**Biblid**: 1450-5029 (2009) 13; 2; p.178-180
**UDK**: 634.11;635.13:664.151.2:664.854

Original scientific paper
Originalni naučni rad

# INFLUENCE OF MONO AND DOUBLE EDIBLE STARCH COATING ON IMPROVING OF OSMOTIC DEHYDRATION OF APPLE IN SACCHAROSE SOLUTION AND SUGAR BEET MOLASSES

# UTICAJ JEDNOSTRUKIH I DVOSTRUKIH JESTIVIH SKROBNIH PREVLAKA NA POBOLJŠANJE OSMOTSKE DEHIDRATACIJE JABUKE U RASTVORIMA SAHAROZE I MELASI ŠEĆERNE REPE

*Nevena MIŠLJENOVIĆ BSc., Gordana KOPRIVICA BSc, dr Ljubinko LEVIĆ, dr Tatjana KULJANIN*
*Faculty of Technology, 21000 Novi Sad, Serbia, Bulevar Cara Lazara 1*
*e-mail:* nevenam@uns.ns.ac.yu

## SUMMARY

*The effect of edible starch coatings was studied with the objective to achieve higher efficiency of osmotic dehydration process of the apple. This study encompassed treatments of apple with 3% maize starch solution applied in the form of single and double coatings. The aim of application of edible coatings during osmotic dehydration was to promote water loss from calls to surrounding osmotic solution and to prevent solid uptake from osmotic solution to samples, on the other hand. Samples of apple were dehydrated in 70% saccharose and 80% sugar beet molasses as osmotic agent, during 5 h, at 55°C and normal pressure. Insertion of edible starch coatings achieves higher water loss and reduction of solid gain in apples. It was concluded that double-coated samples in sugar beet molasses give the best results.*

***Key words**: Osmotic dehydration, apple, edible coating, sugar beet molasses, saccharose solution.*

## REZIME

*Da bi se postigla što veća efikasnost pri osmotskoj dehidrataciji jabuke ispitana je mogućnost primene jestivih skrobnih prevlaka. U radu je korišćen 3% rastvor kukuruznog skroba u vidu jednostrukih i dvostrukih prevlaka. Upotrebom jestivih prevlaka teži se povećanju difuzije vode iz uzorka u okolni osmotski rastvor, s jedne strane, i onemogućavanje prodiranja materija iz osmotskog rastvora u uzorke s druge strane. Osmotska dehidratacija je obavljena u rastvorima 70% saharoze i 80% melasi šećerne repe, u trajanju od 5 sati, na temperaturi 55°C i atmosferskom pritisku. Primena jestivih prevlaka dovodi do povećanja gubitka vlage i smanjenja priraštaja suve materije u uzorcima jabuke. Ustanovljeno je da se upotrebom dvostruke prevlake, na uzorcima jabuke koji su dehidrirani u melasi šećerne repe, postižu najbolji rezultati.*

***Ključne reči:** Osmotska dehidratacija, jabuka, jestiva skrobna prevlaka, melasa šećerne repe, saharoza.*

## INTRODUCTION

Osmotic dehydration is one effective way to reduce the water content with minimal negative effect on sensorial properties and nutritive value. Osmotic drying, of mainly fruits and vegetables, is obtained by immersing them in hypertonic solutions. In our country and in the world concentrated saccharose solution, sodium chloride and their combination are usually used as hypertonic solution (*Jokić et al., 2007*). At the Faculty of Technology in Novi Sad already exists a developed method of osmotic drying in sugar beet molasses as hypertonic solution. Sugar beet molasses emerges as excellent medium for osmotic dehydration primarily due to higher content of dry matter (80%) which provides high osmotic pressure in solution (*Lević et al., 2007, Filipčev i sar., 2006*), as well as the specific chemical composition which is caracterised with high content of vitamins, minerals, antioxidants and betain (*Šušić & Sinobad, 1989*). During osmotic dehydration, the tendecy is to increase the diffusion of water from the sample in the surrounding solution and to decrease penetration of solids from solution in the plant tissue, on the other hand (*Matuško et al., 2004*). However, when sugar beet molasses was used as hypertonic solution penetration of mineral matter, vitamins and etc., it could be considered as favorable because in that way the nutrition value of fruits and vegetables is higher *(Koprivica et al., 2008)*.

Until now, a large number of studies have been done with the aim of reducing of solid gain in osmo-dehydrated fruits and vegetables. Most of the methods which have been applied are based on the application of edible coatings. Edible coating should be biodegradable, capable of modifying the product's surrounding i.e. to act as a promoter of water removal and to prevent penetration of solids from surrounding solution in plant tissue (*Baldwin, 1994*).

The edible coatings are usually made of various polysaccharides, proteins or lipids. For successful application in osmotic dehydration process, the properties of coating materials should fit several requirements: good mechanical properties, satisfactory sensory properties, easy and rapid film formation, high water diffusivity, and prevention of excessive solute uptake by the tissue (*Camirand at al., 1992*).

For the preparation of edible coatings aqueous solutions of several substances which, most often, include pectins, gelatine, agar-agar, tragant gum, maltodextrins, starch, alginic acid, sodium-alginate, low metoxy pectinate (LMP), maltodextrines and starch were used most often *(Khin et al., 2005; Matuško et al., 2004; Lenart and Piotrowski, 2001; Lević et al, 2008)*. Investigation of *Lenart and Dabrowska (2001)* indicate that 2% LMP has the greatest influence on increasing of the water loss of apple, while maltodextrine solution has the greatest influence on decreasing of solid gain.

The usage of maize starch as edible coating improves the process of osmotic dehydration of carrots in sugar beet molasses and saccharose solution (*Lević at al., 2008)*.

The objective of this study was to investigate the possibility of using maize starch in the form of single and double edible coating, whether and how much maize starch has an effect on efficiency of osmotic dehydration process and decreasing of solid gain. The results of osmotic dehydration in sugar beet molasses and 70 % saccharose solution were compared.

## MATERIAL AND METHOD

Apples were purchased on a local market in Novi Sad, Serbia and stored at 4°C. Prior to the treatment, the apples were thoroughly washed and cut into cylindrical shapes, 20 mm in height and diameter, with a sharp apple corer**.**

For the preparation of hypertonic solution white sugar saluted in distillate water and pure sugar beet molasses obtained from sugar factory Bač, Serbia were used.

Commercialy available maize starch (produced by Dr. Oetker Kft, Hungary) was used as a coating material. A 3% starch suspension was used for the preparation of mono- and double-layered edible coatings.

For the formation of a single coating, samples of apple were dipped in 3% starch suspension for 60 s, prior to osmotic dehydration. In order to fix starch coating samples were left at room temperature for 15 minutes and then submitted to osmotic dehydration.

For the formation of a double coating, the apple samples were dipped in 3% starch suspension for 60 s, and then taken out and left for 15 minutes at room temperature to fix coating. After the first coating was fixed, the starch dipping was repeated under the same coating procedure.

Each sample was tested in duplicate and mean values were used in calculation.

### Osmotic dehydration

Osmotic dehydration was carried out at 55°C under atmospheric pressure. The coated apple pieces were placed in 600 ml beakers and kept submerged in 70% saccharose solution or sugar beet molasses.

The material to solution ratio was 1:4 (w/w). The beakers were kept in a thermostat at 55°C for 5 hours. Finally, the apple pieces were removed from osmotic solutions, washed with water and gently blotted to remove excessive water. The samples were weighed and analyzed.

Moisture content of the samples was determined by oven drying method according to AOAC methods (*AOAC, 2000*). The samples were kept in an oven (Instrumentaria Sutjeska, Serbia) at 105°C for 24 hours until a constant weight was attained.

### Calculation of osmotic parameters

Kinetics of the process of osmotic dehydration is usually represented with water loss (WL), solid gain (SG) and weight reduction (WR) of the material immersed in osmotic solution. There are different ways to define these quantities but most widely used definitions are: the water loss as net water lost from fresh sample calculated on initial sample mass, the solid gain as net increase in solids calculated on initial sample mass:

$$WL\left[\frac{g}{g}\right]=\frac{m_o-m}{w_o} \quad (1)$$

$$SG\left[\frac{g}{g}\right]=\frac{u-u_o}{w_o} \quad (2)$$

where: $m_o$ – initial moisture content of fresh sample before osmotic treatment (g); $m$ – moisture content in sample after osmotic dehydration(g); $u_o$ – initial solid content in fresh sample (g); $u$ – solid content in sample after osmotic dehydration (g) and $w_o$ – initial mass of fresh sample (g).

$$WR=WL-SG \quad (3)$$

## RESULTS AND DISCUSSION

The usage of edible coatings causes a small increase in water loss from apple tissue. In the coated samples, water loss is about 10% higher in comparison to the control (Figure 1). There was no significant difference in water loss between single-($S_1$) and double–($S_2$) coated samples in case when sugar beet molasses was used as hypertonic solution. In case when saccharose solution was used as hypertonic solution, there the findings contradict the hypothesis. Namely, greater water loss was found in single–coated samples in relation with double – coated. A reasonable explanation could be that double starch coating is a barrier for the water removal from the samples.

In addition, it is very important to notice that the water loss is higher when the hypertonic solution was used sugar beet molasses, and in that case, the water loss is higher for about 12%.

The hypothesis of the experiment was that edible coatings limiting solid uptake in apples during osmotic dehydration. SG value indicates the degree of penetration of solids from osmotic solution in the samples. Results show a decreasing of solid gain to a great extent in samples that edible starch coatings have been applied on (Figure 2). Solid gain was double decreased in coated samples. The highest solid gain was found in non-coated sample osmo-dehydrated in 70% saccharose solution (0.0867 g/g i.s.w.), while the lowest solid gain was encountered in double – coated sample osmo-dehydrated in sugar beet molasses (0.0407 g/g i.s.w.).

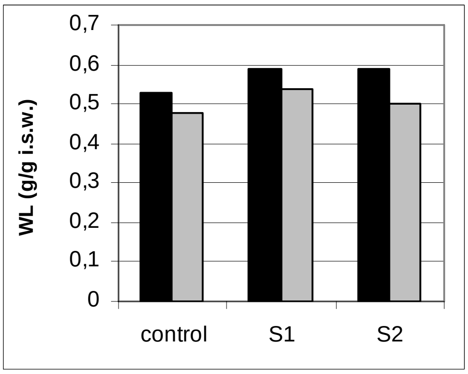


*Fig. 1. Iinfluence of starch coatings on water loss during osmotic dehydration of apple in sugar beet molasses (●) and in 70% saccharose solution (●)*

*Sl. 1. Uticaj skrobnih prevlaka na gubitak vode tokom osmotske dehidratacije jabuke u melasi šećerne repe (●) i 70% rastvoru saharoze (●)*

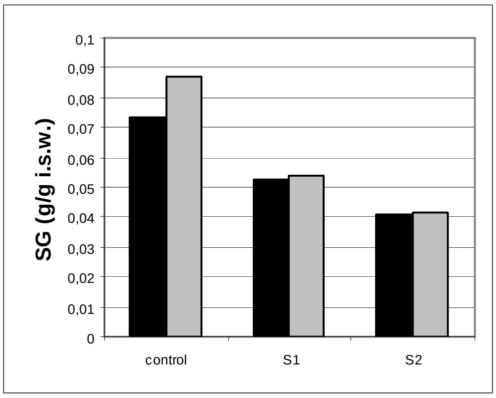


*Fig. 2. Influence of starch coatings on solid gain during osmotic dehydration of apple in sugar beet molasses (●) and in 70% saccharose solution (●)*

*Sl. 2. Uticaj skrobnih prevlaka na priraštaj suve materije tokom osmotske dehidratacije jabuke u melasi šećerne repe (●) i 70% rastvoru saharoze (●)*

Weight reduction (WR) is defined as difference in water removal and solid uptake. The highest weight reduction was found in apple coated twice with 3% starch solution, which was dehtdrated in sugar beet molasses, and it come 0.549 g/g i.s.w

(Figure 3). Difference in weight reduction between single- and double- coated samples was insignificant.

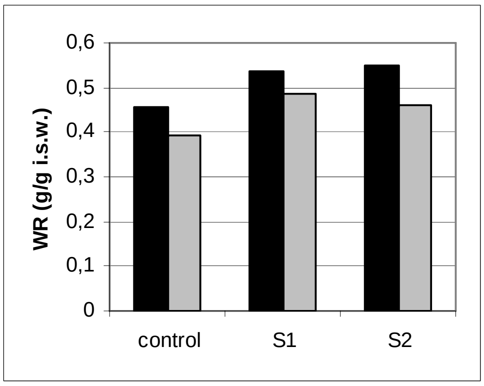


*Fig. 3.Iinfluence of starch coatings on weight reduction during osmotic dehydration of apple in sugar beet molasses (●) and in 70% saccharose solution (●)*
*Sl. 3. Uticaj skrobnih prevlaka na smanjenje mase tokom osmotske dehidratacije jabuke u melasi šećerne repe (●) i 70% rastvoru saharoze (●)*

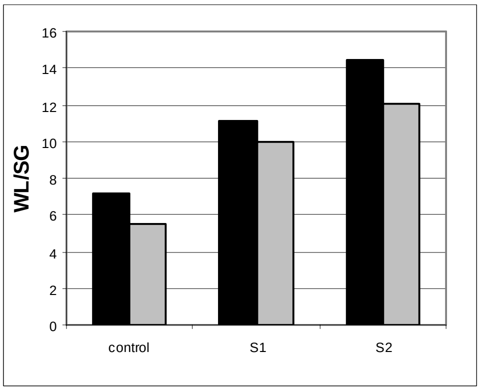


*Fig. 4. Influence of starch coating on WL/SG ratio during osmotic dehydration of apple in sugar beet molasses (●) and in 70% saccharose solution (●)*
*Sl. 4. Uticaj skrobnih prevlaka na odnos parametara WL/SG tokom osmotske dehidratacije jabuke u melasi šećerne repe (●) i 70% rastvoru saharoze (●)*

Water loss (WL) to solid gain (SG) ratio (WL/SG) is a unique index that clearly indicates the efficiency of osmotic dehydration process. High values of this ratio indicate an extensive dehydration with minimal solid uptake. On the other hand, a small WL/SG ratio indicates that during the process comes to significant diffusion of solids from osmotic solution in samples with minimal water loss (i.e. candying).

WL/SG ratio indicates the effectiveness of various edible coatings. The lowest value of WL/SG ratio was determinated in non – coated apples, osmo–dehydrated in 70% saccharose solution. Double – coated samples, which were dehydrated in sugar beet molasses, have a higher WL/SG ratio (14.49). All coated samples have a highest WL/SG ratio compared to control, which indicates the efficiency and relevance of applying edible coatings in osmotic dehydration (Figure 4).

All previously presented results show that the application of double starch coatings have the most influence on the efficiency of osmotic dehydration of apple.

## CONCLUSION

Sugar beet molasses was shown as a much better hipertonic solution compared to 70% saccharose solution at all samples of apple which were osmoticaly dehydrated. Edible starch coatings reduced the penetration of solids from osmotic solution in the samples. The best results were observed in cases of double starch coatings. WL/SG ratio has proved as an excellent parameter for assessment of efficiency of osmotic dehydration. On the basis of this parameter we can conclude that the double coating gave the best results and it is a very effective and simple way for improving the osmotic dehydration process.

*ACKNOWLEDGEMENTS:This research is part of the project supported by the Ministry of Science and Technological Development, Republic of Serbia, TR – 20112, 2008-2010.*

## REFERENCES

[1] AOAC, Official Methods of Analysis (2000), Washington, USA.
[2] Baldwin E. A: Edible coatings for fresh fruits and vegetables: past present, and future. In: Krochta J.M., Baldwin E.A, Nisperos-Carriedo, M.O. (Eds.), Edible Coatings and Films to Improve Food Quality. Technomic Publishing, Lancaster:Basel, pp. 25–64, 1994
[3] Camirand W., Krochta J.M., Pavlath A. E., Wong D., Cole M. E.: Properties of some edible carbohydrate polymer coatings for potential use in osmotic dehydration, Carbohydrate Polymers, 17, 39 - 49
[4] Dobrowska R., Lenart A.: Influence of edible coatings on osmotic treatment of apples. In P. A. Fito and J. M. Chiralt (Eds), Osmotic dehydration and vacuum impregnation, Pennsylvania, Technomic Publishing Company (2001), pp. 43-49
[5] Filipčev Bojana, Lević Lj., Šimurina Olivera, Kuljanin Tatjana: Priprema voća postupkom osmotske dehidratacije u melasi šećerne repe sa ciljem njegove primene u pekarskoj industriji, PTEP - Journal on Processing and Energy in Agriculture, 10(2006)5, 154-157
[6] Jokić A., Prodanić Bojana, Gyura Julianna, Zavargo Z., Lević Lj.: Kinetika osmotske dehidratacije mrkve u rastvorima saharoze, PTEP – Journal on Processing and Energy in Agricultural, Novi Sad, 11 (2007) 1-2, 42-44
[7] Khin May May, Zhou W., Perera C. O.: A study of mass transfer in osmotic dehydration of coated potato cubes, Journal of Food Engineering, 77 (2006), 84-95
[8] Koprivica Gordana, Mišljenović Nevena, Lević Lj., Petkova Mariana, Pribiš Vjera: Osmotsko sušenje jabuke u rastvorima saharoze i melase šećerne repe: promena nutritivnih karakteristika finalnog proizvoda, PTEP – Journal on Processing and Energy in Agriculture, Novi Sad, 12 (2008) 4, 215-218
[9] Lenart A., Piotrowski D.: Drying characteristics of osmotically dehydrated fruits coated with semipermeable edible films, Drying Technology, 19 (2001) 5, 849 -877
[10] Lević LJ., Filipović V., Kuljanin Tatjana: Osmotski tretman oblikovanog korena mrkve u saharozi i melasi, PTEP - Journal on Processing and Energy in Agriculture, 11 (2007) 3, 132-135
[11] Lević Lj., Koprivica Gordana, Mišljenović Nevena, Filipčev Bojana, Šimurina Olivera, Kuljanin Tatjana: Effect of starch as an edible coating material on the process of osmotic dehydration of carrot in saccharose solution and sugar beet molasses, Acta Periodica Technologica, University of Novi Sad, Faculty of Technology, 39 (2008) 29-36
[12] Matuska Malgorzata, Lenart A., Lazarides H. N.: On the use of edible coatings to monitor osmotic dehydration kinetics for minimal solids uptake, Journal of Food Engineering, 72 (2006), 85-91
[13] Šušić S., Sinobad Vesna: Istraživanja u cilju unapređenja industrije šećera Jugoslavije. Hem. Ind. 43 (Suppl. 1-2), (1989), 10 -21. University in Belgrade

Primljeno:11.03.2009. Prihvaćeno:28.03.2009.