Journal of Fruit and Ornamental Plant Research Vol. 17/(2) 2009: 107-113

OSMOTIC DEHYDRATION OF PUMPKIN IN STARCH SYRUP

Agata Pękosławska and Andrzej Lenart

Warsaw University of Life Sciences, Faculty of Food Sciences
Department of Food Engineering and Process Management
Nowoursynowska 159 C, 02-776 Warsaw, POLAND
e-mail: agata_pekoslawska@sggw.pl

(Received July 28, 2009/Accepted October 16, 2009)

A B S T R A C T

Osmotic dehydration of pumpkin could be a useful technique to obtain new processed products of interest to the consumer. The aim of this work was to analyze the effect of concentration of starch syrup solutions, and temperature, on osmotic dehydration of pumpkin cubes. The process was carried out in a water bath for 60, 180 and 300 min. The most significant changes of water content, water loss and solid gain took place during osmotic dehydration in 66.3% starch syrup at a temperature of 60°C. Water activity of osmotically dehydrated pumpkin decreased at higher starch syrup concentrations, and at higher temperatures.

Key words: osmotic dehydration, pumpkin, starch syrup

INTRODUCTION

Pumpkin originated in the Americas. It is a member of the family *Cucurbitaceae*, a wide family that includes other fruits such as melon, watermelon and cucumber (Goncalves et al., 2007; Mayor et al., 2008). In Central European countries, pumpkins belonged to *Cucurbita pepo* L. (also called 'squash'), *Cucurbita maxima* Duch. (called 'winter squash') and *Cucurbita moschata* Duch. ex Poir species are mostly grown. In Poland, two pumpkin species are grown and harvested to the phase of physiological maturity: *Cucurbita maxima* and *Cucurbita pepo* (Gajewski et al., 2008; Zawirska et al., 2009). Pumpkin fruits are consumed both immature and ripe. The flesh of the fruit can be boiled, canned, dried and pickled or processed to obtain juice and pomace. (Goncalves et al., 2007; Zawirska et al., 2009). Pumpkin is a very important food as part of a diet and it is also considered medicinal and therapeutic (Krzysik and Bogucka 1981; Senderski 2004). It is a valuable source of carotenoids and vitamins, e.g. C, E, B_6, as well as minerals, e.g. potassium, phosphorus, magnesium, iron and selenium (Niewczas et al., 2005; Zawirska et al., 2009).

Pumpkin is a seasonal crop which shelf-life needs to be extended. The use of an osmotic process can be an interesting tool in the production of new processed products of interest to the consumer based on fresh pumpkin fruits (Mayor et al., 2008). Vegetable dehydration by immersion in osmotic solutions has been arousing interest during the last few decades. It can improve food quality (reduce heat damage and minimize their colour and flavour changes) when combined with air, freeze or vacuum drying or other preservation techniques such as freezing. The process involves removal of water by immersing the material in concentrated solutions; mainly of sugar, salt or spices (Sablani and Rahman, 2003). The difference of chemical potential between components in the solution and the material leads to mass transfer. This mass transfer involves water transfer from the material to the solutions, uptake of solutes from solution into dehydrated material and leaching of low molecular mass compounds, minerals, vitamins, colorants from the material to the osmotic medium (Sablani and Rahman, 2003; Mayor et al., 2006). Dewatering degree of the material and changes in its chemical composition depend on many factors mainly: type of osmotic solution, its concentration and temperature, immersion time, type and size of the material (Rastogi et al., 2002; Kowalska and Lenart, 2003). It is important to describe the influence of these factors on the properties of the final product. A few studies have been carried out on the process of osmotic dehydration of pumpkin (Mayor et al., 2006; Kowalska et al., 2008; Zawirska et al., 2009). The aim of this work was to analyze the effect of starch syrup concentration and temperature on osmotic dehydration of pumpkin.

MATERIAL AND METHODS

The fruits of a new registered pumpkin cv. 'Justynka F1' were used in this investigation. Plants were grown in the experimental field of Warsaw Agricultural University. Fruits after harvest were stored at 8°C and 80% relative humidity. Water content of pumpkin was 86.4% (±3%).

Before each experiment, the raw material was washed and peeled, and the seeds were removed. Then the pumpkin flesh was cut to 10 mm cubes. Osmotic dehydration was carried out in water solutions of starch syrup (glucose equivalent DE 32.2, JAR, Jaskólski Aromaty), containing 20%, 40%, 66.3% of sugars (determined refractometrically) and temperature 20 °C, 40 °C and 60°C.

Syrup solution to fruit ratio was 4 : 1. Time of dehydration of pumpkin cubes was 60 min, 180 min and 300 min. The process was carried out in a water bath (Water Bath Shaker Type 357 ELPAN) with continuous shaking (speed 50 c.p.m). After each dehydration time, samples were taken out from the solution and blotted with paper to remove any adhering osmotic agent. Each experiment was replicated twice.

The following kinetic parameters have been determined: water content (Wc) in g per g of dry matter of the dehydrated sample, water loss (Wl) and solid gain (Sg) in g per g of the initial dry matter of the sample. Water activity and colour changes were described. Water activity was measured with Aqua-Lab CX-2 at 25^{o}C. Pumpkin surface colour was measured with a colorimeter (Minolta CR-300). Colour was recorded using aCIE L* a* b* uniform colour space, where L* indicates lightness (Goncalves et al., 2007). Water content and water activity measurement were repeated three times and lightness 6 times. Statistical analysis was made with Statgraphics Plus 4.1 programme using Duncan’s Multiple Range Test for means separation at a significance level of 0.05.

RESULTS AND DISCUSSION

During osmotic dehydration, as an effect of mass flow, a water loss and solid gain were observed. Increasing the concentration of the osmotic solution generally produce higher water loss and larger solute uptake simultaneously. This effect was due to a higher difference in the chemical potential solutes between the sample and osmotic solution. The most intensive mass flow was observed at the beginning of the process for 60 and 180 min (Fig. 1,2,3). After that time the mass flow did not proceed significantly hence the process was described based on results obtained after 180 min.

It was observed that the water loss and solid gain increased with a higher concentration of the osmotic solution (Fig. 1,2), but water content showed the opposite tendency (Fig. 3). After 180 min of dewatering at 20^{o}C water loss amounted to 0.15 g/g i.d.m. for samples dehydrated in 20% solution, to 1.5 g/g i.d.m. in 40% and to 2.5 g/g i.d.m. in 66.3% (Fig. 1). Water content was reduced from 7.1 8 g/g d.m. to 4.8 g/g d.m. in samples dehydrated in 20% solution, to 3.9 g/g d.m. in 40% solution and to 2.7 g/g d.m. in 66.3%. Time of the process did not have an influence on the water content of samples dehydrated in 20% at 20^{o}C (Fig. 3).

At each level of the osmotic solution concentration (20%, 40% and 66.3%), increasing the process temperature caused higher water loss, especially when changing the temperature from 40 to 60^{o}C. After 180 min of dewatering in a 66.3% solution, water loss amounted to 2.7 g/g i.d.m. at 20^{o}C; 3.5 g/g i.d.m. at 40^{o}C and 5.5 g/g i.d.m. at 60^{o}C (Fig. 1), and water content decreased from initial 7.1 g/g d.m. to 2.7 g/g d.m.; 2.4 g/g d.m. and 1.0 g/g d.m., respectively (Fig. 3).

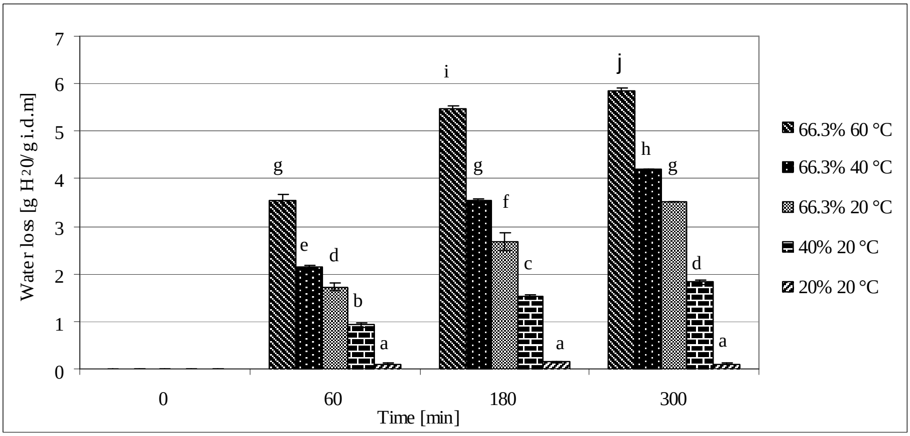

Figure 1. Water loss from pumpkin during osmotic dehydration in a starch syrup solution

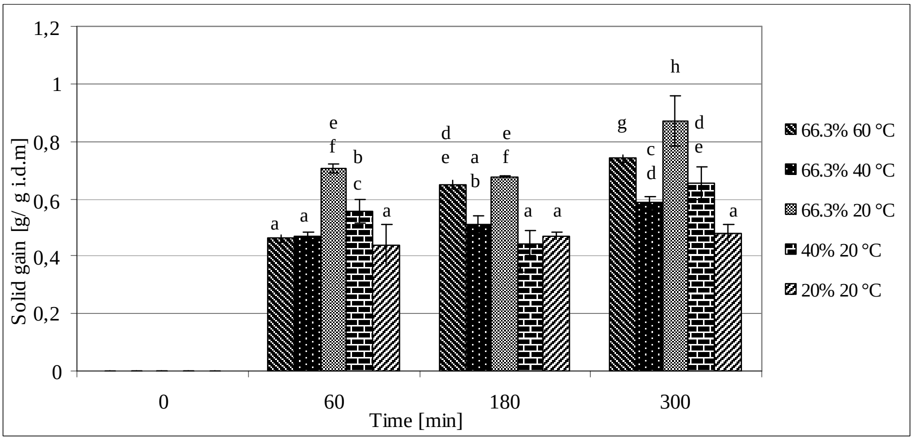

Figure 2. Solid gain in pumpkin during osmotic dehydration in a starch syrup solution

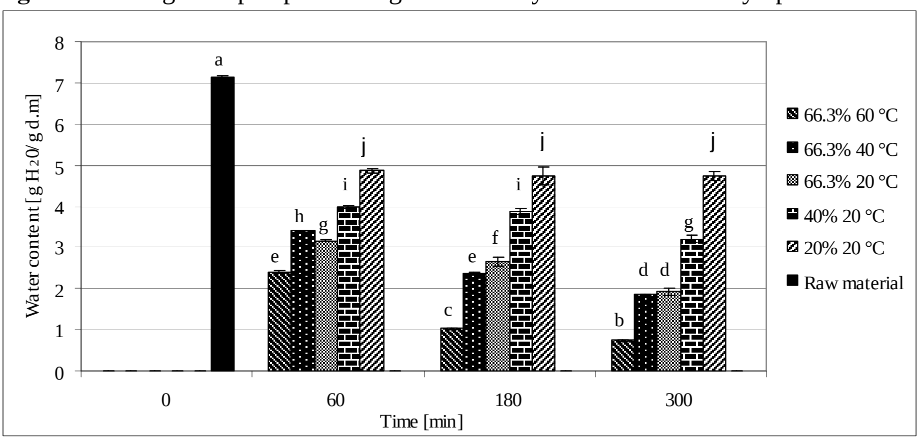

Figure 3. Water content in pumpkin during osmotic dehydration in a starch syrup solution

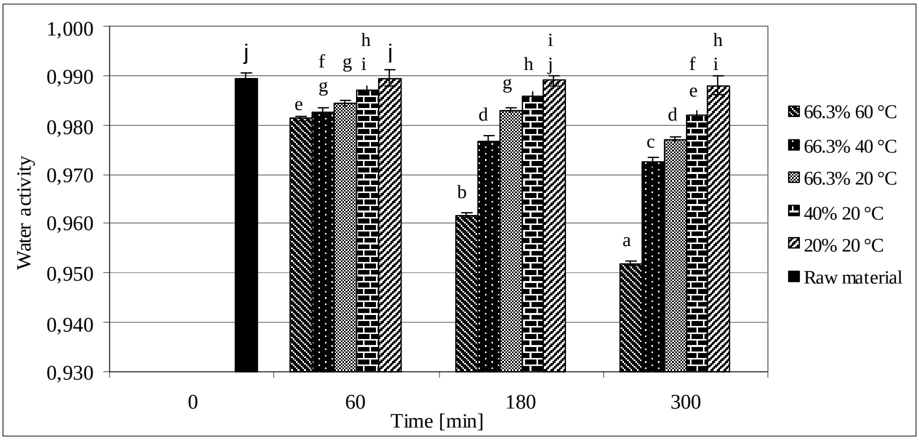

Figure 4. Water activity of pumpkin during osmotic dehydration in a starch syrup solution

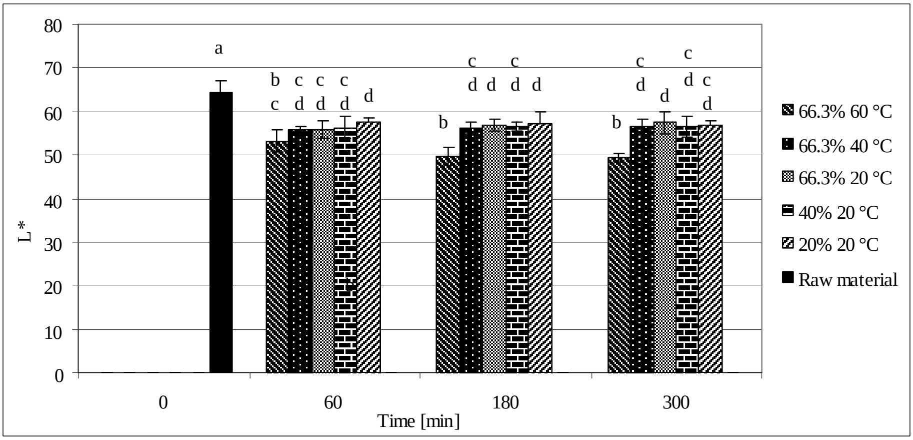

Figure 5. Lightness L* of pumpkin during osmotic dehydration in a starch syrup solution

The highest solid gain was observed after dewatering in 66.3% at 20°C. Pumpkin dehydrated in a higher concentration of starch syrup solution generally had a higher solid gain than samples dehydrated in a lower solute concentration. After 180 min of the process, solid gain in samples dehydrated in a 66.3% solution was 0.7 and 0.5 g/g i.d.m. for 20% solution (Fig. 2).

A decrease in the water activity of pumpkin was observed when immersion time increased, for all process conditions. It is seen from Figure 4 that there was a decrease in water activity when the temperature and solution concentration was increased. For example after 180 min of dewatering in 66.3% solution, water activity was decreased from an initial 0.990 to 0.983 at 20°C and to 0.962 at 60°C.

After dewatering in a starch syrup solution, samples became darker, as expressed by decrease of parameter L* (Fig. 5). The highest colour changes took place at the beginning of the process; hence it might be the effect of soaking the material in the starch syrup solution. For all process conditions values of L* varied from 55.7 to 58.7. The significant influence of time, temperature and concentration of solute on colour changes was not observed. Only samples dehydrated in 66.3% at 60°C differed significantly and for example after 300 min the L* value decreased to 49.4. It has been observed that osmotic dehydration in sucrose solutions reduces browning and can retain or improve food product colour (Giannakourou et al., 2003; Giraldo et al., 2003).

CONCLUSIONS

- Osmotic dehydration in starch syrup solution might be a good method for partial removal of water from pumpkin.
- The temperature and concentration of starch syrup solution, have an influence on kinetics of osmotic dehydration and water activity of pumpkin.
- The significant influence of temperature and concentration of starch syrup solution on colour changes of pumpkin during osmotic dehydration was not observed.
- Osmotic dehydration might be proposed as an effective pretreatment in combined preservation techniques. It may also act as a treatment for producing fresh-like, minimally processed food or manufacturing food pieces as additional components in many products. But more research is needed.

REFERENCES

Gajewski M., Radzanowska J., Danilcenko H., Jariene E., Cerniauskiene J. 2008. Quality of pumpkin cultivars in relation to sensory characteristics. NOT. BOT. HORT. AGROBOT. CLUJ. 36 (1): 73-79.

Giannakourou M.C., Taouki P.S. 2003 Stability of dehydrofrozen green peas pretreated with nonconventional osmotic agents. J. FOOD SCI. 68 (6): 2002-2010.

Giraldo G., Talens P., Fito P., Chiralt A. 2003. Influence of sucrose solution concentration on kinetics and yield during osmotic dehydration of mango. J. FOOD ENG. 58: 33-43.

Goncalves E.M., Pinheiro J., Abreu M., Brandao T.R.S., Silva C.L.M. 2007. Modeling the kinetics of peroxidase inactivation, colour and texture changes of pumpkin (*Cucurbita maxima L.*) during blanching. J. FOOD ENG. 81: 693-701.

Kowalska H., Lenart A. 2003. Ruch wody i substancji rozpuszczonych w jabłkach odwadnianych osmotycznie. ACTA TECHNICA AGRARIA. 2 (1): 13-22.

Kowalska H., Lenart A., Leszczyk D. 2008. The effect of blanching and freezing on osmotic dehydration of pumpkin. J. FOOD ENG. 86: 30-38.

Krzysik K., Bogucka W. 1981: Dynia – wartościowy surowiec do produkcji przetworów dla dzieci. PRZEM. FERM. OWOCOWO-WARZYWNY 4: 23-25.

Mayor L., Moreira R., Chenlo F., Sereno A.M. 2006. Kinetics of osmotic de-

hydration of pumpkin with sodium chloride solutions. J. FOOD ENG. 74: 253-262.
Mayor L., Pissarra J., Sereno A.M. 2008. Microstructural changes during osmotic dehydration of parenchymatic pumpkin tissue. J. FOOD ENG. 85: 326-339.
Niewczas J., Szweda D., Mitek M. 2005. Zawartość wybranych składników prozdrowotnych w owocach dyni olbrzymiej (Cucurbita, Maxima). ŻYWNOŚĆ NAUKA TECHNOLOGIA JAKOŚĆ. 2 (43) supl.: 147-154.
Rastogi N.K., Raghavarao K.S.M.S., Niranjan K., Knorr D. 2002. Recent developments in osmotic dehydration: methods to enhance mass transfer. TRENDS FOOD SCI. TECHNOL. 13: 48-59.
Sablani S.S., Rahman S.S. 2003. Effect of syrup concentration, temperature and sample geometry on equilibrium distribution coefficients during osmotic dehydration of mango. FOOD RES. INT. 36: 65-71.
Senderski M.E. 2004. Prawie wszystko o ziołach. Wydawnictwo Senderski, Podkowa Leśna.
Zawirska A., Figiel A., Kucharska A.Z. Sokół-Łetowska A., Biesiada A. 2009. Drying kinetics and quality parameters of pumpkin slices dehydrated using different methods. J. FOOD ENG. 94: 14-20.

ODWADNIANIE OSMOTYCZNE DYNI W ROZTWORZE SYROPU SKROBIOWEGO

Agata Pękosławska i Andrzej Lenart

STRESZCZENIE

Proces odwadniania osmotycznego może posłużyć do utrwalania dyni i uzyskania produktu o określonych właściwościach odżywczych i sensorycznych, a tym samym sprostać wymaganiom konsumenta. Celem pracy było określenie wpływu stężenia i temperatury roztworu syropu skrobiowego na proces odwadniania osmotycznego dyni. Proces prowadzono w łaźni wodnej przez okres 60, 180 i 300 min. Największe zmiany zawartości wody, ubytku wody i przyrostu masy suchej substancji nastąpiły w materiale odwadnianym w roztworze o stężeniu 66,3% i temperaturze 60°C. Przy wyższym stężeniu i temperaturze roztworu następowało większe obniżenie aktywności wody dyni.

Słowa kluczowe: odwadnianie osmotyczne, dynia, syrop skrobiowy