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EFFECT OF SOLAR DRYING AND PRETREATMENTS ON THE DRYING CHARACTERISTICS AND QUALITY OF DRIED FICUS CYCOMORE FRUITS

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ABSTRACT: *Thin layer solar drying expriments were conducted on Ficus cycomore. Ficus cycomore preteated with different solutions :(C) water as a control,(T1) 80 % fructose +1 % sodium metabisulphate, (T2) 80% fructose + 1% citric acid, (T3) 80% sucrose + 1 % sodium metabisulphate and (T4) 80% sucrose + 1 % citric acid. Air heated by the solar heater was moved through the product by natural convection. The best fit of the thin layer drying of Ficus cycomore is obtained by exponential equation or Newtoen model which fitted very well with the experimental data at various pretreated Ficus cycomore. The required drying times were 26,22,26,22, and18 hours for C,T_1, T_2, T_3, and T_4 respectively. The drying rate data indicated linear falling rate after 6 hours of drying process. The drying constant value was affected by the fluctuating chamber temperture, moisture content & pretreatment of Ficus cycomore. Moisture content was changed depending on the pretreatment and solar drying process. On the other side, total bacterial count, psychrophilic bacterial count mold and yeast were high in fresh Ficus cycomore , these values were decreased after pretreatments and solar drying.*

Concerning physical propertis, dried Ficus cycomore soaked in water had the higher rehydration ratio, while Ficus cycomore soaked in 80 % fructose solution +1 % citric acid had the lower rehydration ratio and had the higher PH. Organoleptic evaluation reavaled that sample treated with 80% fructose + 1% sodium metabisulphate had the higher score follwed by Ficus cycomore soaked in 80% sucrose + 1% sodium metabisulphate.

Key word: *(Solar drying – Ficus cycomore- osmotic – rehydration).*

INTRODUCTION

Dried agricultural products, especially fruits and vegetables are becoming popular and can be an attractive source of income to the rural communities. Drying of fruits and vegetables is one of the oldest forms of food preservation methods known to man and is the most important process for preserving food since it has a great effect on the quality of the dried products. The major objective in drying of agricultural products is the reduction of moisture content to a level which allows safe storage over an extended period. Also, it brings about substantial reduction in weight and volume, minimizing packaging, storage and transportation costs(Doymaz 2005).

Solar drying of crops and some fruits and vegetables has been practiced in various plants of the world for centuries. A large portion of the world's supply of dried in the open without technical aids. Being unprotected from rains, windborne dirt, dust and from infestations by insects, rodents and other animals, the quality of the food is seriously degraded, sometimes so far that it is inedible. The conditions in tropical countries make the use of solar energy for drying foods practically attractive. The introduction of solar dryers in developing countries can reduce crop losses and improve the quality of dried product significantly compared to traditional drying methods (Muhlbauer, 1986).

Solar drying systems must be properly designed in order to meet particular drying requirements of specific crops and to give satisfactoring performance with respect to energy requirements (Steinfield & Segal, 1986).

Solar energy is an important alternative source of energy and preferred to other energy source because it is abundant, inexhaustible and non-pollutant. Also, it is renewable, cheap and environmental friendly(Basunia andAbe,2001).

Egypt has a high potential for the production of solar energy, which can be considered as a reliable energy source even during the winter season. It lies within the subtropical region. The annual daily average of solar radiation on a horizontal plane in Egypt is 8 kW/m^2 day. The average of solar radiation intensity during winter is about 7 $kW/\ m^2$ day, and the measured annual average of daily sunshine duration amounts to approximately 11 h (Moharam, 1993).

The origin of Ficus cycomore is central Africa, the tree appeared about 5000years ago in Egypt probably from seeds imported with the fruit from the headwaters of the Nile. The fruit of Ficus cycomore is large(25-50mm in diameter) to medium or even small and are yellow to red when ripe. The fruits are not very sweet, but extremely aromatic and they can compete 100 with Ficus cycomore. It is bark and milky latex used in folk medicine against ringworm and other skin disorders.

Osmotic dehydration is widely used for the partial removel of water from plant issues by immersion in a hypertonic (osmotic) solution. The drying force for the diffusion of water from the tissue into the solution is provied by the higher osmotic pressure of the hyper tonic solution. The diffusion of the water is accompained by the simulataneous counter diffusion of the solutes from the osmotic solution into the tissue. Since the membrance responsible for osmotic transport is not perfectly selective, other solutes present in the celles can also be leached into the osmotic solution (Sablani *et al* ; 2002; Rastogi & Raghavarea, 2004). However, foods treated slowly by s-osmotic dehydration are usually unsutable and as such complementary treatments(drying, freezing ,pasteurization, or addition of chemical preservatives) are necessary to ensure proper food conservation.

Simulation models are needed in the design and operation of solar dryers. Several investigations have been carried out by (Zaman & Bala, 1989; Diamante and munro, 1993; Pala *et al* 1996; Gamea, 1998; Yaldiz *et al,* 2001; Gamea *et al,* 2005; Ebru *et al,* 2003; Ertekin and Yaldiz 2004).

The main objective of this research is to investigate the drying behavior with attempts to fit a mathematical model of the thin layer solar drying for Ficus cycomone using an indirect natural convection solar dryers. Also, determind some varies chemical physical, microbiological and organoleptic characteristcs of Ficus cycomore during the drying process as well as quality attributes of dried products were evaluated.

MATERIALS AND METHODS

1. Solar dryer

An indirect natural convection solar dryer consisted of a solar collector and a drying chamber as schematically depicted in fig.1 was used in all experiments (Saad *et al,* 1992). The dryer was installed on the roof of the Agriculture Engineering Building, Faculty of Agriculture, Minufiya University and was oriented so that the collector faces south. The solar collector was tilted at an angle of 20^0 from the horizontal plane, which was determined to be an optimum tilt angle for the specific location and time of the year. The heated air was allowed to enter in the drying chamber through the bottom and up through the samples and through the chimney. The dryer can be oriented continuously facing the sun on movable wheel to increase the absorbed incident solar energy.

2. Measurements

2.1. Solar radiation Ably Radio Meter (Model 8-8 Serial No. 14046) was used to measure the solar radiation (W/m^2) flux incident on the horizontal plane. A factor of 10.8×10^6 v/w m^2 was used to convert the readings of the instrument to watts.

2.2. Temperature The temperature (^0C) was measured using the thermocouple wires placed in the required measuring points. Two thermocouples were placed at the inlet and exit ports in the drying chamber to measure the air inlet and outlet temperatures. Three thermocouples were inside the drying chamber to measure the air temperature at three locations after leaving the tray, two thermocouples were evenly spaced in the solar collector to measure the air temperature. Temperature reading at a certain time intervals (60 min) was recorded using a data logging system and basic computer program.

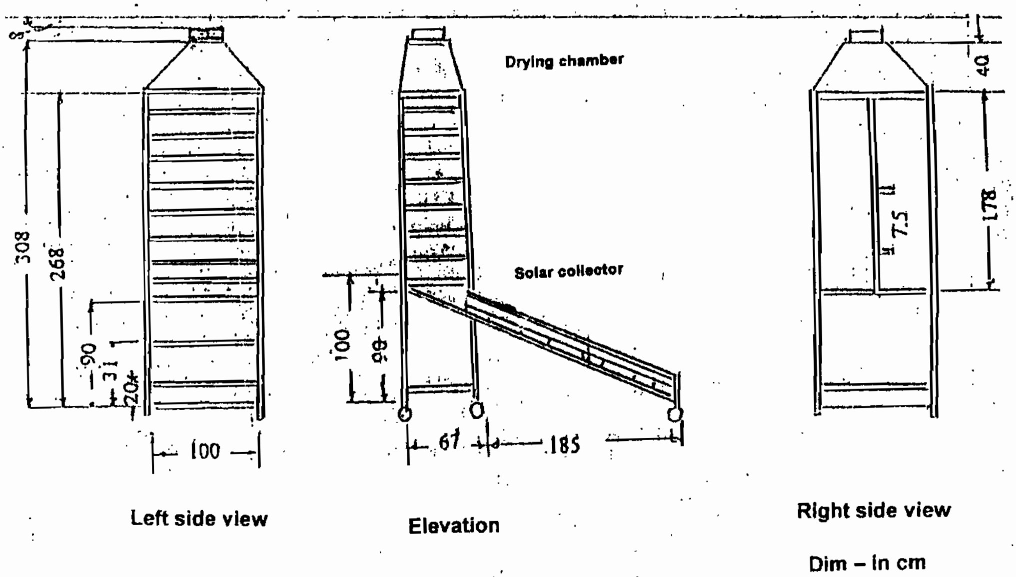

Figure (1). Experimental hatural convection indirect solar dryer.

2.3. Relative humidity Thermos Hygrometer (model 37200, OAKTON) was employed to measure the air relative humidity (RH, %) outside and inside the drying chamber at different points.

2.4. Air velocity The air velocity of ambient air, inside the dryer and inside the collector was measured, by means of a Dwyer thermal anemometer 470, to the nearest ft/min. The readings were then converted into m/min.

3. Experimental procedures

Ficus cycomore fruits were obtained from private farm in Zefta Center, Gharbia Governorate, Egypt., harvested by hand and transported immediately to the laboratory on the same day. The average diameter and weight of the samples were 4.5cm and 43.4g. respectively. The samples were washed with tap water, then divided five parts soaked overnight at room temperature in the following solutions except the first part which dried directly without any preparation

- (C) Soaked in water only as a control.
- (T_1) Soaked in 80 % fructose solution +1 % sodium metabisulphate.
- (T_2) Soaked in 80 % fructose solution +1 % citric acid.
- (T_3) Soaked in 80 % sucrose solution + 1 % sodium metabisulphate.
- (T_4) Soaked in 80 % sucrose solution + 1 % citric acid.

Some samples were picked randomly from the pretreated fruits to determine the initial moisture content. The pretreated fruits were spread (single layer) with a near uniform distribution density. The loading density of the drying tray was 5 kg/m^2. the loaded trays were then placed very quickly in the drying chamber. Drying starts at 8.00 AM and terminated at 6.00 PM drying data were monitored using three labeled samples, which were individually weighed and positioned at the content and the two sides of each tray. The weights of the labeled samples were recorded every 2h throughout the drying test.

The drying test was terminated when the decrease In the weight of the samples had almost ceased. According to AOAC (1990) the final moisture content of the dried samples was determine. Solar dryer experiments were carried out during June 2006 at the Faculty of Agriculture, Shibin El-Kom City, Egypt, (latitude 30.^{0}N). The average of ambient air temperature increased to a maximum of 36.1 ^{0}C at 1:00 PM. The hourly average of solar insolation intensity was about 600 W/m2. Measurements of solar radiation, and drying air temperature, and relative humldity were recorded during the drying tests.

4. Mathematical modeling of solar drying curves

The solar drying curves obtained were fitted with eight different moisture ratio equations given by several authors and cited by Yaldiz *et al* (2001) table.1.

Table (1): Mathematical models applied to the drying curves.(Yaldiz *et al* 2001)

Model	Name of Model
MR= e^{-kt}	Newton
MR= e^{-kt^n}	Page
MR= $e^{-(kt)^n}$	Modified pabis
MR= a e^{-kt}	Handerson and Pabe
MR= a $e^{(-kt)+c}$	Logarthmic
MR= a $e^{(-kot)}$ +b$e^{(-k,t)}$	Two term
MR= a $e^{(-kt)}$ + (1-a) $e^{(-kat)}$	Two term exponential
MR= 1 + at +bt^2	Wang and singh

However, the moisture ratio (MR) was simplified to M/M_o instead of ($M - M_e$) / ($M_o - M_e$) because relative humidity of the drying air continuously fluctuated in solar drying (Diamante and Muno, 1993 ; Doymaz and Pala, 2002)

The correlation coefficient (r^2) is of the primary criteria that could be used to select the best equation that account from variation in the solar drying curves of the dried samples (Ozdermir and Devers, 1999; Saravadia *et al*, 1999).

The regression analysis was performed using the statistical computer program (Expert 3.1). The goodness of fit of the tested mathematical models to the experimental data was evaluated from (r^2) and reduced (χ^2) between the predicted and experimental values. The higher (r^2) and the lower (χ^2) values, the better is the goodness fit (Eruteken and Yaldiz 2004)

5. Analytical methods

Moisture contnet, protein value, fat, ash and fiber were estimated according to the methods of AOAC(1990). Reducing sugars were determined in the 70 % ethanol extracted by the phenol sulphoric method of (Dubois *et al.*,1956). Non-reducing sugars were determained as glucose after hydrolyzation by HCL. Rehydration ratio was measured as the total mass of rehydrated Ficus cycomore per unit weight of dry matter. Coefficient of rehydration was determained according to Ranganna, (1979) using the following equation.

$$CR = \frac{D_{WH} \times [100 - M_{CD}]}{[W_{DR} - M_{DR}] \times 100}$$

Where:

CR= Coefficient of rehydration

D_{WH}= Drained weight of dehydrated sample

M_{CD}= Initial moisture content (WB)

W_{DR}= Weight of dried sample taken for rehydration

M_{DR}= Amount of moisture present in the dried sample taken for rehydration

6. Bacteriological examination:-

Bacteriological examination were detrmanid according toFAO (1992) methods.

7. Organolepic evaluation

A panel of ten members were asked to evaluate the quality of Ficus cycomore using a composite scoring test. The tested Ficus cycomore samples were presented in a randomized order to the panelists to evaluate the color, texture, tast, appearance and overall acceptability using a scale ranged from 10 as excellent to as very poor.

8. Statistical analysis

Statistical analysis of data was carried out by analysis of variance (ANOVA) according to (Statistical Analysis System 1996) Least Significant Difference test was used to determaine differences between means. Significance was assumed at ($P< 0.05$).

RESULTS AND DISCUSSION

During the drying experiments, ambient air temperature ranged from 25.9 to 37.3 c^{o}, ambient air relative humidity from 39.8 to 76.8 %, drying air temperature from 27.0 to 48.9 c^{o} , drying air relative humidity 21.9 to 62.5 % and average solar radiation was about 600 w/m^{2}. The difference of maximum air temperature between ambient and drying air temperature was 11.6 c^{o}, this gave an indication about the efficiency of the dryer. The average air flow rate through the drying chamber was a about 1.85 m^{3}/min. Also it was noticed that the air flow rate during the day was a function of solar time. The air flow rate increased as the difference between the drying chamber outlet and inlet air temperature increased.

Fig. 2., present the drying curves for five different pretreated of Ficus cycomore. The required drying times to reach mean final moisture content of 21.36 , 19.33 ,26.24 , 25.52 , and 19.02 % (d.b.) for control , 80 % fructose +1 % sodium metabisulphate, 80 % fructose +1 % citric acid, 80 % sucrose + 1 % sodium metabisulphate and 80 % sucrose + 1 % citric acid, were 26 ,22, 26,22 and 18 hour respectively.

Drying rates were quite low during the first hour while solar radiation on the collection was low in the morning and as the drying chamber warmed up. It can be seen also, that maximum drying rate occurred between 2 to 6 hours and corresponded to the drying chamber reaching its maximum temperature during the hottest part of the day. It can be seen also, for the first 4 hour of drying, the trends in moisture losses for the five different pretreated of Ficus are approximately similar and curves show constant drying rates during this period. This occurs, as there is considerable free surface moisture in the product at any time in the drying curves, the moisture content for the Ficus pretreated with 80 % sucrose solution + 1 % citric acid were less than the others.

The Ficus cycomore were clearly entering their falling rate period at a bout 6 h , so the drying rate falls as show in Fig. 3.

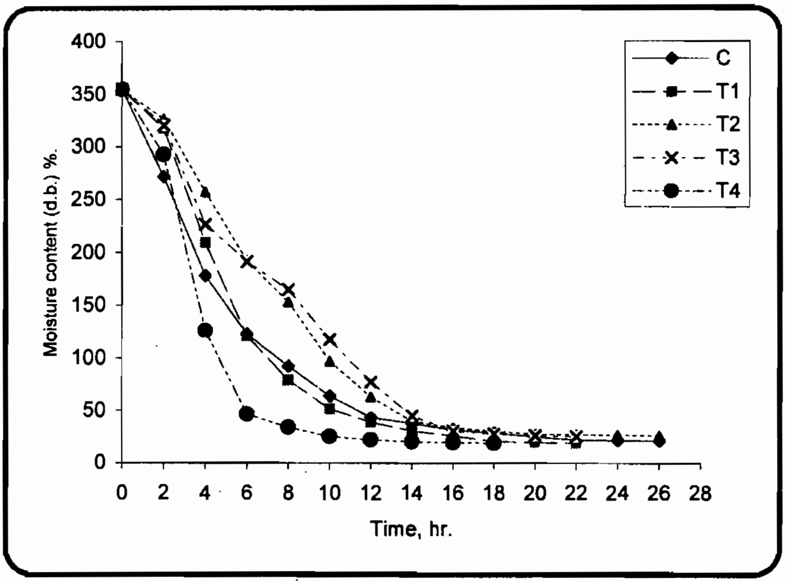

Fig. 2. Moisture content vs time plots (drying curves) for solar drying of ficus cycomore.

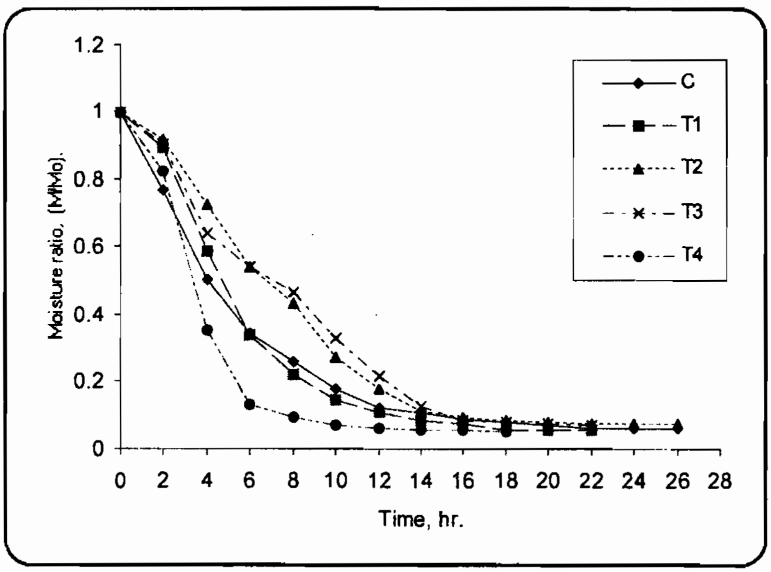

Fig. 3. Moisture ratio vs time plots (drying curves) for solar drying of ficus cycomore.

Fitting equations for drying curves

The drying curves were fitted with eight equations presented in table 1. All the equations gave consistently high r^2 values in the range of 0.93 to 0.9968 . This indicates that all equations could satisfactorily describe the solar drying rates of Ficus cycemere.Exponential equation gave higher (r^2) values with lower χ^2 values with other equations.

The linear regrission of the moisture reduction with drying time using eponentail equation yielded drying constant (k). The following values for drying constant were found 0.135 , 0.155, 0.14, 0.158 and 0.24 for C , T_1, T_2, T_3, T_4 respectively.

The reliability of the exponential model is evaluated by comparing the experimental and predicted moisture contents as shown in Fig. 4.

The results revealed that, the model fitted very well the experimental data for the various pretreated Ficus cycomore, which is indicated by high values coefficient correlation (r^2) in the range of 0.95 – 0.977 and low values of χ^2 ranging from 0.0105 to 0.0006

Data presented in table. 2., show the gross chemical composition of fresh Ficus cycomore sample and the effect of prior pretreatment on the chemical composition of solar drying. Fresh Ficus cycomore composed 86.49 moisture;0.64 protein;0.41 fat ; 0.70 fiber;6.98 reducing sugars;4.41 non reducing sugars and11.39 total carbohydrates(on wet weight basis) respectively. Concerning, moisture content it was changed depending mainly on the pretreatment and solar drying process .Sample soaked with 80 % sucrose+1% sodium metabisulphate, 80 % sucrose+1% citric acid, 80 % fructose +1% sodium metabisulphate and 80% fructose +1% citric acid were retained high moisture content (17.95 to21.31) compared with control sample (14.61), this may be due to the sugar solution which improved water binding activity and increase the moisture content in the Ficus cycomore (Raoul-twack 1994). In addition pretreatment (soaking in sugar solution) before solar drying had no effect on the protein , fat and fiber content of dried Ficus cycomore. On the other hand, soaking of cycomore Ficus cycomore in sucrose or fructose solution prior solar drying increased considerably the carbohydrates content this could be due to the diffusion indicative of sucrose and fructose into cycomore Ficus cycomore during soaking in all treatments except control which soaked in water without any addition. These results are in agreement with those reported by Ehab *et al.*,(2006).

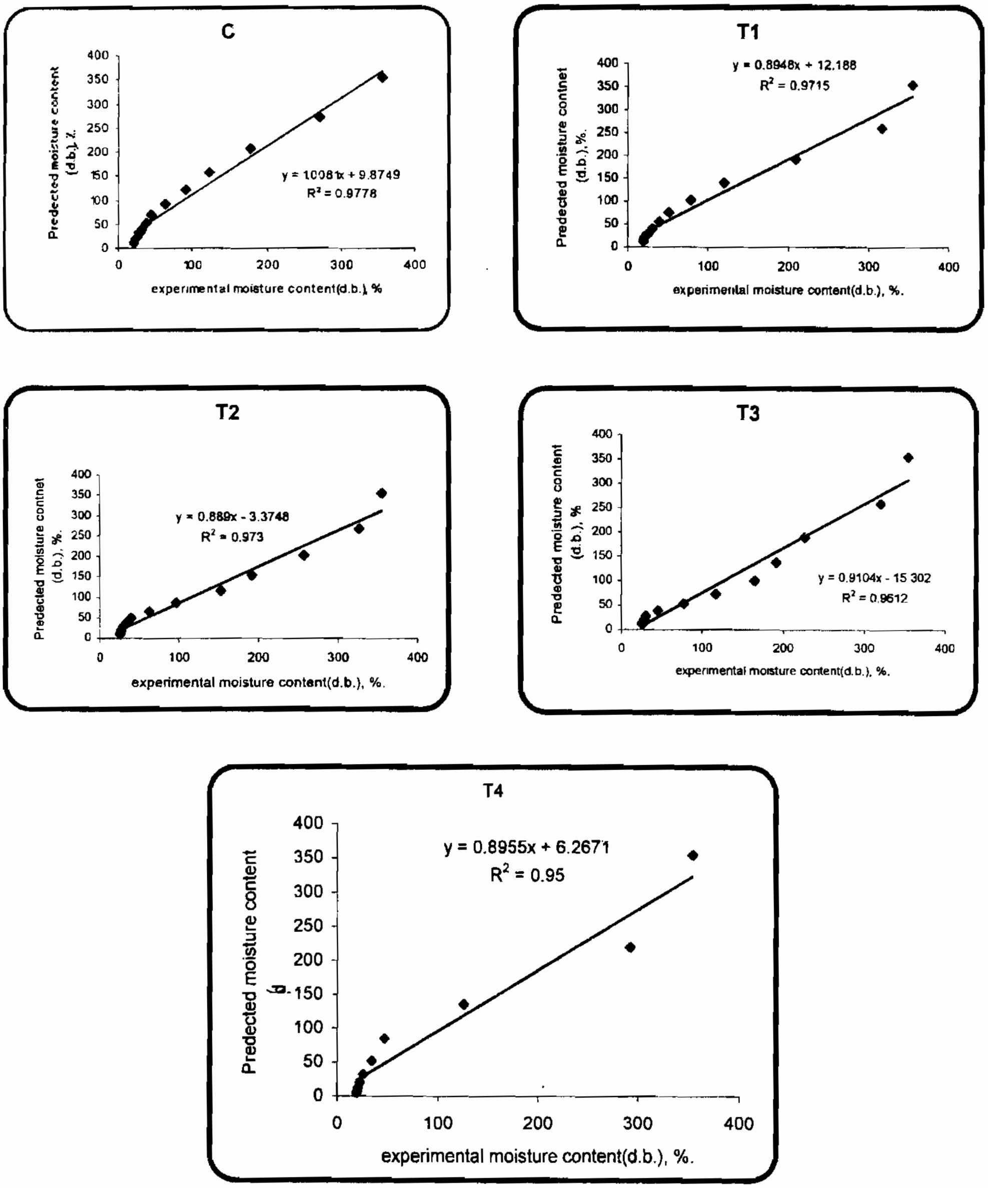

Fig. (4). The relatioship between the experimental data and the predected data according to the exponential modeling for of ficus cycomore drying.

Table (2): Chemical composition of fresh and solar dried of Ficus cycomore .

Treatments	Moisture		Proteio		Fat		Ash		Fiber		Reducing Sugars		Non reducing Sugars		Total carbohydrate	
	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW
Fresh	86.49	-	0.64	4.73	0.41	3.03	0.27	1.99	0.70	5.18	6.98	51.66	4.41	32.64	11.39	84.30
Dried																
Control	14.61	-	4.26	4.98	2.56	2.99	1.69	1.97	5.01	5.98	43.13	50.50	28.60	33.49	71.73	82.89
T_1	20.75	-	3.65	4.60	2.05	2.58	1.31	1.65	4.02	5.82	43.25	54.57	24.30	30.66	67.55	85.23
T_2	19.72	-	3.11	3.87	2.35	2.92	1.25	1.55	4.30	5.35	44.2	55.06	24.77	30.85	68.98	85.92
T_3	20.31	-	3.25	4.07	2.16	2.71	1.12	1.40	4.32	5.42	43.95	55.15	24.62	30.89	68.57	86.04
T_4	20.21	-	3.45	4.32	2.13	2.66	1.19	1.49	4.20	5.26	43.57	54.60	25.10	31.45	68.67	86.06

Control= Soaked in water before solar drying.
T1= Soaked in 80 % sucrose+ 1% sodium metabisulphate.
T2= soaked in80% sucrose +1% citric acid
T3= Soaked in 80% fructose + 1% sodium metabisulphate
T4= Soaked in 80% fructose +1% citric acid

Bacteriological aspects

Bacteriological profile of Ficus cycomore are presented in table. 3. From this table, it could be observed that total bacterial count, psychrophillic count and mold & yeast were high in fresh Ficus cycomore (78×10^5 , 34×10^5 and 59×10^3 cfu) respectively. This may be attributed to the poor sanitary handling condition during harvesting and marketing. These values were decreased after soaking in sugar solution and solar drying, such decrease was more pronounced in case of 80% sucrose+ 1 % citric acid and 80 % fructose +1 % citric acid for all organisms investigated. Such decrease may be due to the combination of soaked in sugar solution which caused plasmolysis of cell bacteria and solar drying which caused reduction in moisture content of Ficus cycomore.

Table (3): Effect of soaking and solar drying on microbiological profile of Ficus cycomore.

Treatments	Total count	Psychrophilic count	Mold&Yeast
Fresh	$78X10^5$	$34\ X10^5$	$59\ X10^3$
Dried			
Control	$76\ X10^3$	$61\ X10^3$	$17\ X10^2$
T_1	$41\ X10^3$	$42\ X10^3$	$28\ X10^2$
T_2	$25\ X10^3$	$32\ X10^3$	$22\ X10^2$
T_3	$38\ X10^3$	$54\ X10^3$	$35\ X10^2$
T_4	$27\ X10^3$	$46\ X10^3$	$26\ X10^2$

Organoleptic quality

Organoleptic properties (color, texture, taste, appearance and overall acceptability) of fresh and dried Ficus cycomore are presented in table (4). Data reveal that sample treated with 80% fructose+ 1% sodium metabisulphate had the higher score followed by Ficus cycomore soaked in 80% sucrose+ 1% sodium metabisulphate respectively. While control sample which soaked in water only showed mean score in all characteristics, this may be due to the pretreatment which improved the quality of the dried Ficus cycomore. On the other side, there is a significant differences ($P< 0.05$) between fresh Ficus cycomore and other treatment except color. Finally, it could be stated that soaking of Ficus cycomore in sugar and sodium metabisulphate or citric acid solution had a rather significant effect on the organoleptic quality of solar drying Ficus cycomore.

Table (4) : Organoleptic evaluation of fresh and dried Ficus cycomore .

	Fresh	Control	T_1	T_2	T_3	T_4	LSD
Color	9.0	2.8	7.4	7.1	6.7	6.9	0.98
Texture	5.0	3.6	8.6	7.3	8.1	6.8	1.25
Tast	5.5	2.1	8.2	6.8	7.9	6.5	1.03
Appearance	5.3	2.2	8.6	6.9	7.4	7.2	1.00
Overall acceptability	5.2	2.0	8.0	7.2	7.6	7.1	0.92

Physical properties

The effect of soaking in 80 % sucrose or fructose and 1% sodium metabisulphate or 1 % citric acid solution on some quality attributes of solar dried Ficus cycomore are shown in table (5). From this table it could be concluded that dried Ficus cycomore soaked in water only had the higher rehydration ratio(2.36) follwed by Ficus cycomore soaked in 80 % fructose + 1% sodium metabisulphate and Ficus cycomore soaked in 80% sucrose +1 % sodium metabisulphate (2.11 and 1.98) respectively. While Ficus cycomore soaked in 80% fructose and sucrose +1 % citric acid had the lower dehydration ratio (1.70 and 1.44). This may be due to the relatively higher moisture content of Ficus cycomore (El-Beltagy *et al.*, 2007).

Solar drying of Ficus cycomore previously dipped in solution contained 80% fructose or sucrose +1% sodium metabisulphate had significantly ($P<0.05$) higher PH than other treatments, this could be attributed to the alkaline effect of sodium metabisulphate .

Table (5): Effect of soaking in sugar solution and sloar drying on some physical properties of Ficus cycomore.

Treatments	Rehydration ration	Rehydration coeffecient	PH	Titretable a cidity
Fresh	-	-	4.75	0.64
Dried				
control	2.36	0.29	4.25	1.72
T_1	2.11	0.26	5.18	3.37
T_2	1.70	0.22	3.83	5.28
T_3	1.98	0.23	4.97	2.76
T_4	1.44	0.19	3.58	6.14
LSD	0.13	0.06	0.08	0.71

Conclusion

- The indirect solar drying using the principles of natural convection was succesfully tested under weather conditions of Minoufiya, Egypt, where high quality dried ficus cycamore was obtained.

The performance of the solar collector had the drying air assumed satisfactorily.The reqired drying times to reach moisture contents of 21.36, 19.33,26.24,25.52, and 19.02 (on dry basis.) were 26, 22,26,22 and 18 hours for C,T1,T2,T3,and T4 respectively. The moisture content data found to perfectly fit the simplified exponential equation

$$M/Mo = e^{(-kt)}$$

The solare drying constent was affected by the fluctuating chamber temperature, moisture content and pretreatment. The final moiture content of ficus cycomere was found to be affected by the pretreatment. The drying rate data indicate linear falling rate drying begining from 6 hour.

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تأثير التجفيف الشمسي ومعاملات ماقبل التجفيف علي خصائص التجفيف والجودة لثمار الجميز

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الملخص العربي

يهدف هذا البحث إلى دراسة إمكانية استخدام الطاقة الشمسية في تجفيف ثمار الجميز وسلوك التجفيف الشمسي . وذلك باستخدام مجفف شمسي غير مباشر يعمل بتيارات الحمل الطبيعية.

وقد شملت الدراسة :

- استخدام مجفف شمسي غير مباشر يعمل بتيارات الحمل الطبيعية.
- تم دراسة العوامل الشمسية من (شدة اشعاع شمسي – ودرجات حرارة الهواء – والرطوبة النسبية) وتأثيرها على خواص هواء التجفيف داخل حجرة التجفيف
- تم إجراء التجارب لتجفيف ثمار الجميز بعد معاملتها كيماوياً بأربع محاليل مختلفة.
- تم توفيق منحنيات التجفيف لثمار الجميز مع عدد من معاملات التجفيف المختلفة
- تم تقييم الثمار المجففة بعدة طرق لبيان مدى جودتها من الناحية الحسية والكيماوية.

ويمكن تلخيص النتائج التي تم التوصل إليها في النقاط التالية :-

- المجفف الشمسي غير المباشر باستخدام تيارات الحمل الطبيعية أعطى نتائج مرضية في تجفيف المنتج من حيث مدة التجفيف وجودة المنتج .
- الزمن الكلي المطلوب للتجفيف كان ٢٦ ، ٢٢ ، ٢٦ ، ٢٢، ١٨ ساعة لكل من الثمار المعاملة بالمحاليل التالية (الماء – محلول ٨٠% فركتوز + ١% صوديوم ميتاباى سلفيت

الصوديوم – محلول ٨٠% فركتوز + ١%حمض الستريك – محلول ٨٠% سكروز + ١% صوديوم ميتاباى سلفيت – محلول ٨٠ % سكروز ١+ % حمض الستريك) على الترتيب.

- وجد أن معادلات التجفيف يمكن وصفها بواسطة المعادلة الآتية

Simplified exponential equation

$M/M_0 = e^{-kt}$

وهذا يعني أن المنتج يدخل في مرحلة التجفيف المتناقص بعد فترة قصيرة وربما يرجع ذلك لإنخفاض درجة حرارة هواء التجفيف والخواص الطبيعية للجميز

- ثابت التجفيف للثمار المعاملة بـ (T_4, T_3, T_2, T_1, C) وجد أنه (٠,١٣٥ – ٠,١٥٥ – ٠,١٤ – ٠,١٥٨ – ٠,٢٤) على الترتيب.
- نسبة الرطوبة النهائية تأثرت بمعاملة ما قبل التجفيف.

حدث تغيير في المحتوي الرطوبي بناء على المعاملات المبدئية وعملية التجفيف الشمسي على الجانب الأخر احتوت العينه الطازجة على أعلى محتوى من العد الكلي للبكتريا ، البكتريا المحبة للبرودة والفطريات والخمائر هذا المحتوى العالى من الكائنات الدقيقة حدث له انخفاض بعد المعاملات المبدئية والتجفيف .

- فيما يتعلق بالخواص الطبيعية وجد أن المعاملة التي تم نقعها في الماء فقط هي التي كانت نسبة تشرب الماء فيها عالي بينما كانت أقل نسبة تشرب في العينات التي تم نقعها في (٨٠ % فركتوز وسكروز + ١ % حمض ستريك) بينما كانت تحتوي علي أعلى قيم PH .
- دل التقييم الحسي أن العينة المعاملة المعاملة مع (٨٠ % فركتوز + ١% صوديوم ميتاباى سلفيت حازت على قبول المستهلك يليها العينة التي تم نقعها مع (٨٠ % سكروز + ١% صوديوم ميتاباى سلفيت)