CHANGES IN NUTRITIVE QUALITY OF OSMODEHYDRATED PORK MEAT IN SUGAR BEET MOLASSES

*Milica R. Nićetin [*a], Biljana Lj. Ćurčić [a], Vladimir S. Filipović [a], Gordana B. Koprivica [a] Ljubinko M. Lević [a] and Ljubomir M. Milašinović [b]*

[a] University of Novi Sad, Faculty of Technology, 21000 Novi Sad, Bulevar cara Lazara 1, Serbia
[b] University of Novi Sad, Faculty of Medicine, 21000 Novi Sad, Hajduk Veljkova 3, Serbia
*corresponding author: e-mail address: milican85@live.com

ABSTRACT

The aim of this study was to examine effects of sugar beet molasses as hypertonic solution during osmotic dehydration on nutritional properties of pork meat. Samples of pork meat were dehydrated in sugar beet molasses as an osmotic agent during 5 hours, at room temperature of 22°C and atmospheric pressure. This paper presents basic chemical composition and mineral contents of fresh meat, as compared to meat osmotically treated in sugar beet molasses. It was detected that dehydrated product shows enhanced chemical composition and considerable increased mineral content, thus confirming the usefulness of molasses from a nutritive point of view. The enrichment of the meat in protein, fat, sucrose, sodium chloride and analyzed minerals (K, Na, Mg, Fe and Ca) proves their diffusion from molasses into the raw material during process.

1. INTRODUCTION

Meat is a very important foodstuff in human nutrition because it is a rich source of biologically and nutritionally valuable ingredients, protein and essential amino acids, fat, minerals and vitamins (1).

Fresh pork meat has the highest percentage of water which has the significant impact on the physico-chemical, sensory and technological properties of meat (2). In order to prevent spoilage of meat and with the aim to obtain better quality and sustainability of meat many techniques for reducing water content have developed. These traditional processes are salting, drying, cooking, smoking, marinating and their combinations and they are carried out by placing product (meat) in contact with a concentrated solution (salt, sugar, acid, seasonings, etc.) (2,3).

These preservation methods have been applied to prolong the shelf life of meat, but produce meat products that are low in quality compared to their original fresh state. During these processes care must be taken to protect the nutritional and organoleptic (taste, smell, texture and appearance) properties of meat (4). Osmotic dehydration (OD) is an effective way to reduce the water content in processed product before further drying, additionaly improving sensory, functional and even nutritional properties (5). Compared to the other preservation treatments OD shows significant advantages: environmentally acceptability, energy efficiency, providing stable and quality products (6).

OD is a process of the partial removal of water by direct contact of foods (fruit, vegetable, meat and fish) with a suitable hypertonic solution. Driving force for water removal is the concentration gradient between the surrounding solution and the intracellular fluid (7). During OD, water from the plant or animal tissue flows out into the osmotic solution while osmotic solutes diffuse from the solution to the tissue. Simultaneously, third transfer process takes place, leaching of tissue's own solutes into the osmotic solution, but it is quantitatively negligible compared to the first two transfers (8).

The choice of optimal hypertonic aqueous solution appears to be the key problem in OD, and aqueous solution containing sodium-chloride and saccharose has been proposed as the best solution (9). High salt concentrations decrease the water holding capacity, which contributes to meat dehydration and shrinkage while there is no swelling of muscle fibers or myofibrils (2).

Sugar beet molasses emerges as an appropriate medium for OD primarily due to the high dry matter and specific nutrient content. The application of sugar beet molasses as osmotic agent has many advantages: it is nutritionally richer than sucrose and NaCl, sensory acceptable, always accessible and cheap raw material (10). Also, sugar beet molasses can be used in the osmotic dehydration process without previous preparation and therefore leads to saving of process time and energy. High content of solids (around 80%) provide high osmotic pressure in the solution and allows greater loss of water during osmotic dehydration and thus enhances the efficiency of this process. On the other hand, specific chemical composition of molasses (approximately 51% sucrose, 1% raffinose, 0,25% glucose and fructose, 5% proteins, 6% betaine, 1,5% nucleosides, purine and pyramidine bases, organic acids and bases) enriches nutritional composition of dehydrated products (11).

The objective of this work was to investigate the influence of sugar beet molasses, applied in the process as hypertonic solution, on the nutritional quality of pork meat.

2. MATERIALS AND METHODS

Pork meat (*M. triceps brachii*) for the experiment was purchased on the local butcher shop in Novi Sad, shortly before use. Initial moisture content of the fresh meat was 74.40%. Before the osmotic treatment, fresh meat was cut into cubes, dimension of approximately 1x1x1cm. Sugar beet molasses, used in the process, was obtained from the sugar factory Pećinci, Serbia. Inital dry matter content of sugar beet molasses was 79.45%. The material to solution ratio of 1:5 was used during experiment. The experiment was carried out under atmospheric pressure at the room temperature of $22^{\circ}C$. The process was performed in laboratory jars. Sample of meat was dipped into sugar beet molasses, and the immersion lasted for 5 hours. On every 15 minutes meat sample in osmotic solutions was manually agitated to provide better homogenization of the osmotic solution. After 5 hours meat sample was taken out from osmotic solution and then lightly washed with water and gently blotted with paper towels to remove excessive water from the surface.

The content of mineral matters was determined in accordance to SRPS ISO 6869/2004 (12). The content of dry matter was determined in accordance with the requirements of the Serbian National Regulation (13). Determination of the content of NaCl was done by the SRPS ISO 1841-1/1999 (14); determination of the ash content was done by the SRPS ISO 936/1999 (15); determination of the protein content was done in accordance to the AOAC 992.15 methods (16); determination of the fat content was done by the SRPS ISO 3496.2002 (17); determination of the total phosphorus content expressed as P_2O_5 was done by SRPS ISO 13730/1999 (18); determination of the sucrose content was done using Luff-Schoolr method. For each determination measurements were performed in triplicate.

3. RESULTS AND DISCUSSION

3.1 Chemical composition of meat before and after OD

Initial weight of meat sample before treatment was 100g, and after 5 hours of dehydration was measured weight of 75.10 g for dehydrated meat product. Chemical analysis was performed to achieve a better understanding of the mechanism involved in three simultaneous flows that take place in the process of dehydration. Based on mass balance of the chemical composition of meat before and after OD it is possible to quantitatively and qualitatively define the mass transfer occurring during the dehydration process.

In table 1 chemical contents of fresh and osmotically dehydrated pork meat are shown to represent the changes of the quantity of chemical components: dry matter, protein, fat, ash, sodium-chloride, sucrose and phosphate in the meat after OD.

Table 1. Chemical composition of dehydrated meat sample compared to the initial meat sample

Chemical parameter (g)	Fresh pork meat (100g)	Meat dehydrated in molasses (75,10g)
Dry matter	**25.60**	**41.46**
Ash	**1.12**	**2.85**
Protein	**20.78**	**21.14**
Fat	**6.65**	**6.72**
NaCl	**0.00**	**0.18**
Sucrose	**0.00**	**8.79**
Phosphate	**4.97**	**3.84**

Dry matter content (DMC) of the unprocessed pork meat was 25.60g, and result for DMC in processed meat was 41.46g. These data point out on increase of solids for 15.86g, which represents the amount of dry matter that penetrated from molasses into the meat submerged in it. When added up and subtracted mass of examined chemical compounds that entered and left the meat sample during dehydration, it can be concluded that the DMC of dehydrated sample was increased for 10.04g. Remaining 5.82g of dry matter that penetrated into the treated meat are compounds that are not analyzed in this study. On the other hand, initial water content in meat was 74.4g, whereas after OD was 33.7g. This means that 40.7 g of water has leaked from meat into molasses. The main aim of the OD process is obtaining high water loss from the fresh sample, providing products extended sustainability (19), as was achieved in this case.

The analysis was revealed that there were differences in quantity of the components which constitutes dry matter before and after OD. Starting mass of protein was 20.78 g, but after OD it was 21.14g indicating slightly increase of 0.36g. The increased protein content in final meat product is the result of the use of molasses as osmotic solution. Sugar beet molasses contains about 5% proteins (20), and it is possible that some of them diffuse into the meat dipped in molasses. The increase of protein composition is desirable since proteins are an important source of essential amino acids necessary for human organism (1).

The ash content in meat before OD was 1.12g, whereas after this process was 3.8g. There was an increase of 1.73g because of diffusion of substances which make ash from molasses into the final product.

The change in fat content in dehydrated meat is negligible compared to the initial fat content. The process of OD with molasses as osmotic solution increase content of fat in meat on average about 0.1 g. The fat is an important source of energy, but in certain circumstances and in inappropriate proportions has a negative effect on human health (21). Taking this fact into account a slightly increase is still acceptable.

Based on the results of chemical analysis it was observed that 0.18 g of sodium-chloride was entered from molasses into the meat product during dehydration. Reduced salt intake is important from the health point of view (21). Therefore, the low enrichment of final product with salt gives advantage to the molasses in relation to the conventional osmotic solutions that lead to penetration of greater amount of salt.

On the other hand, quantity of sucrose was noticeable increased after process of OD. Compared to the fresh state of meat that was not contain sucrose, in dehydrated product was measured 8.79g of sucrose which was diffused from molasses. Considering the high concentration of sucrose in molasses (approximately 50%) evident increase of sucrose content in dehydrated meat was expected (20).

Salt and sucrose can increase the water-binding and fat-emulsifying capacities of the myofibrillar proteins and improve the taste of the final products. Increasing water-binding, NaCl and sugar, favorably affect on the texture of meat. Although, higher amounts of salt are undesirable because lead to protein denaturation and decrease water-binding (24,25). Due to the high sucrose concentration in molasses, by the presence of sugar, salt impregnation is hindered (24). For this reason, molasses is a suitable medium for dehydration causing increase of salt and sucrose in desired quantities for product quality.

In the case of phosphate an opposite mass transfer was occurred. From meat sample was flow out 1.12 g of phosphates into the molasses underway the process. From the health aspect, reduction of phosphate content is reasonable because large amounts of phosphorus in the human organism can cause certain health problems such as damage and degeneration of cells kidney, mainly as a result of precipitation of calcium phosphate. Also, excess phosphorous disrupts the absorption of calcium in the intestine, which has a result in the release of calcium from the bones (23).

3.2 Mineral composition of meat before and after OD

It is well known that the minerals have irreplaceable significance for normal functioning and revitalization of every organism, they are necessary for specific metabolic functions and their role in maintaining health is very important (9). In this study mineral composition of meat before and after OD was determined.

Table 2 is shown the changes of the contents of the analyzed mineral components (K, Na, Mg, Fe and Ca) in the pork meat dehydrated in sugar beet molasses.

Table 2. Mineral composition of dehydrated meat sample compared to the initial meat sample

Mineral substances (g)	Fresh pork meat (100g)	Meat dehydrated in s molasses (75.10g)
K	0.471	1.164
Na	0.089	0.259
Mg	0.032	0.042
Fe	0.002	0.003
Ca	0.014	0.072

Sugar beet molasses is rich in minerals and other biogenic substances, and contains about 4g/100g K (20). Diffusion of this mineral was occurred from the molasses into the meat sample, so an increase in the content of K took place in the treated meat. From this result it is possible to conclude that the content of K was about 2.5 times higher in comparison to the amount of K in the starting, non-dehydrated meat.

The content of Na was slightly increased in treated meat product, for 0.17g. Final Na content of meat was 0.259g. From the health point, this amount of Na in meat is in the acceptable range considering that the value of recommended daily sodium intake amount is 2.4g. Recently, emphasis has been placed on reducing level of salt in meat products in view of its relationship to hypertension, since the sodium is the component of salt that causes increase in blood pressure (21,22). Sugar beet molasses contains small amount of salt, less than 1g (20), and for this reason, application of molasses as osmotic agent is preferred.

Based on the analysis it was found that the content of Mg, Fe and Ca was increased in dehydrated sample of meat that enhanced its nutritive value. The increase of Mg and Fe was expressed in a slightly extent, but increase of Ca was more expressed. About 0.06g Ca was penetrated from molasses into the meat during dehydration. The increase of Ca content is considerable, highlighting the fact that the Ca is important element useful for bone development and growth (22).

4. CONCLUSIONS

On the basis of presented results, a general conclusion is that the use of sugar beet molasses during OD improves the nutritional profile of meat.
After osmotic OD was obtained meat product with increased content of protein, fat, salt and sucrose in appropriate extent, except of phosphates, which content was reduced. The chemical components in the obtained meat product are in optimal quantities for human health. It can be considered that the dehydrated meat product has the characteristic of functional food.

By analyzing the content of mineral components (K, Na, Mg, Fe and Ca) in the sample osmotically dehydrated in sugar beet molasses increase the amount of mineral substances, particularly K, was observed. Therefore, dehydrated meat has enhanced nutritional properties.

The presence of complex solute compositions in molasses maintains a high transfer potential favorable to water loss, and at the same time to impregnation of desirable nutritional compounds and minerals in meat product. Sugar beet molasses is suitable osmotic agent for OD process, and this study confirms usefulness of its applying.

ACKNOWLEDGEMENT

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

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