RE-USE OF OSMOTIC SOLUTION

[1]Violeta Knežević, [1]Vladimir Filipović, [1]Biljana Lončar, [1]Milica Nićetin, [1]Tatjana Kuljanin, [1]Ljubinko Lević, [2]Lato Pezo

[1]University of Novi Sad, Faculty of Technology,BulevarcaraLazara 1, 21000 Novi Sad, Serbia
[2]University of Belgrade, Institute of General and Physical Chemistry, Studentski trg 12/V, 11000 Beograd, Serbia
email: ovioleta@uns.ac.rs

ABSTRACT

In this paper the re-use of osmotic solution after osmotic treatment has been studied. A large amount of used osmotic solution remaining after the process is one of the major unsolved problems of osmotic treatment process. This problem has both ecological and economic aspects that should be concerned.

Pork meat cubes were treated in three different osmotic solutions diluted with distilled water (R1 -sugar beet molasses, R2 – solution of salt and sucrose and R3 - combination of R1 and R2 solutions in a 1:1 mass ratio). Osmotic process has been observed during 5 hours, at temperature of 35°C and atmospheric pressure. Osmotic treatment has been performed simultaneously in concentrated solutions and diluted solutions (dilutions were obtained by mixing the solution and water in the mass ratio of 7:1 and 3:1). Parameters monitored during osmotic treatment were: dry mater content (*DMC*), water loss (*WL*), solid gain (*SG*) and osmotic dehydration efficiency index (*DEI*). Maximum values of these parameters were obtained in the dehydration with concentrated solutions, while recorded values in diluted solutions were much lower.

The results show that the least effect on the osmotic process efficiency, when the osmotic concentration is lowered, has been observed for solution R3. This conclusion indicates that molasses is good osmotic solution with the possibility of re-using in successive processes of osmotic dehydration, with minimal treatment of reconstitution to original values of concentration.

INTRODUCTION

Many traditional techniques and their combinations, such as salting, drying, cooking, smoking and marinating, are used to prevent spoilage of meat its products by reducing water content. Common step in these processes is placing product (meat) in contact with concentrated solution (salt, sugar, acids, seasonings, etc.) (*Filipović, 2013*).

Osmotic dehydration process has proven to be a good method for obtaining minimally processed fruits, due to the high similarity between the sensor and dehydrated fresh produce, although the specificity of the process compared to other drying processes, reflected in a solid gain as a secondary mass transfer accompanying the transfer of water from the primary tissue in osmotic solution.(*Lerici et al., 1985; Sousa et al. 2003*)

Osmotic dehydration is used as a pre-treatment for many processes, to improve nutritional, sensorial and functional properties of food without changing its integrity (*Nićetin et al.,2012*). This technique also is interesting because it provides partial water removal from a food product, with low energy consumption and mild heat treatment (*Vieira et al., 2012*;

Manivannan et al.,2011). Sugar beet molasses is an excellent medium for OD, primarily due to the high dry matter (80%) and specific nutrient content (*Ćurčić et al.,2012*).
Ability to re-use osmotic solution for osmotic dehydration process is important from an economic point of view, and also in terms of environmental protection, has more and more influence in the overall evaluation of any process (*Valdez-Frugosoa et al., 1998*).
Analysis of the impact of equal measures of dilutions of various osmotic solutions on the parameters of osmotic dehydration may indicate a different behavior during reducing concentration of osmotic solutions that could occur during the re-use of osmotic solutions, and also, it may indicate on different levels of required treatment of solution before use (*García-Martínez et al., 2002; Rahman, 2007*).
The main objective of this paper was to investigate the possible use of molasses in comparison to other osmotic solutions, concerning the possibility of re-using in successive processes of osmotic dehydration with minimal treatment of reconstitution to original values of concentration.

MATERIAL AND METHODS

Materials

For the experiment, fresh pork (*M.tricepsbrachii*) was purchased on the local butcher shop, shortly before use. Before the osmotic treatment, fresh meat was cut into cubes, dimension of approximately 1x1x1cm. Concentrated sugar beet molasses from sugar factory Pećinci was used as one osmotic solution (R1). Ternary solution (R2) was prepared by mixing three components, commercial sugar in the quantity of 1200 g/kg water, NaCl in the quantity of 350 g/kg water and distilled water. Combine solution was obtained by mixing molasses and ternary solution in range 1:1. The material to solution ratio of 1:5 was used during experiments.

Methods

All experiments were carried out under atmospheric pressure at the temperature of 35°C. The process was performed in laboratory jars. Samples of meat were dipped into all three solutions, and the immersion lasted for 5 hours. On every 15 minutes meat samples was manually agitated to provide better homogenization of the osmotic solutions. After 5 hours meat samples was taken out from osmotic solutions and then lightly washed with water and gently blotted with paper towels to remove excessive water from the surface.
From the obtained data, *DMC*, *WL*, *SG* and *DEI* were determined at different time intervals, according to the following expression (*Filipović, 2013*):

$$DMC = \frac{m_d}{m_i} \cdot 100\% \qquad (1)$$

$$WL = \frac{m_i z_i - m_f z_f}{m_i} \quad \left[\frac{g}{g\ fresh\ sample}\right] \qquad (2)$$

$$SG = \frac{m_f s_f - m_i s_i}{m_i} \quad \left[\frac{g}{g\ fresh\ sample}\right] \qquad (3)$$

$$DEI = \frac{WL}{SG} \qquad (4)$$

where: m_d dried sample weight (g), m_i and m_f are the initial and final weight (g) of the samples, respectively; z_i and z_f are the initial and final mass fraction of water (g water/g sample), respectively; s_i and s_f are the initial and final mass fraction of total solids (g total solids/ g sample), respectively.

RESULTS AND DISCUSSION

The effects of dilution of osmotic solution were studied by its influence on kinetic parameters of osmotic dehydration (*DMC*, *WL*, *SG* and *DEI*). The results of osmotic treatment for all three solutions are presented in Table 1. Concentrated solutions achieved maximums in the dehydration process, while the dilution introduced the observable decrease in kinetics parameters compared to the maximum value in concentrated solutions (dilutions were obtained by mixing the solutions and water in the mass ratio of 7:1 and 3:1). Water activity (a_w) obtained in dehydrated meat, using concentrated osmotic solutions was lower, compared to a_w gained using diluted solutions (Table 2).

Table 1 Influence of dilution of the osmotic solution on osmotic dehydration parameters

	DMC (%)	WL (%)	SG (%)	DEI (%)
Concentrated R1	0	0	0	0
Attenuation: R1:water=7:1	-10.97	-16.66	-8.98	-8.38
Attenuation: R1:water=3:1	-16.90	-24.95	-11.03	-14.72
Concentrated R2	0	0	0	0
Attenuation: R2:water=7:1	-3.94	-13.57	-8.24	-6.89
Attenuation: R2:water=3:1	-12.52	-20.00	-18.66	-2.30
Concentrated R3	0	0	0	0
Attenuation: R3:water=7:1	-8.23	-9.45	-5.54	-4.66
Attenuation: R3:water=3:1	-12.69	-11.73	-7.76	-4.04

The largest decreases in monitored kinetics parameters were noticed in the most diluted solutions. Dilution of osmotic solutions decreased the final dry matter content of dehydrated meat in varying degrees. The largest reductions was observed in *DMC* values for R1 solution, while the reducing of *DMC* value in R2 and R3 were at almost similar level (reduction of 12.52% and 12.69%, compared with dehydration in concentrated R2 and R3, diluted to 3:1). The most pronounced decrease in *WL*, due to dilution, was observed in R1 osmotic solution (24.95%), followed by R2 (20.00%). The most acceptable value is gained, using R3 solution; *WL* is decreased 11.73%, which was the lowest value compared to R1 and R2 solutions. Similarly, *SG* was reduced to a minimum level, when using R3 osmotic solution (7.76%) compared to R2 (18.66%) and R1 (11.03%). Osmotic dehydration efficiency index showed the least decrease in value when using osmotic solution R2 (2.3%), while the observed decrease when using R3 solution was 4.04%. The largest decline in *DEI* was observed when using R1 solution (14.72%).

When concentration of osmotic solutions is reduced, the increase of a_w is observed (higher a_w is gained for diluted solutions).
The most appropriate results, i.e., the lowest increase the a_w value, due to dehydration in diluted solution were observed, when using solution R3 (a_w increasing percentage was 7.89%), compared to the a_w values in concentrated solution. The increase of a_w in diluted solution R2 reached 9.82%, and the largest increase in a_w value of dehydrated meat is noticed in the meat dehydrated in dilute solution R1 (11.60%) compared with a_w of dehydrated meat, in concentrated solution R1.

Table 2 Influence of dilution of the osmotic solution on a_w of pork

	a_w**(%)**
Concentrated solution R1	0
Attenuation: R1:water=7:1	+9.08
Attenuation: R1:water=3:1	+11.60
Concentrated solution R2	0
Attenuation: R2:water=7:1	+8.94
Attenuation: R2:water=3:1	+9.82
Concentrated solution R3	0
Attenuation: R3:water=7:1	+6.41
Attenuation: R3:water=3:1	+7.89

After the comparison of results shown in Table 1 and Table 2, it can be concluded that R3 is the best osmotic solution regarding possible re-using in successive processes of osmotic dehydration. Decreasing of *DMC* in diluted solution is similar for R3 and R2 solution, but the *WL* and *SG* decreasing are much more acceptable when using R3 as osmotic solution. The *DEI* ratio is a bit better when using R2 solution, but a_w is more acceptable for R3 solution.

ACKNOWLEDGMENT

These results are part of project supported by the Ministry of Education and Science of the Republic of Serbia, TR-31055, and 2011-2014.

REFERENCES

Ćurčić B., LevićLj, Filipović V., Nićetin M., Knežević V., Pezo L., Šuput D. (2013). Osmotic drying Crucian carp (Carassiuscarassius) using sugar beet molasses solutions, Journal on processing and energy in agriculture, 17, 4, 173-175

Filipović V. (2013).Uticaj procesa osmotske dehidratacije na prenos mase i kvalitet mesa svinja, Doktorska disertacija, Tehnološki fakultet, Novi Sad.

García-Martínez E., Martínez-Monzo J., Camacho N., Martínez-Navarrete M., (2002).Characterization of reused osmotic solution as ingredient in new product formulation, Food Research International, 35, 307-313.

Lerici C.R., Pinnavaia G., Rosa M. i Bartolucci L. (1985).Osmotic dehydration of fruits. Influence of osmotic agents on drying behavior and product quality. Journal of Food Science. 50, 1217-1226.

Manivannan P., Rajasimman M., (2011). Optimization of parameters for the osmotic dehydration of beet root in sugar solution. Journal of Food Engineering,34, 804-825.

Nićetin M., Filipović V., Ćurčić B., Pezo L., Knežević V., Gubić J., Kuljanin T.(2012). The influence of different osmotic solutions on nutritive profile during osmotic dehydration of pork, XV International Feed Technology Symposium "Feed-to-Food''/Cost Feed for Health Joint Workshop,University of Novi Sad, Institute of Food Technology, Proceedings, 203-208.

Rahman M.,(2007). Osmotic Dehydration of Foods. U M. S. Rahman (Ur.), Handbook of Food Preservation (2 ed.). CRC Press.

Sousa P.H.M., Souza Neto M.A., Maia G.A., Souza Filho M.S.M. i Figueiredo R.W. (2003).Desidrataçãoosmótica de frutos.Boletin da SociedadeBrasileira de Ciência e Tecnologia de Alimentos., 37, 94-100.

Valdez-Frugosoa A., Welti-Chancsb J., Girouxa F.(1998). Properties of a sucrose solution reused in osmotic dehydration of apples, An International Journal, 16, 1429-1445.

Vieira G., Pereira L., Hubinger M., (2012). Optimization of osmotic dehydration process of guavas by response surface methodology and desirability function. International Journal of Food Science & Technology, 47, 132-140.