



Osmotic dehydration of *Amorphophallus paeoniifolius* slices & its phyto-chemical investigation

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Abstract

Amorphophallus paeoniifolius known as Elephant foot yam is a highly potential tropical tuber crop of Araceae family. The tubers are rich in nutrients. It is a healthy low-fat food containing a good source of protein as well as starch. It is a natural product that is high in fiber, rich in potassium, calcium (50 mg g⁻¹), phosphorus (34 mg g⁻¹) vitamin A (260 IU g⁻¹), vitamin B₆, as well as with trace minerals like selenium, zinc and copper. Fresh yams are difficult to store and deteriorate on storage. Various drying operations like freeze drying, sun drying has been reported for developing a stable form of dried Yam products but the effect of these food processes are not reported. In this investigation the yam slices were osmo-dehydrated after pretreatment i.e. at 4°C for 12 hours, prior to this dehydration the phytochemicals levels as well as enzymes like protease and cellulase activity was checked. The effect of the osmotic substance, time, temperature of this dehydration process on enzyme activity after rehydration is studied.

Key-Words: *Amorphophallus*, Osmotic dehydration, Sugar solution

Introduction

It is already well known fact that bulk of the vegetables and fruits grown only during predetermined season and there is a need to increase the shelf life of these perishable natural resources. Dehydration is one of the most common natural and reliable method where vegetables and fruits in its dehydrated form are preserved for a longer period and are made available during off-season.

Osmotic dehydration is used to improve the economics of dehydration processes for extension of the sustainability of fruit and vegetable drying. The aim of osmotic dehydration is a partial removal of water from the material to obtain a better quality final product. Tomato, potato, pumpkin, carrot, onions are some vegetables that are good example of osmotic dehydration. (Le Maguer 1988, Filipčev, B et al; 2008) In this process first, fruits and vegetables are dipped in a hypertonic aqueous solution of sugars, salts or a combination of both and multicomponent mass transfer occurs through the semi permeable cell wall due to difference in osmotic pressure of water in the plant tissue and hypertonic aqueous solution leading loss of water from fruits and vegetables. Diffusion of solute from osmotic solution into fruits and vegetables is also seen. (Koprivica, G., 2009)

Diffusion of cell juices from the plant tissue into the osmotic solution also occurs this is known to affect the nutritive value of osmo-dehydrated fruits and vegetables (Mizrahi, S., S. Eichler, J.L.; 2001) Osmodehydrated fruits and vegetables are partially dehydrated which can be directly used in human nutrition or as an intermediate material for further drying to the form a product can be used as components of cereals or snacks for direct consumption with appropriate moisture content (Lenart, 1996; Filipčev, B., Lj. Lević, O. Šimurina, T. Kuljanin ;2006 and Torreggiani, D. Bertolo, G.; 2001)

Dehydration process parameters and osmotic agent used can modify the quality traits and nutritional value of osmodried fruits and vegetables (Mandala *et al.*, 2005; Chiralt and Talens, 2005) Main factors effecting the mass transfer rate in this process are temperature of the osmotic solution, agitation of the osmotic solution, concentration of the osmotic solution, type of osmotic agent, time duration, geometry (size) of the food material, variety of the food material, physico-chemical properties of the food materials and operating pressure. Advantage of this process is quality improvement, Packaging and distribution cost reduction, influence on the principal drying method, product stability during storage, no chemical requirement, shortening of the drying process, resulting in lower energy requirements. (Lenart and Lewicki, 1988) Since heat is not applied in

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this process, which leads to higher retention of initial food characteristics, like colour, aroma, nutritional constituents, and flavour compounds (Beaudry 2001).

Amorphophallus paeoniifolius is a good source of protein as well as starch. Commercially cultivation of this crop is due to its production potential (50-80 t ha⁻¹) and popularity as a vegetable in various Indian cuisines. In India, it is cultivated in Andhra Pradesh, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharashtra, Uttar Pradesh, and Jarkhand. The net economic return is over 1 lakh rupees per ha. It has a great export potential since its commercial cultivation is not in other countries (Misra and Shivalingaswamy, 1999; Misra et al., 2001).

In India, Sree Padma, Gajendra, Sree Athira (a hybrid), Bidhan Kusum and NDA-9 are some of the high yielding *Amorphophallus* varieties released for cultivation (AICRP, 2006).

Osmotic dehydration of *Amorphophallus* can be a useful technique to preserve and obtain new processed products of interest to the consumer. This study was aimed to produce a novel shelf stable high quality dried *Amorphophallus* cubes using combination of pre-treatment, osmotic dehydration and conventional hot-air drying. The effect of different concentration of sugar, dehydration time, dehydration temperature on the rate of dehydration and its effect on enzyme activity and phytochemicals is studied. Process condition was optimized in order to produce good quality product.

Material and Methods

Fresh *Amorphophallus* tubers were purchased from the local market. Prior to the treatment, the elephant foot yam were thoroughly cleaned and cut into square shapes of, 2cmx2cm. Osmotic solution used was table sugar aqueous solutions (solid content: 50%, 60% 70% and 80%) that were prepared by mixing sugar in deionized water (30°C) to complete dissolution.

Prior to osmotic dehydration of cubes were kept at 4°C for 12 hours as their pretreatment. Osmotic dehydration was carried out at constant temperature (55°C) in the water bath with minor shaking, under atmospheric pressure. After measuring the initial mass, *Amorphophallus* cubes were dipped into different concentrations of the hypertonic sugar solutions. Sugar solutions had a concentration of 50% (indicated as S1), 60% (S2), 70% (S3), 80% (S4).

The material to hypertonic solution ratio was kept constant at 1:10. The evenly sliced samples were kept for dehydration and samples were removed after 0 min, 60min, and 150 min. The slices were then washed with water blot dried for 15 min to remove excessive water, oven dried at 65 °C for 2 hours until constant weight

was attained. During the process the values the changes in weight and in the content of dry matter observed. The following

parameters were calculated: water loss (WL), weight reduction (WR), dry matter growth (SG)

(Le Maguer, M.1988)

$$WR [g/g] = \frac{w_0 - w}{w_0} \quad [1]$$

$$SG [g/g] = \frac{u - u_0}{w_0} \quad [2]$$

$$WL [g/g] = WR + SG \quad [3]$$

*W*₀ - initial weight of the sample (g), *W* - weight of the sample after osmotic dehydration (g), *u*₀ - weight of dry matter in the fresh sample (g), *u* - weight of dry matter in the sample after osmotic dehydration (g). of plant collection has been shown in the Figure 1.

Results and Discussion

The intensity of the yams yellow or orange flesh color nutrient is not lost on osmotic dehydration this color is an indicative of presence of "Provitamin A." We report that *Amorphophallus paeoniifolius* is a good source of digestive enzyme protease and cellulose as well as saponins. Saponins are surface active sterol or triterpene glycosides and saponin-containing food plants, lower plasma cholesterol levels in several mammalian species and reduce the risk of coronary heart disease. Saponins are also effective in suppressing rumen protozoa thus decreasing the impact of protozoal diseases (coccidiosis) in animal. The increase of cellulase activity in yam causes the progressive degradation of cellulose, which is the main component of fiber in the tuber (Gohl, 1982; Kouadio, 2004). The predominance of amylase and cellulase activities are responsible for the decrease in content of the potato starch and fiber (Diopoh and Kamenan, 1981). Cellulase activity was checked and its presence 259.44(IU/ml/minute) in pretreated samples and absence after osmotic dehydration (results not shown) can be an indication of presence of fiber in processed yam slices. Further studies are in progress to estimate the content of fiber and other micronutrients in osmotically dehydrated slices.



0 min

30 min



Fig. 1: Shows the osmotic dehydrated slices after 0min, 30min, 120min, 150 min, 180min

Table 1: Kinetic parameters of osmotic dehydration of *Amorphophallus* in sugar solution

CONCENTRATION OF SUGAR,%d.m.	TIME (minute)	WRX10 ² (g/g initial sample weight)	SGX10 ² (g/g initial sample weight)	WLX10 ² (g/g initial sample weight)
50%	0 min	5.626134	15.97096	21.5971
	60 min	13.77049	12.78689	26.55738
	150 min	11.92308	21.92308	33.84615
60%	0 min	3.526971	5.809129	9.3361
	60 min	6.373626	20.65934	27.03297
	150 min	15.27166	26.87225	42.14391
70%	0 min	1.98915	6.690778	8.679928
	60 min	9.836066	18.50117	28.33724
	150 min	17.06924	22.86635	39.93559
80%	0 min	6.321839	72.22222	78.5441
	60 min	8.614232	70.41199	79.0262
	150 min	12.8655	70.76023	83.6257

Tables 1 Shows, osmotic dehydration of *Amorphophallus* slices depend on the concentration of sugar solution as well as duration of osmotic dehydration process. The process of osmotic dehydration decreased weight of the slices, The *Amorphophallus* slices dehydrated in the 80% sugar solution showed maximum water loss 83.6257X10⁻².

Table 2: Phytochemical screening in pre-treated *Amorphophallus* slices

Sample	Saponin	Tannins	Terepenoids	Cardiac glycoside
<i>Amorphophallus paeoniifolius</i>	++	-	-	-

Cellulase Activity in pretreated *Amorphophallus* slice

Sample	Activity of cellulase (IU/ml/minute)
<i>Amorphophallus paeoniifolius</i>	259.44

Protease Activity in pretreated *Amorphophallus* slices

Sample	Total activity(U)	Total protein(mg)	Specific Activity(EU/mg)
<i>Amorphophallus paeoniifolius</i>	11.5	89	0.13

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References

1. Beaudry, C. 2001. Evaluation of drying methods on osmotically dehydrated cranberries. Unpublished M.Sc. thesis. Montreal, QC: Department of Agricultural and Biosystems Engineering, McGill University.
2. Charles Tortoe, (2010), A review of osmodehydration for food industry, African journal of Food Science Vol. 4(6), pp. 303 - 324, June 2010
3. CHIRALT, A. and TALENS, P. (2005). Physical and chemical changes induced by osmotic dehydration in plant tissues. *Journal of Food Engineering*, 67, 167-177.
4. Diopoh J. and Kamenan A. (1981). Distribution de l'amylase, de la phosphorylase et de la phosphatase acide dans quelques dioscoracées (Icnames) de Côte d'Ivoire. *Physiologie Végétale*. 19 :401-405.
5. Gohl B. (1982). Les aliments du bétail sous les tropiques. Collection FAO (12). Données sommaires et valeurs nutritives. Fondation internationale pour la science, Stockholm, Suède, 143 p.
6. Filipčev, B., Lević, Lj., Pribiš, V., D. Kabić: Melasa šećerne repe kao pogodan hipertoničnirastvor za osmotski predtretman jabuke, XIII Savetovanje o biotehnologiji, Čačak, 28-29. Zbornik radova 13 (2008) 323-331.
7. Filipčev, B., Lj. Lević, O. Šimurina, T. Kuljanin: Priprema voća postupkom osmotskedehidracije u melasi šećerne repe sa ciljem njegove primene u pekarskoj industriji, PTEP- Journal on Processing and Energy in Agriculture 10, 5 (2006) 154-157.
8. Koprivica, G., N. Mišljenović, Lj. Lević, T. Kuljanin: Influence of nutrients presentin sugar beet molasses and saccharose solutions on the quality of osmodehydrated carrot, PTEP 13, 2 (2009) 184 -187
9. Kouadio N. E. J. P. (2004). Contribution to the study of the tuber of taro *Xanthosoma* spp. Var. "ATOUMBOU ORONO. Doctorat de 3ème cycle en Sciences et Technologie des aliments. Université d'Abobo-Adjamé. Abidjan Côte d'Ivoire. 103 p.
10. Le Maguer, M.: Osmotic dehydration: review and future directions, Proceedings of the symposium in food preservation process, Brussels (1988): CERFCI vol. 1, 283-309.
11. LENART, A. (1996). Osmo-convective drying of fruits and vegetables: technology and application. *Drying Technology*, 14, 391-413.
12. Lenart A, Lewicki PP (1989). Osmotic dehydration of apple at high temperature. In *Drying* 89. Mujumdar A S, Roques M (Eds.). Hemisphere Publication Corporation, New York, USA. pp. 501.
13. Misra, R. S. and Shivlingaswamy, T. M. 1999. Elephant foot yam: atropical tuber crop with high yield potential. 4th Agricultural Science Congress, February, 21-24, 1999, Jaipur, Abstracts of papers, 270
14. Misra, R. S., Shivlingaswamy, T. M. and Maheshwari, S. K. 2001. Improved production

- technology for commercial and seed crops of elephant foot yam. *J. Root Crops*, 27: 197-201.
15. Mizrahi, S., S. Eichler, J.L. Cuq: Osmotic dehydration in gel systems, *Journal of Food Engineering* 49 (2001) 87-96.
 16. Ramallo, L.A., R.H. Mascheroni: Rate of water loss and sugar uptake during the osmotic dehydration of pineapple, *Brazilian Archives of Biology and Technology* 48, 5(2005) 761-770.
 17. S Jain & R. C. Verma & L. K. Murdia & H. K. Jain & G. P. Sharma: Optimization of process parameters for osmotic dehydration of papaya cubes(2009), *J Food Sci Technol* (Mar-Apr 2011) 48(2):211-217
 18. Torreggiani, D. and Bertolo, G. (2001). Osmotic pre-treatments in fruit processing: chemical, physical and structural effects. *Journal of Food Engineering*, 49, 247-253
 19. V. Ravi, C.S. Ravindran and G. Suja(2009), Growth and Productivity of Elephant Foot Yam (*Amorphophallus paeoniifolius* (Dennst. Nicolson): an Overview: *Journal of Root Crops*, 2009, Vol. 35 No. 2, pp. 131-14