Studies on Osmotic Dehydration of Sapota (Achras Sapota L.)

Miss Vaishali Wankhade[1],
[1]Department of Agricultural Engineering
Maharashtra Institute of Technology
Aurangabad-431010(M.S) India

Miss Sonali Wankhade[2]
[2]Department of Horticulture
Dr. PDKV, Akola
Akola (M.S.) India 444104

Mrs. Bhagyashree Patil[3]
[3]Department of Agricultural process engineering
Dr. PDKV , Akola
Akola (M.S.) India 444104

Abstract **- The present study was carried out in the Department of Agril. Process Engineering to investigate the effect of osmotic dehydration parameters on waterloss and solid gain of sapota. Fresh sapota were osmotically dehydrated using syrup concentration (40, 50 and 60 ºB), syrup temperature (40, 50 and 60 ºC) and duration (120, 180 and 240 min). Fruit to syrup ratio (1:5) was constant for all experiments. The response variables tested were water loss and sugar gain. The result obtained showed that the minimum and maximum water loss after osmotic dehydration was 24.20 and 35.97% respectively, corresponding to low levels (40 ºB, 40 ºC after 4 h) and high levels (60 ºB, 60 ºC after 4 h) of syrup concentration and temperature. The water loss was increased from 0 to 24.20, 0 to 25.13 and 0 to 26.86% when duration of osmotic dehydration increased from 0 to 4 h for 40 ºB concentration at 40, 50 and 60 ºC syrup temperatures respectively. Similarly for 50 and 60 ºB concentrations, it varied from 0 to 27.41, 0 to 31.03, 0 to 32.07 and 0 to 31.73, 0 to 34.41, 0 to 35.97 % for 30, 40 and 50ºC syrup temperatures, respectively**

The result obtained showed that the sugar gain was increased from 0 to 6.44, 0 to 7.51 and 0 to 8.20% when duration of osmotic dehydration increased from 0 to 4 h for 40 ºB concentration at 40, 50 and 60 ºC syrup temperatures, respectively. Similarly for 50 and 60 ºB concentrations, the sugar gain was found to vary from 0 to 7.51, 0 to 8.25, 0 to 9.69 and 0 to 9.45, 0 to 10.87 and 0 to 11.95% for 40, 50 and 60ºC syrup temperatures, respectively

Keywords: Sapota Fruit, Osmotic Dehydration, Waterloss And Solid Gain

1. INTRODUCTION

Sapota (*Achras sapota* L.) commonly known as chiku is mainly cultivated in India for its fruit value, while in South-East Mexico, Guatemala and other countries it is commercially grown for the production of chickle which is a gum like substance obtained from latex and is mainly used for preparation of chewing gum.

Sapota contains fiber hence the sapota powder can be consumed as a fiber supplement for children as well as adults. The sapota fruit contains carotene, which is known as antioxidant and it can be consumed for its laxative property. Thus sapota powder can be considered as a complete food rich in vitamins, carbohydrates, fibers and proteins.

Osmotic dehydration is one of the methods of moisture removal where the product is dried by concentration difference or by use of osmotic pressure difference. When two solutions of different concentrations are separated by a semi permeable membrane there is a tendency to establish uniform osmotic pressure throughout the system, the solute molecules being large in size cannot pass through the membrane. Hence, the solvent molecules pass through the membrane from dilute to concentrated solution until a uniform osmotic pressure is established throughout the system. [3] The rate of osmosis, being proportional to the difference of osmotic pressure, is maximum at the beginning and slowly decreases. About 50% reduction in weight is found to occur within 3 h at 45 to 48 °C temperature in most fruits. [1]

Sapota fruit is highly perishable and also sensitive to cold storage. Therefore, bulk of the produce is used for table purpose and is handled at ambient condition causing considerable post-harvest losses. Due to mishandling of produce about 25 to 40% is being wasted [6]. Commercial processing is negligible due to the sensitivity of the fruit to heat (changing the flavour and colour of the pulp), high labour requirement in peeling, removal of seeds etc. Nowadays dry segments and flakes of the fruit are being processed but to a limited extent. Processed food items *viz.* jam, jelly, squashes and fruit drinks are produced from sapota after blending it with other fruits. It is essential to produce value added products based on sapota, so that farmers can get an assured price for their produce all the times. Creation of essential infrastructure for preservation, cold storage, refrigerated transportation, rapid transit, grading, processing, packaging and quality control are important aspects which need attention to give a high quality commercial production. The development of a simple osmotic dehydration process for fruits necessitates the study of the osmotic kinetics and air drying behaviour of osmotically dehydrated products.

Objectives of the present investigation were to study the osmotic behaviour of sapota fruit and to study the effect of osmosis on waterloss and sugargain of sapota fruit.

2. MATERIALS AND METHODS

Selection of Fruit

The ripened sapota fruits (cv.Cricketball) were selected for study. The fresh fruits were purchased from Department of Horticulture Dr. PDKV, Akola for conducting the experiments. Fruits were selected according to size, ripeness, colour and freshness

Sample and Solution Preparation

The fruits were thoroughly washed under tap water to remove adhering impurities, then carefully peeled by using a stainless steel knife and cut it into thin size slices. Sugar was used as an 'osmotic agent'. The syrup were prepared by dissolving required amount of sugar in distilled water. The fruit to syrup ratio 1:5 was kept as constant treatment.

Osmotic Dehydration of Sapota Fruit

In the process of osmotic dehydration, a sample placed in the hypertonic solution and due to concentration difference water comes out from the sample to solution. Simultaneously transport of solids takes place from the solution to sample and vice versa. The mass transport in terms of water loss, mass reduction and solid gain were studied as explained below.

Mass transport data for osmotic dehydration

Mass transport data during osmotic concentration was calculated as explained below [5][4]

Water loss (WL)

The waterloss was calculated as the net loss of water from food material on an initial mass basis as:

$$WL = \frac{W_{si} X_{swi} - W_{s\theta} X_{sw\theta}}{W_{si}} \times 100$$

Mass reduction (WR)

The mass reduction was calculated as the net mass reduction of the food material on initial mass basis as:

$$WR = \frac{W_{si} - W_{s\theta}}{W_{si}} \times 100$$

Solid gain (SG)

The solid gain was calculated as a net uptake of solids by the food material on an initial mass basis as:

$$SG = \frac{W_{s\theta}(1 - X_{sw\theta}) - W_{si}(1 - X_{swi})}{W_{si}} \times 100$$

3. RESULTS AND DISCUSSION

Osmotic Dehydration of Sapota Slices

The experiments on the osmotic dehydration were conducted in order to study its kinetics.

Where, WL = water loss (g water per 100 g initial mass of sample)

WR = mass reduction (g mass per 100 g initial mass of sample)

SG = solid gain (g solids per 100 g initial mass of sample)

W_{si} = initial mass of sample, g

$W_{s\theta}$ = mass of the sample after time θ, g

X_{swi} = water content as a fraction of the initial mass of the Sample and,

$X_{sw\theta}$ = water content as a fraction of the syrup at time θ.

Experimental setup

A small capacity laboratory temperature controlled water bath of size 68 x 31 x 35 cm (approximate capacity, 10 litres) was used as osmotic dehydration unit. The temperature controller was used to regulate the required temperature in the investigation

Process variables

The following independent and dependant process parameters were considered in the present study.

A. *Process parameters (Independent variables)*

1. Temperature, °C : 3 levels (40, 50 and 60)
2. Sugar syrup concentration, °B : 3 levels (40, 50 and 60)
3. Duration of osmosis, min : 3 levels (120, 180 and 240)
4. Ratio of concentration : 1:5 (Fruit to syrup)

B. *Response parameters (Dependent variables)*

1. Water loss
2. **Solid gain**

Experimental setup of osmotic dehydration process

The mass loss, water loss and sugar gain were observed in the range of 8.58 to 24.02, 11.35 to 35.97 and 2.77 to 11.95%, respectively, for 4 h duration of osmosis for various concentration and temperature ranges of the syrup.

Water loss

The initial moisture content of sapota fruit varied from 67.24 to 73.25% (wb). The kinetics of osmotic dehydration are shown in Figs. 1 and 2 giving the variation in water loss at various concentrations and temperatures of syrup. The water loss from test samples under selected process parameters are shown in different curves, indicating relatively smooth progression of drying despite the fact that almost all data points came from independent test runs. The water loss was different for different conditions of syrup temperatures and concentrations.

The result obtained showed that the minimum and maximum water loss after osmotic dehydration was 24.20 and 35.97% respectively, corresponding to low levels (40 ºB, 40 ºC after 4 h) and high levels (60 ºB, 60 ºC after 4 h) of syrup concentration and temperature. The water loss was increased from 0 to 24.20, 0 to 25.13 and 0 to 26.86% when duration of osmotic dehydration increased from 0 to 4 h for 40 ºB concentration at 40, 50 and 60 ºC syrup temperatures respectively. Similarly for 50 and 60 ºB concentrations, it varied from 0 to 27.41, 0 to 31.03, 0 to 32.07 and 0 to 31.73, 0 to 34.41, 0 to 35.97 % for 30, 40 and 50ºC syrup temperatures, respectively

It can be observed that when syrup temperature was increased from 40 to 50 ºC for 60 ºB syrup concentration, water loss increased from 31.73 to 34.4% after 4 h of osmotic dehydration causing approximately 2.98% point increase and on further increase in syrup temperature to 60 ºC, the water loss was observed to be 35.97 % (1.56% point increment). For 50 ºB syrup concentration, the water loss increased from 27.41 to 31.03% (3.62% point increment) when syrup temperature increased from 40 to 50 ºC, and on further increase in syrup temperature from 50 to 60 ºC, the water loss was increased to 32.07% (1.04% point increment). The similar results were obtained for 40 ºB syrup concentration also with the corresponding increase of 0.93% point when syrup temperature was increased from 40 to 50 ºC and 1.73% point when temperature was increased from 50 to 60 ºC

The Inference can now be drawn that a low temperature-low concentration condition (40 ºC and 40 ºB) gives a low water loss (24.20% after 4 h of osmosis) and a high temperature-high concentration conditions (60 ºC and 60 ºB) gives a higher water loss (35.97% after 4 h of osmosis). The low temperature–high concentration condition 40 ºC and 60 ºB gives a slightly higher water loss of 31.73% after 4 h of osmosis than high temperature-low concentration condition 60 ºC and 40 ºB (26.86% after 4 h of osmosis) indicating a pronounced effect of concentration on water loss .This indicates that water loss can be increased by increasing either the syrup concentration or temperature of solution. However, an increase in concentration of sugar solution has more influence on water loss than an increase in temperature

The water loss at any concentration was affected by the temperature of the syrup and increased with increase in syrup temperature. This may be due to changes in semi-permeability of the cell membrane of the fruit, allowing more water to diffuse out in a shorter period.[9][2] Increase in water loss with increase in syrup concentration may be due to increased osmotic pressure in the syrup at higher concentrations, which increased the driving force available for water transport.[8]

Sugar gain

The variations in sugar gain at various concentrations and temperatures of syrup are shown in Fig.3 and 4 Similar to water loss, the sugar gain also indicates relatively smooth progression of various curves despite the fact that almost all data points came from independent test runs. It can be seen that sugar gain increased with duration of osmosis and did not approach the equilibrium even after 4 h of osmotic dehydration.

The result obtained showed that the sugar gain was increased from 0 to 6.44, 0 to 7.51 and 0 to 8.20% when duration of osmotic dehydration increased from 0 to 4 h for 40oB concentration at 40, 50 and 60 ºC syrup temperatures, respectively. Similarly for 50 and 60 ºB concentrations, the sugar gain was found to vary from 0 to 7.51, 0 to 8.25, 0 to 9.69 and 0 to 9.45, 0 to 10.87 and 0 to 11.95% for 40, 50 and 60ºC syrup temperatures, respectively.

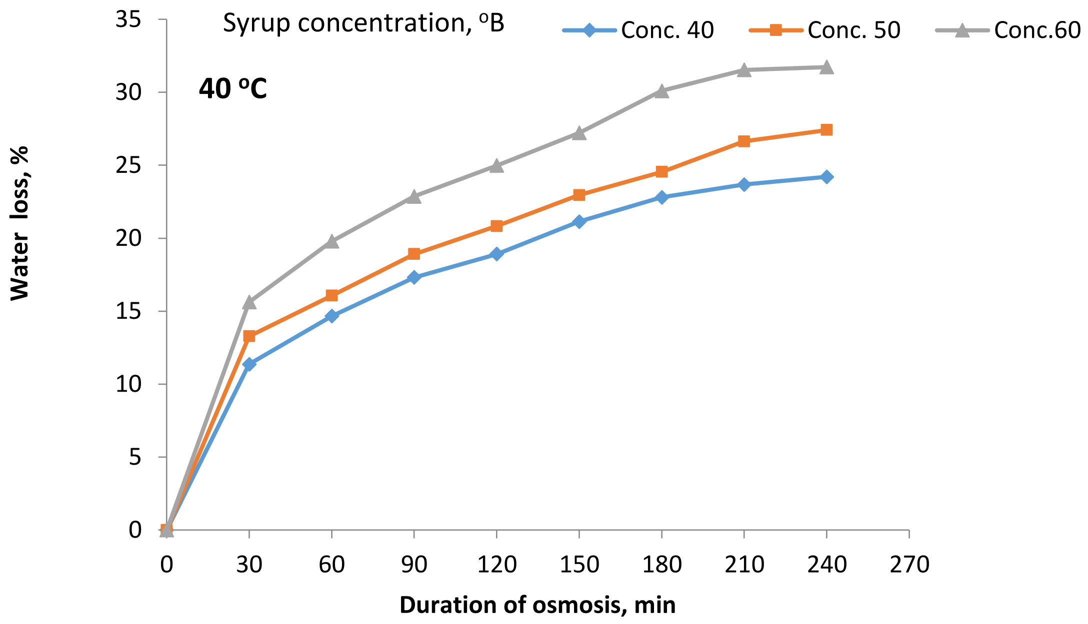
It can be observed from the data that when syrup temperature is increased from 40 to 50 ºC for 60 ºB concentration, sugar gain increased from 9.45 to 10.87% causing 1.42% point increase after 4 h of osmosis. However, for further increase in syrup temperature to 60 ºC, the sugar gain was 11.95% (1.08% point increase) in the same period of osmosis. Similarly for 50 ºB syrup concentration, the sugar gain increased from 7.51 to 8.25% (0.74% point increment) when syrup temperature was increased from 40 to 50 ºC, while it increased to 9.69% (1.44% point increase) with further increase in syrup temperature from 50 to 60 ºC. However for 40 ºB syrup concentration the increase in sugar gain was 1.07% point and 0.69% point, when the syrup temperature was increased from 40 to 50 ºC and 50 to 60 ºC respectively

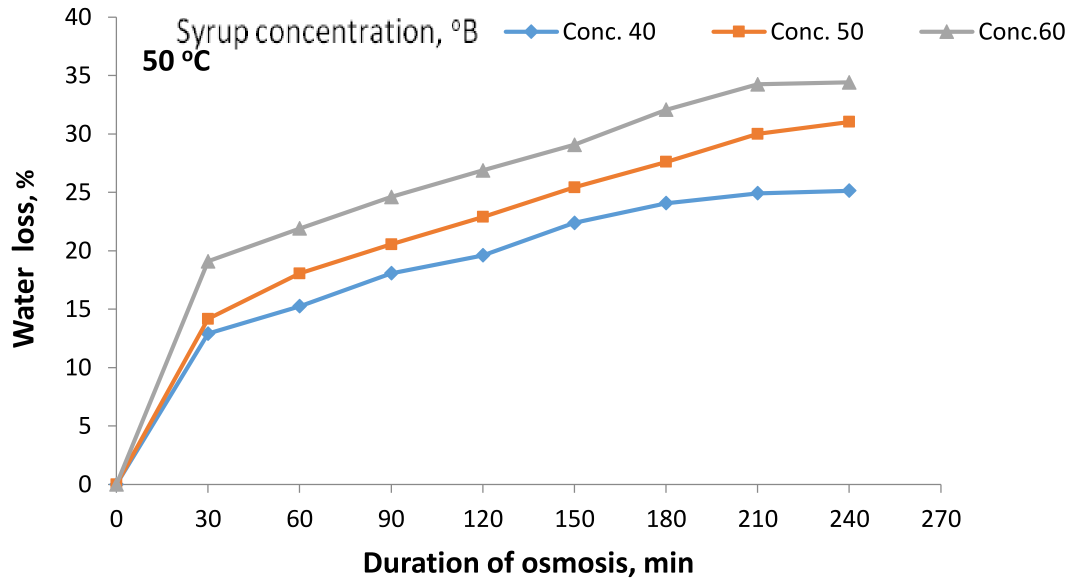
The increase in sugar gain with the concentration of the syrup may be because of the increased concentration difference between fruits and syrup.The increased sugar gain with increase in syrup temperature might be due to the collapse of the cell membrane at higher temperatures. [7][2] Fig.4 also shows that a low temperature-low concentration condition (40 ºC and 40 ºB) gives a low sugar gain (6.44% after 4 h of osmosis) and a high temperature-high concentration conditions (60 ºC and 60 ºB) gives a higher sugar gain (11.95% after 4 h of osmosis). The low temperature–high concentration condition 40 ºC and 60 ºB gives a higher sugar gain of 9.45 % after 4 h of osmosis than high temperature low concentration i.e.60ºC and 40ºB (8.20% after 4 h of osmosis) indicating a slightly better effect of concentration on sugar gain. This indicates that sugar gain can be increased by increasing either the syrup concentration or temperature of solution. However, an increase in concentration of sugar solution has more influence on sugar gain than an increase in temperature in the study range

4. CONCLUSIONS

Following conclusions were drown from the investigation of effects of osmotic dehydration on waterloss and solid gain of sapota

1. Minimum and maximum waterloss after osmotic dehydration was 24.20 and 35.97% respectively.
2. Minimum and maximum sugargain after osmotic dehydration was 2.77 to 11.85% respectively
3. Low temperature low concentration condition gives low waterloss and sugar gain while high temperature and high concentration condition gives high waterloss and sugar gain respectively
4. Waterloss and solid gain were increased with increase in both concentration and temperature
5. Increase in concentration has more influence on waterloss and sugar gain than an increase in temperature





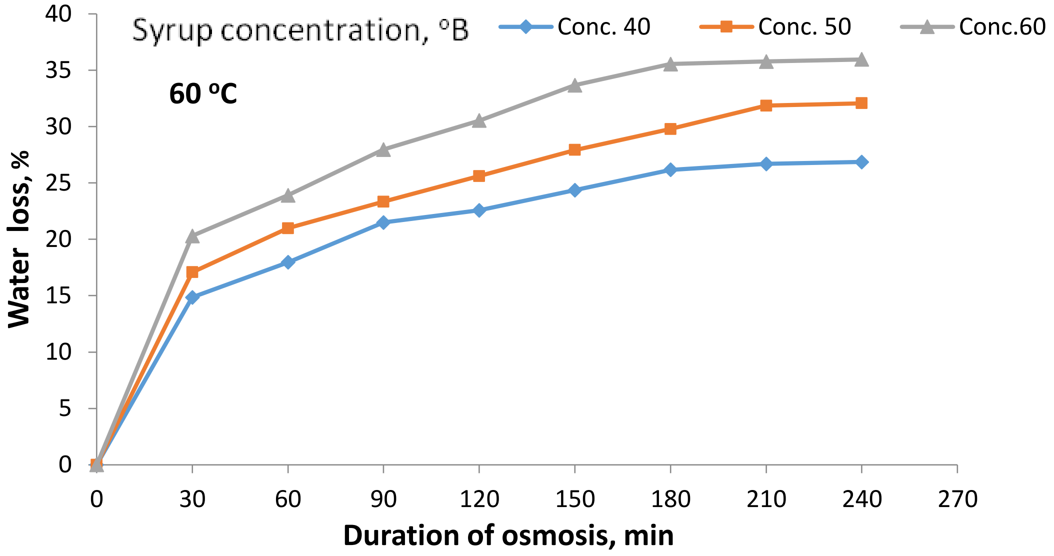
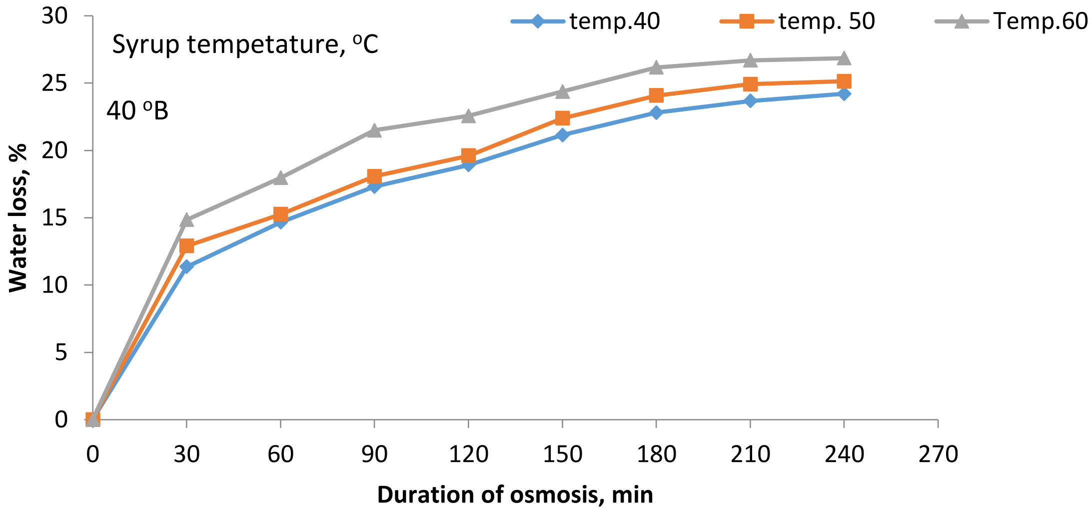
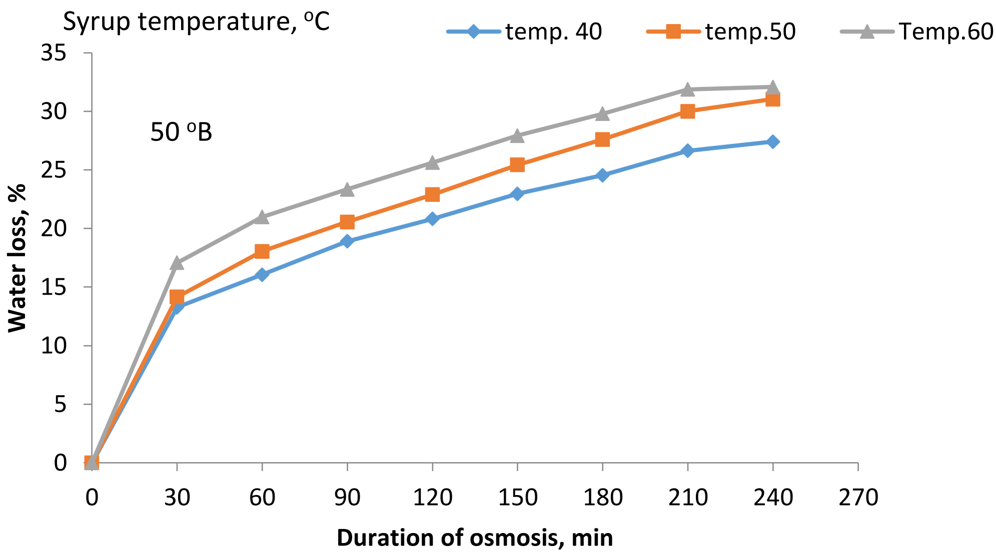


Fig. 1 Variation in Water loss with respect to concentration at various temperatures





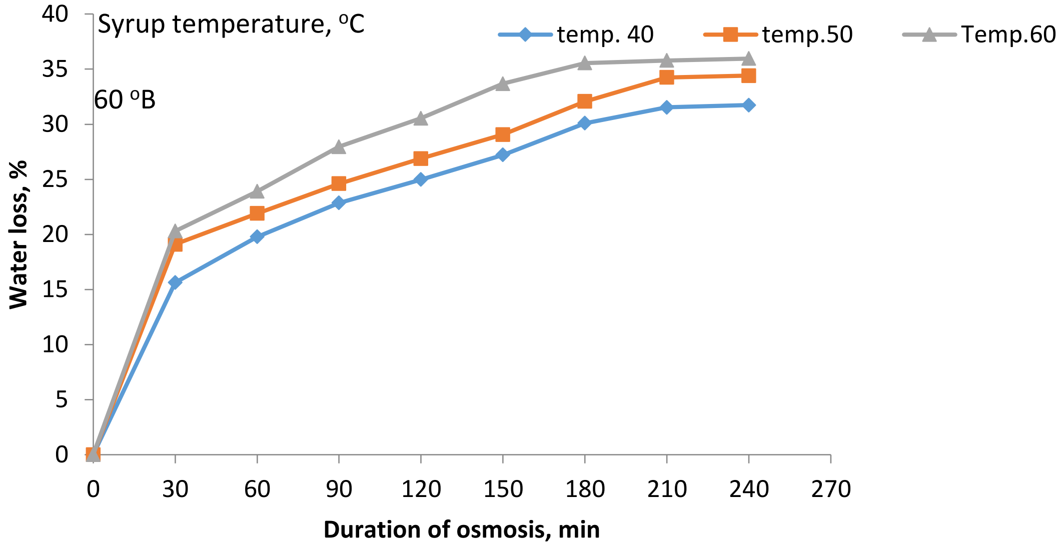
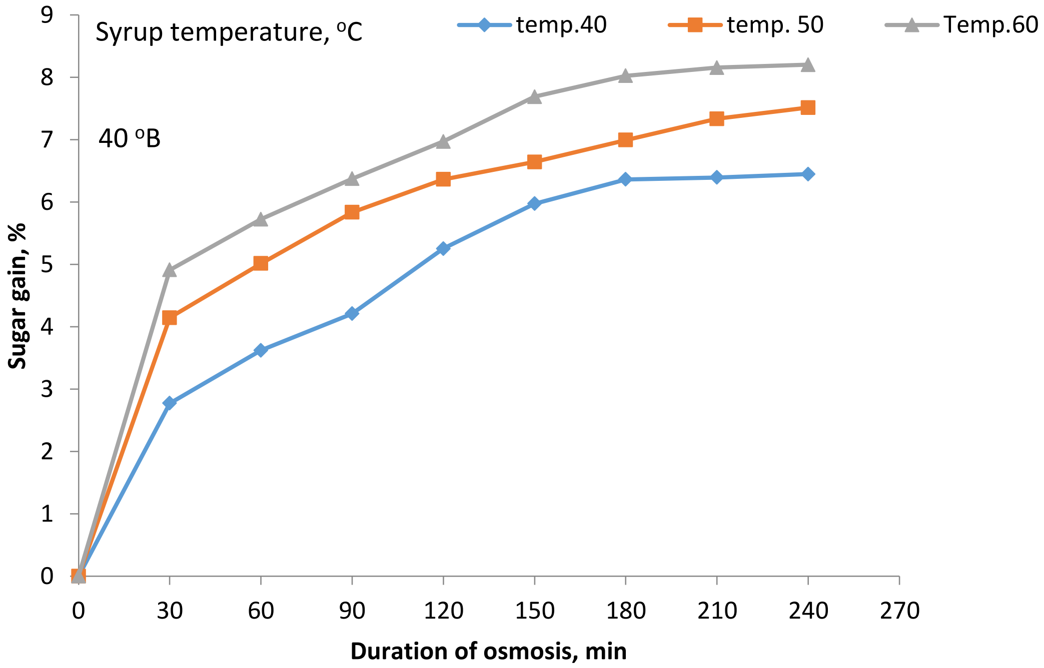


Fig. 2 Variation in water loss with respect to temperature at various concentrations



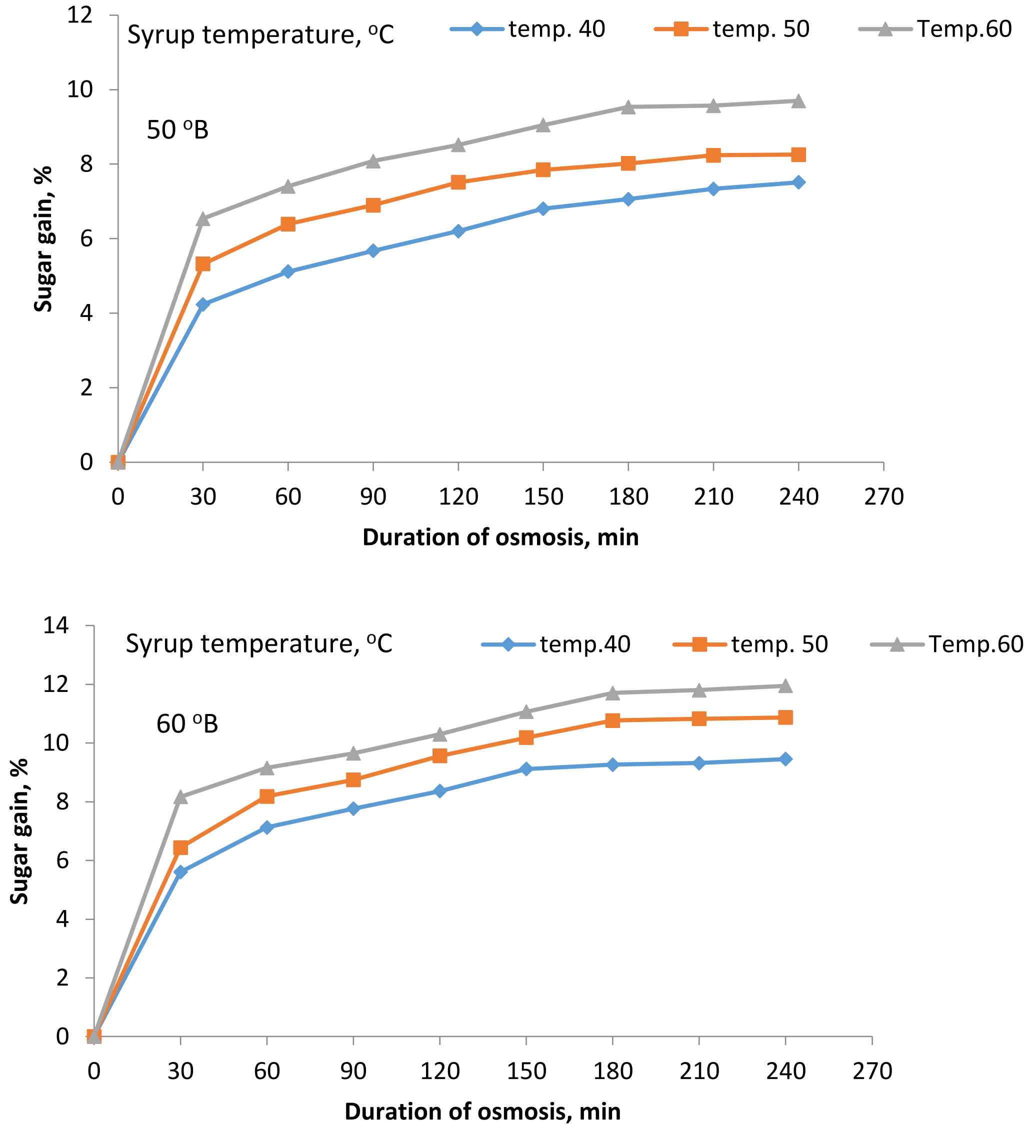
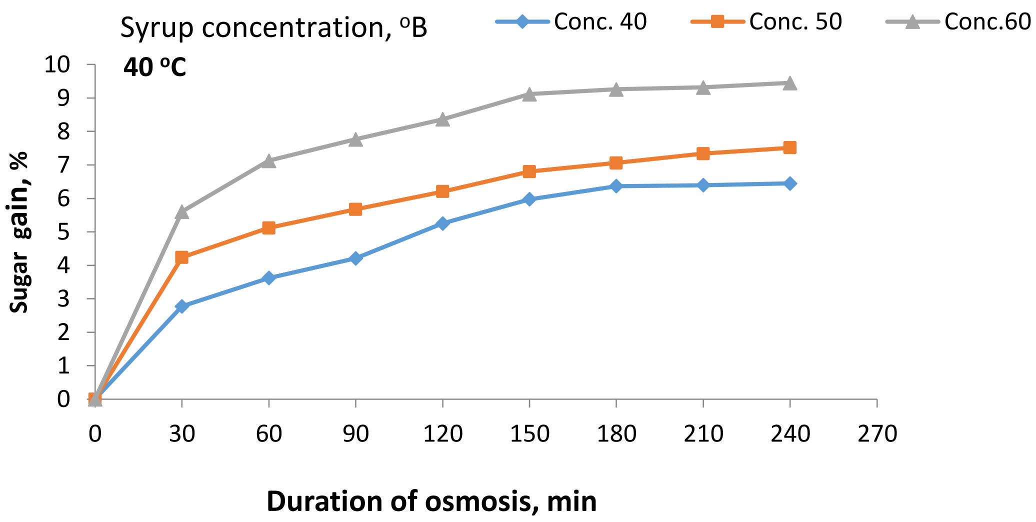


Fig. 3 Variation in sugar gain with respect to syrup temperature at various concentrations



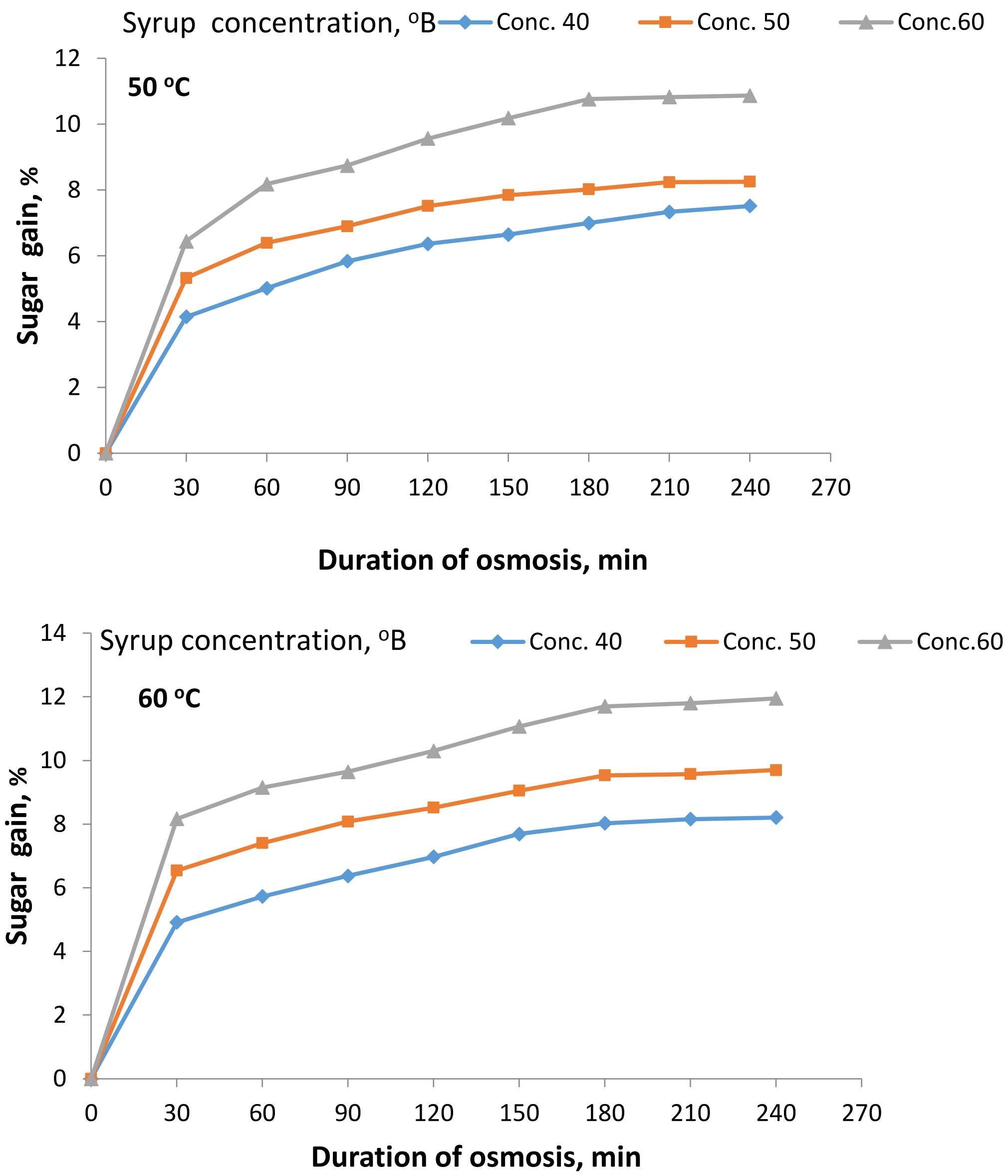


Fig. 4 Variation in sugar gain with respect to concentration at various temperatures

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