J. Agric. Sci. Mansoura Univ., 26 (11): 7279 - 7291, 2001.

MATHEMATICAL MODEL TO PREDICT KINETICS OF OSMOTIC DEHYDRATION OF BANANAS AND STRAWBERRIES

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ABSTRACT

The effect of temperature (30°, 40° and 50°C) and sucrose, glucose, and fructose concentrations (40, 50 and 60%) on the osmotic dehydration of bananas and strawberries were studied. It was found that the water loss (WL) and solid gain (SG) were influenced by the temperature, the concentration of the osmotic agent and duration of the osmotic process. The values of WL and SG were higher during osmotic dehydration using glucose and fructose than sucrose solutions. The WL of bananas and strawberries at 60% fructose, 50°C was 40.9% and 40.7% respectively, while at 60% sucrose, 50°C it was 36.95% and 40.02% respectively. The same trend was observed for SG which was 9.85% and 7.05% for fructose solution and 8.44% and 6.87% for sucrose solution under the same previous conditions of concentration and temperature.

A two-parameters equation was used to predict the kinetics of osmotic dehydration and the final equilibrium point, and this model was found to correlate highly (r^2>0.98) with the experimental data of bananas and strawberries.

Key words

Osmotic dehydration, water loss, solid gain, kinetic model, banana, strawberry.

INTRODUCTION

An important task of the food industry is to maintain food quality as best as possible. Among the methods for preserving raw materials, osmotic dehydration is the process by which products may well-retain texture and nutritive value with marked decrease in water content to accomplish the phase change. Depending on the properties of material, type of osmotic solute, and conditions of the process, up to 70% of water can be removed from the material by osmotic dehydration (Lenart and Cerkowniak; 1996). In fruits, the usual osmotic dehydration agents are aquatic solutions of low-molecular weight, pure sugars, or mixtures with corn syrup, etc. (Lewicki and Lenart; 1995).

Two quantities may represent adequately the osmotic process: the water loss (WL), indicating the water that diffuses from the fruit to the solution; and the solid gain (SG) which represents the amount of solids that diffuses from the solution to the fruit less the solids of the fruit that are lost to the solution (Panagiotou *et al.,* 1998).

Rahman and Perera (1996) stated that the use of the osmotic dehydration process in the food industry has several advantages: quality improvement in terms of colour, flavour, and texture; energy efficiency; packaging and distribution cost reduction; chemical treatment not required; and product stability and retention of nutrients during storage.

Pokharkar and Prasad (1998) evaluated the mass transfer during osmotic dehydration of banana slices at different syrup concentrations and temperatures. They noticed that the water loss and sugar gain varied with sugar concentration as well as temperature.

Waliszewski *et al.* (1997) investigated the effect of temperature (50°, 60° and 70°C), sucrose concentration (50, 60 and 70%) and pH (6, 7 and 8) on the mass transfer during osmotic dehydration of banana chips.

Whole and blanched strawberries were osmotic dried in glucose solutions prior to air drying to determine change in the effective diffusion coefficient of the water in strawberries as a result of the pretreatments (Alvarez *et al.,* 1995). Also, Garrote *et al.* (1992) studied the osmotic drying of strawberries in sugar solutions at 5° and 25°C.

The aim of the present study was to evaluate the effect of several process variables (type of solute, solute concentration, temperature and duration of osmotic dehydration) on the mass transfer phenomena in the osmotic dehydration of bananas and strawberries, in order to calculate water loss (WL) and solid gain (SG); and also to estimate both the amount of water loss & solid gain at equilibrium (WL_{∞} & SG_{∞}) and rate constant of water loss & solid gain (S_1 & S_2).

MATERIALS AND METHODS

Bananas (*Musa sapientum;* Welliams) and strawberries (*Fragaria x ananassa*; Sweet Charli) of good and uniform quality were chosen.

Each banana was cut into cylinders or rings with a diameter of 2.5 cm and thickness of 1.0 cm. Whole strawberries were perforated to facilitate the mass transfer. Sucrose, glucose and fructose with a purity of 98% were used as the osmotic concentration agent. The osmotic solutions used had three different levels of sugar content, 40, 50, and 60% expressed in percentage of weight of sugar per total solution weight (w/w).

The samples after slicing and initial weight recording were immersed in sugar solution - the ratio of raw material to sugar solution was 1:4 (w/w)- contanied in glass beaker, then placed in a water bath at constant temperature (30°, 40° and 50°C) and process times of ½, 1, 2, 4 and 6 hours, then the samples were set to drain and blotted with a piece of tissue paprer to remove surface water. After osmotic treatment, final moisture content and final sample weight were measured. Experimental treatment was performed in triplicate runs.

Moisture content analysis of the investigated samples was measured according to the procedure mentioned by James (1995) and previously published in more details by Ranganna (1986) using infrared moisture determination balance FD-620 until constant weight of the samples which gave the following results: fresh bananas; 75.4% ± 1.4 (wet basis) and fresh strawberries; 88.0% ± 1.65 (wet basis).

Water loss and solid gain:

The water loss (WL) and solid gain (SG) of foodstuff after time t of osmotic treatment are defined as:

Mathematical modelling:

The kinetics of water loss and solid gain were fit to the model of Azuara *et al.* (1992) as follows:

تلصق المعادلات

where:

WL is the amount of water lost by the foodstuff at time t.

SG is the amount of solid gained by the foodstuff at time t.

WL_{∞} is the amount of water lost at equilibrium.

SG_{∞} is the amount of solid gained at equilibrium.

S_1 and S_2 are the rate constant of water loss and solid gain during the osmotic process respectively, and

t is the osmotic dehydration time.

RESULTS AND DISCUSSION

The experimental data for water loss (WL) from bananas and strawberries during osmotic treatment in sucrose, glucose and fructose solutions (40, 50 and 60%) at different temperatures (30°, 40° and 50°C) are shown in Figures 1 and 2. At the same manner, Figs. 3 and 4 depicts the solid gain (SG) by bananas and strawberries respectively.

From Figs. 1 and 2, the values for water loss (WL) from bananas and strawberries as calculated from equation (1) were increased with both increasing the processing temperature, sugar concentration and duration of the osmotic process. The values of water loss from both bananas and strawberries were higher during osmotic treatment in glucose and fructose solutions than sucrose solutions.

Fig1

fig2

fig3

fig4

According to the principle of osmosis, the rate of water loss from the fruit to the syrup with a high molecular weight solute is lower than that of syrup with a small molecular weight solute when both syrups are at the same mass concentration. This is due to low vapour pressure of the syrup with a low molecular weight solute (Rahman and Perera, 1996).

Lenart (1992) found that the rate of water removal for osmotic dehydration of apple decreases faster with reduced molecular weight of sugar. With increased molecular weight of sugar the rate of water removal from osmosed apple decreased. The same result was observed by Panagiotou *et al.* (1999).

Panagiotou *et al.* (1998) found that the water loss from osmotic dehydrated banana in 40% sucrose at 40°C after 0.5, 2 and 6 h was 8, 16 and 22% respectively. These results agree with the results of the present study. Also, Viberg *et al.* (1998) noticed that the water loss of osmotic dehydration of strawberry in 40, 50 and 60% sucrose solutions was 34, 36.5 and 43% respectively.

The experimental solid gain (SG) by bananas and strawberries during osmotic treatment calculated from equation (2) is shown in Figs. 3 and 4. As shown in Fig. (3), the solid gain by bananas reach up to 8-9% at the highest levels of sucrose, glucose and fructose concentration, process temperature and time of the osmotic process. While, the corresponding values for strawberries are 6-7% (Fig. 4).

Lazarides and Mavroudis (1996) noticed that besides tissue differences in structure, compactness, intercellular spaces, soluble solids content etc., the larger specific surface played a substantial role in the solute uptake.

In the present work, in all experiments the amount of sugar absorbed by the samples increased with increasing initial concentration of sucrose, glucose and fructose in the syrup. Higher temperatures also promoted faster water migration from the sample. Water loss and solid gain appeared to increase exponentially with time (Figs. 1 to 4). The same relationship (exponential in character) was noticed by Beristain *et al.,* (1990) and Conway *et al.,* (1983).

In the present study, a relationship between the final water loss and osmotic dehydration conditions was found, that is to say, for every 10°C increase in temperature, or by increasing the concentration of the sugar solution by 10%, there was a corresponding increase in the final water loss percentage. It was noticed that the water loss (WL) for both bananas and strawberries osmodehydrated e.g., at 50°C and 50% sucrose solution, is 31.60% and 37.89% respectively which are almost similar to the WL for the osmodehydrated ones at 40°C and 60% (31.69% and 36% respectively). Conway *et al.,* (1983) observed a similar trend.

On the other hand, the effect of osmotic dehydration can be evaluated on the basis of the final moisture content taking into account also the water loss and solid gain. The water loss / solid gain (WL/SG) ratio is of particular importance. Therefore, changes in water loss have been analysed to be presented as a function of solid gain.

Increased molecular weight of the osmotic agent results in a significant increase of the WL/SG ratio. For bananas, e.g.; at 50°C and 60% sucrose, glucose and fructose solutions, the highest value of WL/SG ratio was 4.38, 4.25 and 4.14 respectively. The same trend was observed under the similar conditions for strawberries at which the WL/SG ratio was 5.83, 5.36 and 5.77 respectively.

The kinetics of water loss and solid gain gave fit with equations 3 and 5. Estimated parameters (WL_∞, S_1, SG_∞ and S_2) for both bananas and strawberries are presented in Tables 1 to 4.

The positive effects of the sucrose, glucose and fructose concentration of the osmotic solution and of the process temperature on the equilibrium water loss (WL_∞) of bananas and strawberries are illustrated in Tables 1 and 2. The rate constant of water loss (S_1), remained almost constant as the solute concentration and temperature were increased for bananas (Table 1), the correlation coefficient (r^2) was > 0.98. While, for strawberries (Table 2), the positive effect of solute concentration and temperature was noticed on rate constant of water loss. Similar results were obtained by Panagiotou *et al.,* (1998), when using banana, kiwi fruit and apple fruits.

Table (1): Estimated parameters of equation (3) for bananas

Temp. (°C)	Sucrose solution								
	40%			50%			60%		
	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2
30	22.05	0.97	0.9913	26.98	1.00	0.9779	32.01	1.04	0.9913
40	25.76	0.95	0.9795	31.60	0.92	0.9835	35.23	1.02	0.9793
50	27.98	1.16	0.9927	35.78	0.85	0.9724	41.76	0.86	0.9614
Temp. (°C)	Glucose solution								
	40%			50%			60%		
	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2
30	24.50	0.99	0.9852	29.40	1.07	0.9955	35.18	0.98	0.9974
40	26.04	1.10	0.9892	32.47	1.02	0.9963	38.63	0.97	0.9982
50	28.30	1.31	0.9896	38.66	0.95	0.9952	44.46	0.88	0.9974
Temp. (°C)	Fructose solution								
	40%			50%			60%		
	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2
30	25.42	0.98	0.9933	30.59	1.08	0.9950	35.71	0.97	0.9956
40	28.11	0.88	0.9792	34.41	1.20	0.9946	44.12	0.93	0.9924
50	31.07	1.05	0.9953	38.65	1.15	0.9967	46.52	1.06	0.9952

Table (2): Estimated parameters of equation (3) for strawberries

Temp. (°C)	40%			50%			60%		
Sucrose solution									
	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2
30	25.35	0.49	0.9855	28.43	0.60	0.9980	30.46	0.82	0.9971
40	36.74	0.74	0.9938	38.39	0.97	0.9892	40.01	1.13	0.9925
50	39.65	1.04	0.9926	42.64	1.18	0.9970	43.95	1.54	0.9994
Glucose solution									
	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2
30	27.36	0.47	0.9699	27.50	0.65	0.9810	27.81	0.87	0.9971
40	37.08	0.66	0.9948	37.10	0.94	0.9904	37.53	1.12	0.9939
50	39.87	0.96	0.9893	41.08	1.19	0.9961	41.03	1.54	0.9976
Fructose solution									
	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2	WL_∞ (%)	S_1 (h^{-1})	r^2
30	34.90	0.27	0.9474	35.81	0.34	0.9815	35.02	0.48	0.9731
40	39.45	0.35	0.9757	37.19	0.59	0.9905	45.84	0.62	0.9982
50	41.33	0.45	0.9859	40.33	0.73	0.9951	50.78	0.67	0.9996

WL_∞ (%) = Water loss at equilibrium.
S_1 (h^{-1}) = Rate constant of water loss.

Table (3): Estimated parameters of equation (5) for bananas

Temp. (°C)	40%			50%			60%		
Sucrose solution									
	SG_∞ (%)	S_2 (h^{-1})	r^2	SG_∞ (%)	S_2 (h^{-1})	r^2	SG_∞ (%)	S_2 (h^{-1})	r^2
30	5.72	0.39	0.9877	5.54	0.91	0.9832	7.04	0.88	0.9915
40	5.95	0.46	0.9874	5.96	0.99	0.9709	8.47	0.75	0.9694
50	6.65	0.63	0.9867	7.20	0.90	0.9715	9.71	0.73	0.9621
Glucose solution									
	SG_∞ (%)	S_2 (h^{-1})	r^2	SG_∞ (%)	S_2 (h^{-1})	r^2	SG_∞ (%)	S_2 (h^{-1})	r^2
30	8.27	0.27	0.9890	7.18	0.64	0.9886	8.00	0.82	0.9949
40	9.44	0.28	0.9676	8.54	0.65	0.9884	8.36	1.02	0.9895
50	10.26	0.40	0.9611	9.15	0.77	0.9779	10.29	0.91	0.9941
Fructose solution									
	SG_∞ (%)	S_2 (h^{-1})	r^2	SG_∞ (%)	S_2 (h^{-1})	R^2	SG_∞ (%)	S_2 (h^{-1})	r^2
30	9.27	0.38	0.9892	8.74	0.66	0.9958	8.86	0.80	0.9976
40	12.04	0.37	0.9784	11.19	0.56	0.9985	11.98	0.56	0.9964
50	12.75	0.44	0.9795	11.73	0.66	0.9918	12.09	0.73	0.9976

Table (4): Estimated parameters of equation (5) for strawberries

Temp. (°C)	Sucrose solution								
	40%			50%			60%		
	SG (%)	S_2 (h^{-1})	r^2	SG_∞ (%)	S_2 (h^{-1})	R^2	SG_∞ (%)	S_2 (h^{-1})	r^2
30	6.45	0.29	0.9849	7.40	0.30	0.9904	7.24	0.40	0.9834
40	7.63	0.34	0.9943	7.91	0.44	0.9911	7.76	0.62	0.9954
50	7.90	0.58	0.9734	8.19	0.64	0.9870	7.98	0.90	0.9956

Temp. (°C)	Glucose solution								
	40%			50%			60%		
	SG (%)	S_2 (h^{-1})	r^2	SG_∞ (%)	S_2 (h^{-1})	r^2	SG_∞ (%)	S_2 (h^{-1})	r^2
30	6.81	0.35	0.9991	6.78	0.43	0.9848	6.77	0.52	0.9753
40	7.42	0.40	0.9978	7.50	0.52	0.9878	7.69	0.59	0.9921
50	8.24	0.60	0.9863	8.27	0.63	0.9808	8.25	0.78	0.9918

Temp. (°C)	Fructose solution								
	40%			50%			60%		
	SG_∞ (%)	S_2 (h^{-1})	r^2	SG_∞ (%)	S_2 (h^{-1})	r^2	SG_∞ (%)	S_2 (h^{-1})	r^2
30	7.62	0.24	0.9351	6.89	0.33	0.9853	7.60	0.38	0.9772
40	7.84	0.33	0.9813	7.47	0.47	0.9906	8.36	0.53	0.9979
50	8.02	0.42	0.9912	8.25	0.51	0.9904	9.15	0.55	0.9932

SG_∞(%) = Solid gain at equilibrium.
S_2 (h^{-1}) = Rate constant of solid gain.

Tables 3 and 4 represent the solid gain at equilibrium (SG_∞) and rate constant of solid gain (S_2) of bananas and strawberries. The effect of sugar concentration on the equilibrium solid gain was very slightly positive, whereas the effect of temperature was positive. The positive effects of sucrose, glucose and fructose solutions concentration and process temperature on the rate constant of solid gain (S_2) are more pronounced or evident for strawberries than bananas. Azuara *et al.,* (1996) found that the values of SG_∞, S_2 and r^2 for osmotic dehydration of apple disks in 70% sucrose solution at 30°C were 7.93, 0.21 and 0.956 respectively.

CONCLUSIONS

* Low molecular weight solute caused higher water loss and solid gain in osmotically dried bananas and strawberries than high molecular weight solute, while solute concentration had a positive effect on water loss and solid gain.

* During osmotic dehydration in sugar solutions, the amount of water lost is much greater than the amount of sugar gained, showing that the net result is the removal of water by osmosis.

* Regardless of osmosed product and osmotic agent the rate of osmotic agent penetration is the highest at the beginning of the process (in the first 60 minutes) and then falls down rapidly to approach zero after 6 to 7 hours.

* Equations 3 and 5 were able to predict the kinetics of the osmotic process and the equilibrium point using experimental data. The model may be used to characterize osmotic dehydration of different types of foodstuffs, without restrictions of geometric configurations.

* If WL_{∞}, S_1,SG_{∞} and S_2 are known, it is possible to calculate WL and SG at any time of osmotic dehydration.

REFERENCES

Alvarez, C.A.; R. Aguerre; R. Gomez; S. Vidales; S.M. Alzamora and L.N. Gerschenson. (1995). Air dehydration of strawberries: effects of blanching and osmotic pretreatments on the kinetics of moisture transport. Journal of Food Engineering, 25: 167-178.

Azuara, E.; R. Cortes; H.S. Garcia and C.I. Beristain (1992). Kinetic model for osmotic dehydration and its relationship with Fick's second law. International Journal of Food Science and Technology; 27: 409-418.

Azuara, E.; H.S. Garcia and C.I. Beristain. (1996). Effect of the centrifugal force on osmotic dehydration of potatoes and apples. Food Research International, 29 (2): 195-199.

Beristain. C.I.; E. Azuara; R. Cortés and H.S. Garcia. (1990). Mass transfer during osmotic dehydration of pineapple rings. International Journal of Food Science and Technology, 25:576-582.

Conway, J.; F. Castaigne; G. Picard and X. Vovan. (1983). Mass transfer considerations in the osmotic dehydration of apples. Canadian Institute of Food Science and Technology Journal, 16 (1): 25-29.

Garrote, R.L.; E.R. Silva and R.A. Bertone. (1992). Osmotic concentration at 5°C and 25°C of pear and apple cubes and strawberry halves. Lebensmittel Wissenschaft und Technologie, 25: 133-138.

James, G.S. (1995). Analytical chemistry of foods. Blackie Academic and Professional, London and New York, p. 38.

Lazarides, H.N. and N.E. Mavroudis. (1996). Kinetics of osmotic dehydration of a highly shrinking vegetable tissue in a salt-free medium. Journal of Food Engineering, 30:61-74.

Lenart, A. (1992). Mathematical modelling of osmotic dehydration of apple and carrot. Polish Journal of Food and Nutrition Sciences, 1/42 (1):33-44.

Lenart, A. and M. Cerkowniak. (1996). Kinetics of conection drying of osmodehydrated apples. Polish Journal of Food and Nutrition Sciences, 5/46 (2): 73-82.

Lewicki, P.P. and A. Lenart. (1995). Osmotic dehydration of fruits and vegetables. In: Handbook of industrial drying (edited by A.S. Mujumdar). pp. 691-713. New York, Marcel Dekker.

Panagiotou, N.M.; V.T. Karathanos and Z.B. Maroulis. (1998). Mass transfer modelling of the osmotic dehydration of some fruits. International Journal of Food Science and Technology, 33: 267-284.

Panagiotou, N.M.; V.T. Karathanos and Z.B. Maroulis. (1999). Effect of osmotic agent on osmotic dehydration of fruits. Drying Technology, 17 (1/2):175-189.

Pokharkar, S.M. and Prasad. (1998). Mass transfer during osmotic dehydration of banana slices. Journal of Food Science and Technology, India, 35 (4): 336-338.

Rahman, M.S. and C.O. Perera. (1996). Osmotic dehydration: a pretreatment for fruit and vegetables to improve quality and process efficiency. Food Technologist, 25 (4): 144-147.

Ranganna, S. (1986). Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Second edition; pp. 6-7. Tata McGraw- Hill Publishing Company Limited; New Delhi.

Viberg, U.; S. Freuler; V. Gekas and I. Sjoholm. (1998). Osmotic pretreatment of strawberries and shrinkage effects. Journal of Food Engineering, 35: 135-145.

Waliszewski, K.N.; N.I. Texon; M.A. Salgado and M.A. Garcia. (1997). Mass transfer in banana chips during osmotic dehydration. Drying Technology, 15 (10): 2597-2607.

نموذج رياضى للتنبؤ بحركيات عملية تجفيف الموز والفراوله باستخدام المحاليل الاسموزية

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يهدف هذا البحث الى دراسة تأثير درجة حرارة التجفيف (٣٠°، ٤٠°، ٥٠°م) باستخدام المحاليل الاسموزية (السكروز، الجلوكوز، الفركتوز) بتركيزات ٤٠%، ٥٠%، ٦٠% على كل من الموز والفراوله، حيث تم حساب كمية الرطوبة المنتشرة من المادة الغذائية الى المحلول السكرى وكذلك المحتوى من المواد الصلبة المنتشرة من المحلول السكرى الى المادة الغذائية.

اوضحت النتائج المتحصل عليها ان كلا من كمية الرطوبة المفقودة وكذلك كمية المواد الصلبة المكتسبة تزداد بزيادة درجة الحرارة وتركيز المحلول السكرى ووقت التجفيف الاسموزى. وقد كانت قيم كمية الرطوبة المنتشرة وكمية المواد الصلبة المكتسبة اعلى فى حالة استخدام محاليل الجلوكوز والفركتوز مقارنة بالتجفيف باستخدام محاليل السكروز. فعند استخدام ٦٠% محلول فركتوز على درجة حرارة ٥٠°م على سبيل المثال، فى تجفيف الموز والفراوله كانت قيم كمية الرطوبة المفقودة بعد ٦ ساعات ٤٠,٩%، ٤٠,٧% على التوالى، بينما كانت القيم المتحصل عليها عند استخدام ٦٠% محلول سكروز على درجة حرارة ٥٠°م ٣٦,٩٥%، ٤٠,٠٢% على التوالى. ولقد لوحظ نفس السلوك بالنسبة لقيم كمية المواد الصلبة المكتسبة حيث سجلت ٩,٨٥%، ٧,٠٥% باستخدام محلول الفركتوز، ٨,٤٤%، ٦,٨٧% باستخدام محلول السكروز تحت نفس الظروف السابقة من التركيز ودرجة الحرارة.

وتم استخدام معادلة رياضية ذات ثابتين او معاملين للتنبؤ بحركيات عملية التجفيف باستخدام المحاليل السكرية الاسموزية لمعرفة كل من كمية الرطوبة المنتشرة وكمية المواد الصلبة المنتشرة عند الاتزان وكذلك المعدل الثابت لكل منهم. واظهرت الدراسة ان هناك ارتباط قوى وعالى باستخدام النتائج المتحصل عليها معمليا لكل من الموز والفراوله.

من هذه النتائج المتحصل عليها تتضح اهمية دراسة حركيات عملية التجفيف باستخدام المحاليل الاسموزية المختلفة للحصول على الثوابت او المعاملات التى يمكن الاستفادة منها فى التنبؤ او حساب كمية الرطوبة المنتشرة من المادة الغذائية الى المحلول وكذلك كمية المواد الصلبة المنتشرة من المحلول الى المادة الغذائية عند اى وقت من زمن التجفيف الاسموزى.