different superscript letter(s) within columns are significantly different ($P \leq 0.05$).

## Conclusion

The results presented in this study demonstrated the good quality performance of the tamarind leather containing 15% sucrose dried by cabinet and solar driers. Although it has the lowest drying rate compared with the other three tamarind leathers containing (0, 5 and 10% sucrose). Addition of sucrose to tamarind pulp improved texture, increased pH and reduced the acidity of tamarind leathers.

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# تأثير مستوى سكر القصب على معدل التجفيف وصفات الجودة للفائف العرديب

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**المستخلص**

الغرض من هذه الدراسة، هو دراسة إستعمال ثلاث مستويات من سكر القصب (السكروز) على معدل التجفيف وإنتاج لفائف من العرديب ذات جودة جيدة. تم فرز وغسل ثمار العرديب ونقعها فى الماء ومن ثم خلطها. أضيفت ثلاث مستويات من سكر القصب إلى عجينة العرديب (5، 10 و15%) وجزء من العجينة لا يحتوى على سكر (الشاهد). فردت عجينة العرديب فى صوانى التجفيف ومن ثم جففت بإستعمال مجفف الكابينة عند درجة حرارة 70°م والمجفف الشمسى عند درجة حرارة 54°م±4 وذلك للحصول على لفائف العرديب الرقيقة. تم تقييم المنتج النهائى من حيث خواص التجفيف والخواص الفيزيو-كيميائية. لفائف العرديب التى لا تحتوى على سكر سجلت أعلى معدل تجفيف بينما تلك التى تحتوى على 15% سكر سجلت أقل معدل تجفيف لكلا المجففين. هنالك إختلافات جوهرية بين لفائف العرديب من حيث نسبة التشرب و نسبة التجفيف والملمس و درجة الأس الهيروجينى و الحموضة المعيارية ونسبة المواد الصلبة الذائبة. لفائف العرديب التى تحتوى على 15% سكر أظهرت جودة عالية مقارنة بلفائف العرديب الأخرى.