Mass transfer of pear slices in different osmotic solutions

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ABSTRACT *The influence of osmotic solutions viz glycerol, glucose and sucrose (60%) on mass transfer parameters of pear slices was studied. The pear slices were immersed in osmotic solutions for 18 hrs at 22±2°C. Higher solute gain, weight reduction, and water loss was recorded in pear slices from Bartlett variety. Pear slices treated with glycerol had a greater effect on mass transfer parameters than samples treated with glucose and sucrose. The effect of variety, pretreatments was found to be statistically significant (p<0.05).*

Introduction

Fruit drying is a well-known preservation technique, specifically because water removal and water activity lowering lessen the risk of microbial development. It involves simultaneous heat and mass transfer, particularly under transient conditions. [17, 15]. Pears after harvest deteriorate quickly due to microbial and biochemical activities. However, different techniques are used to extend their shelf life [5].

Osmodehydration is far a beneficial method for the concentration of fruit and vegetables, realized by placing the solid food, complete or in portions, in aqueous solutions of sugars or salts of excessive osmotic pressure. It gives rise to two major simultaneous counter current flows: an important water flow out of the food into the solution and a simultaneous transfer of solute from the solution into the food, that both occur due to the water and solute activity gradients across the cell's membrane [13, 17].

In addition osmotic dehydration is effective at ambient temperature with minimal damaging effect on food quality, achieving product stability, retention of nutrients and improvement of food flavour and texture. Mass transfer during osmosis depends on operating variables such as concentration and solute type of the dehydration solution. Therefore, the solute molecular weight can be a determinant factor influencing solute uptake during osmosis [13, 14]. The aim of the present study was to study the influence of osmotic pretreatments on mass transfer parameters of the pear slices.

Material and methods

Two varieties of pear (Wikar of winkfield and Bartlett) were selected for study. Fruits were sorted, washed & peeled manually. Both the varieties were sliced to 10mm thickness and immersed in glucose, sucrose and glycerol solutions for 18 hrs at 22±2°C. The concentration of all the three solutions were 60%.

Pretreatments:

T_1: control (plain water)
T_2:60% Glucose + 0.5 % Ascorbic acid
T_3:60% Glucose + 0.25 % KMS +0.25% Ascorbic acid
T_4:60% Glucose + 0.5% KMS
T_5:60% sucrose + 0.5% Ascorbic acid
T_6:60% sucrose + 0.25 % KMS +0.25% Ascorbic acid
T_7:60% sucrose + 0.5% KMS
T_8:60% Glycerol + 0.5% Ascorbic acid
T_9:60% Glycerol + 0.25 % KMS +0.25% Ascorbic acid
T_{10}:60% Glycerol + 0.5% KMS

Where as KMS is potassium metabisulphite.

Mass transfer parameters that represent the amount of water removed from the fruit and solutes gained by fruit from surrounding syrup characterized as solute gain, water loss and weight reduction were calculated using below equations [8].

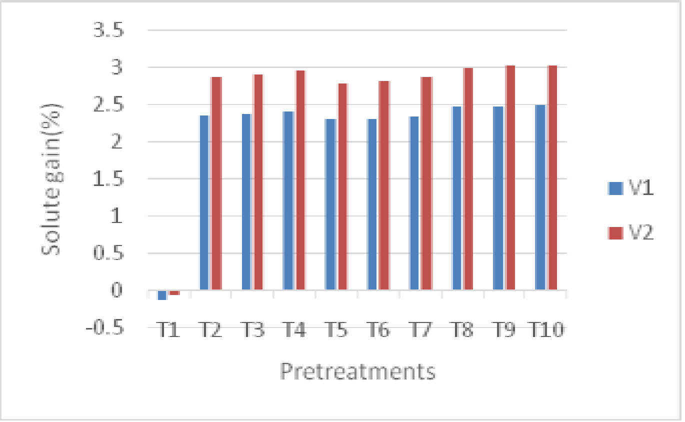
$SG= (S-S_0)/W_0$
$WR= (W_0-W)/W_0$
$WL= WR+ SG$

Whereas S_0 and S are initial and final sample dry matter,
W_0 and W are initial and final sample weights,

And SG, WL and WR are solute gain, Water loss and Weight reduction.

Results and discussion

Solute gain



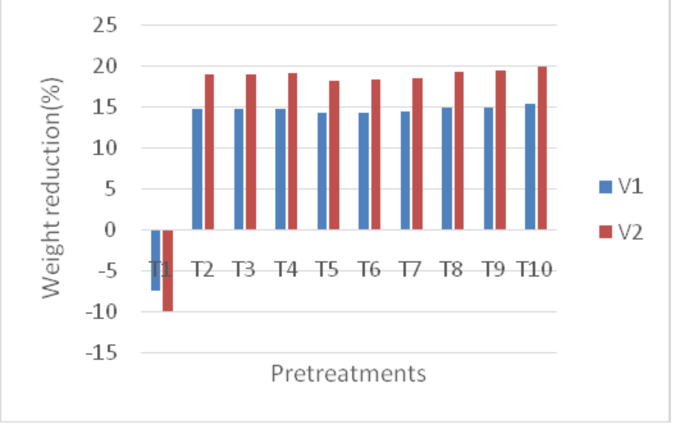
V_1: Wikar of winkfield; V_2: Bartlett

Fig.1. Effect of osmotic pretreatments on solute gain(%) of pear slices

Data from Fig.1 reveals that all the pretreatments exhibited significant influence ($P<0.05$) on solute gain of pear slices. Maximum solute gain (3.04%)was recorded for treatment T_{10} from variety V_2 (Bartlett) and the lowest (-0.06%) for treatment T_1 from the same variety. The effect of variety as well as the interaction between variety and treatments was found to be stastistically significant($P<0.05$).

Numerous workers reported that, the raw material characteristics such as variety and maturity of fruits control the solid gain in osmotic process [17]. The solute gain was found maximum in slices from both the varieties when pretreated with glycerol (T_{10}) compared to the slices pretreated with glucose and sucrose. This is because of the low molecular mass of glycerol that favours the solid uptake due to high velocity of penetration of the molecules [7]. The results were in agreement with Bernardi et al [4] who reported higher sugar gain in mango sticks treated with inverted sugar. The higher concentration of solutes resulted in an increase in the osmotic pressure gradients and, hence, higher solid uptake. Similar results were reported by Azoubel and Murr [3] which indicate that by choosing a higher concentration medium (60%), a much greater gain of solids can be observed.

Weight reduction



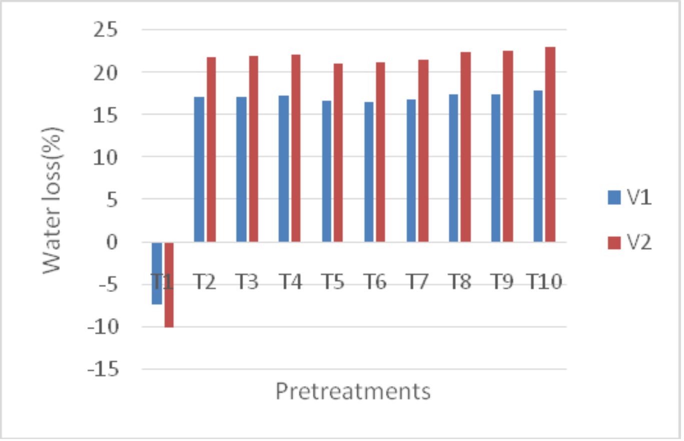
V_1: Wikar of winkfield; V_2: Bartlett

Fig.2. Effect of osmotic pretreatments on weight reduction (%) of pear slices

Results from Fig. 2 indicates weight reduction of fresh Pear slices in all the pretreatments except control. Significant differences ($P<0.05$) were found in weight reduction of osmotreated pear slices as influenced by varieties, treatments and the interaction between varieties and treatment. Highest weight reduction (20.0%) was recorded in treatment T_{10} from variety V_2 (Bartlett) whereas lowest (-7.40%) in treatment T_1 from variety V_1 (Wikar of winkfield).

Maximum effect on weight reduction was observed when the pear slices were treated with glycerol. Similar results were reported by Panda et al. [10] in osmodried grapes. Variation in weight reduction during osmotic dehydration among the varieties of apricot was observed by Sharma et al. [16]. The findings are also in conformity with observations made by other workers in case of mango [18], banana, apple and kiwi fruit [9], pineapple [11]. Variation in the weight reduction in the two varieties may be due to their different structure, compactness of tissues, size of contact surface between fruit and the syrup and also other intrinsic properties of these fruits [6]. The weight reduction was negative for treatment T_1 as the pear slices were placed in plain water. Osmosis occurred resulting in movement of solvent from a lesser concentrated solution to more concentrated one. This increased the weight of the pear slices. The difference between the initial and final weight thus gave the negative values. The results are in accordance with the Rai et al. [12] in osmodehydration of pineapple slices.

Water loss



V$_1$: Wikar of winkfield; V$_2$: Bartlett

Fig. 3. Effect of osmotic pretreatments on water loss (%) of pear slices

Data from Fig. 3 depicts that all the pretreatments resulted in increase in water loss except control. The effect of pretreatments was statistically significant with respect to varieties. The interaction between variety and treatment was also statistically significant ($p<0.05$). Higher water loss (23.04 %) was observed in treatment T_{10} from variety V_2 (Bartlett) and lowest (-7.27%) in treatment T_1 from variety V_1(Wikar of winkfield).

The water loss was found quite higher than solute gain in all the treatments. The results are in agreement with the Alam et al. [1] who recorded the higher water loss in summer onion when subjected to osmo dehydration using sucrose, salt and combined sucrose-salt solution as pretreatments. At high concentration of osmotic solution the osmotic pressure gradients increase resulting in higher water loss. Similar results were reported by Azoubel and Murr [3] in osmodehydration of cherry tomato. The rate of diffusion of solute and water exchange with osmotic solution is accelerated at higher solution concentration which leads to high concentration difference among the pear slices and osmotic solution, consequently increasing the water loss. The higher water loss in treatment T_{10} may be due to lower molecular weight of glycerol which penetrates deeper resulting in gain of solids and higher water loss. Similar results were observed by Anitha and Tiwari [2] in guava. Water loss was negative for treatment T_1 due to the negative values for solute gain and weight reduction.

Conclusion

It was concluded that the osmotic dehydration is an effective process for preservation of fruits. The pear slices treated with glycerol had a higher impact on solute gain, weight reduction, waterloss and moisture content than the samples treated with glucose and sucrose irrespective of the varieties. The osmosed slices prepared from Bartlett variety recorded higher solute gain, weight reduction, waterloss and lower moisture content compared to wikar of winkfield. Further research is needed to investigate the different osmotic agents that affect the mass transfer during osmotic dehydration process in fruits.

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