Effect of Osmo-Dehydration on the Rehydration Properties Structural Aspects and Antioxidant Activity of Banana and Tomato Rings

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Abstract: The objectives of this research were mainly directed towards microstructure and the influence of different osmotic solutions on the rehydration capacity. In banana rings, it is indicated that using sucrose: glucose as an osmotic solution with different concentration gave the highest rehydration ratio. Regarding tomato, the osmosed solutions were different concentrations of NaCl and NaCl: Sucrose; they gave an inversely proportional relationship with rehydration capacity. Antioxidant activity was measured by conjugated diene method, and it is strongly affected by the type of pre-treatments applied. Regarding the microstructure, this study showed important changes in the cell wall cytoplasm and the intercellular spaces

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Keyword: Banana rings – Tomato halves – Osmotic dehydration solutions – Antioxidant activity – Conjugated diene method.

1. Introduction:

Over the past few years, consumers, have increasingly demanded food products providing, both good sensorial quality and specific nutritional properties. In this issue, a great effort has been made in food technology to adequately posses particular consumer requirements.

Partial dehydration and solute intake can be achieved by immersion in a concentrated aqueous solutions, this process is called osmotic dehydration(Lazarides *et al* .,1999) by modifying the extent of the partial dehydration and syrup composition; not only the end product be diversified but chemical, physical and functional properties can be improved (Torregiant and Bartelo, 2001). It was found that solute loss during rehydration is increased due to structural changes induced by osmotic pre-treatments and interaction of the osmo-active substances with the cell components.

Osmotic dehydration of banana rings and tomato halves; can be carried out as a means of pre-drying treatment (Ali *et al.,* 2010). It was found that desirable functional properties can be obtained.

During rehydration, absorption of water into the tissue results in an enhancement in the mass, simultaneously leaching out of solutes (sugars, acids, minerals, vitamins) occur and both phenomena are influenced by the nature of the product and conditions analyzed for rehydration (Korkida and Marinos-Kouris, 2003). Rehydration kinetics can be applied to ascertain the net extent of injures and other processing step prior to it(Restogi *et al.,* 2000). A solute loss during rehydration is enhanced due to structural changes induced by osmotic pretreatments and interaction of the osmo-active substances with the cell components.

Rehydration is influenced by several factors grouped as- intrinsic factors (chemical composition, pre-drying treatment, product formulation, drying techniques and post drying procedure, etc) and extrinsic factors such as: (composition of media used -hydrodynamic conditions (Oliveria and Ilineanu, 1999).

Therefore, this work was carried out to investigate how different osmotic solutions could affect the rehydration properties and structural aspects and antioxidant activity of the osmo-dehydrated banana and tomato rings.

2. Material and Methods

1- Materials

Banana (*Musa cavendishii* var balady) and tomato (*Lycopersicon esculentum* L) were obtained from the local market, Giza, Egypt. The tips of the banana were first removed and its medium part, were cut into rings of 1cm length with a knife. Tomatoes were sorted and sliced to an average thickness of 10mm, and each halve was longitudinally cut into two halves.

2- Methods:

Banana rings were subjected to the following osmotic treatments as follows:-

T_1 = 100% sucrose
T_2 = 50:50 glucose: sucrose.

T_3 = 30:70 glucose: sucrose
Tomato halves were also subjected to different NaCl: sucrose combinations (1:1.5). The samples were ranked as follows:
T_4 : 5% Na Cl
T_5 : 10% Na Cl
T_6 : 20% Na Cl
T7 : 30%Na Cl
T_8 : sucrose: Salt 5%
T_9 : sucrose: Salt 10%
T_{10} : sucrose: Salt 20%
T_{11} sucrose: Salt 30%

The experimental procedures were carried out as described by (Ali *et al.,* 2010).

Methods:

1- Microstructure:

Scanning election micrographs were obtained using scanning electron microscope, Joel JSM-6100 Joel ltd. Tokyo-Japan as described by (Aguilera and Stanely, 1999). These micrographs were taken to investigate the microstructure of Banana rings; osmosed dried with sucrose and glucose solutions. Tomato halves were also osmosed dried with different concentrations of Na Cl and Na Cl: Sucrose.

2- Rehydration Experiments:-

Rehydration experiments were carried out as mentioned by (Maskan, 2001).The rehydration was calculated using the following equation.

Weight gain %=$(w_s\text{-}w_d)/wd$ …………………… (1)

Where:
W_t= weight of the rehydrated samples at any time (g)
W_d= weight of the dried sample (g)

The data were expressed as an average of different rehydration time at 0, 30, 60, 90, 120 and 180 mins.

3- Antioxidant activity:

The antioxidant activity was measured by applying the conjugated diene method using pure sunflower oil as described by (Lingnert *et al.,* 1989). The A_{234} min. was taken as an indication of the course of oxidation using untreated Banana rings and tomato halves as a control.

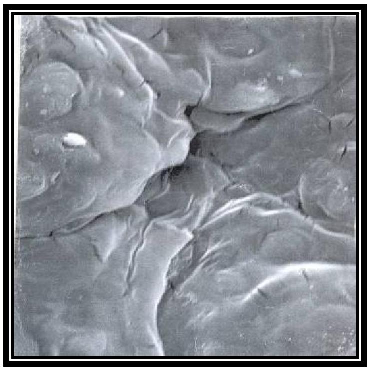
3. Results and Discussion

Osmotic dehydration microstructure:

Figs.(1, 2 and 3) showed the microstructure of the osmosed dried tomato halves and Banana rings, respectively. Those figures showed a disruption of cell walls, covered with cytoplasm. Osmotic treatment of Banana rings and tomato halves caused an important changes in their microstructure levels i.e; cells become, elongated with cell wall, plasma membrane is folded and separated; as quickly as the salt content of the osmotic solution is enhanced; (Tonon *et al.,* 2007). After a certain time a protoplast is released and adapted. a spherical shape, thus reducing the excess of energy associated to the matrix contraction (Barat *et al.,*1998). Great compacting of the cell structure and disorganization of the protoplast contents were also observed by (Heredia *et al.,* 2009). Tedjo *et al.*(2002) suggest that different pretreatments caused different cell poration, which suggests that the mechanisms of cell permeability by the different pretreatments are not the same.

Changes that occurred in Tomato and Banana after osmotic dehydration showed a net like pattern of the intercellular spaces which is no longer distinct and it appears as if these intercellular have been filled with the osmotic solution; which indicated that, there was an accumulation of sugars on the periphery of the fruit, also it is suggested that as the solid gains were enhanced with osmotic dehydration time, the thickness of the sugar layer increased and the viscosity of such layer is getting higher which retards the diffusion of water through this layer into the osmotic solution.

Fig(1) Microstructure of Banana rings osmosed dried with 100% sucrose.



Fig(2) Microstructure of osmo-dehydrated Tomato rings with 30% Nacl

Fig(3) microstructure of osmo-dehydrated Tomato rings with 30% sucrose :Nacl

Influence of osmotic pretreatments on the rehydration capacity

The weight gain of the rehydrated banana rings and tomato halves samples were shown in tables (1, 2 and 3). As the sucrose levels are getting lower; an enhancement in the rehydration capacity was observed; specially when using glucose as a synergistic osmotic solution; an enhancement in the rehydration capacity was observed.

It seems that the lower concentration of sucrose pretreatment might take part in importing structural and mechanical strength to the tissues (Lewicki *et al.,* 2005). Sugar protects the functionality of protein; stabilizing its three dimensional structure; attributed to an enhancement in hydrophobic interactions and hydrophilic properties due to the formation of protein-sugar complex.

Lesile *et al.* (1995) reported that disaccharides maintain the general protein structure in dry state; hence the membrane is protected and upon rehydration, its functionality restored.

Regarding tomato, table (2) showed clearly an inversely proportional relationship between the suggested levels of the previously mentioned osmotic solutions used; and the rehydration capacity as a function of different duration time at the stationary phase.

The same effect was noticed when sucrose was used as osmotic solution in addition to in Nacl. Increasing the level of salt caused the same effect with somewhat higher rehydration level, these changes could be related to the synergistic effect of sucrose as previously mentioned (Figs. 2,3).

Osmotic dewatering affects the rehydration properties of the dried material, because of cell permeabilization due to osmotic stress and hence upon rehydration, these cells cannot absorb as much as control. At the same time, solute loss during rehydration also enhance that possibility due to the structural changes induced by the osmotic pretreatments and interaction of the osmoactive substances with the cell components (Restogi *et al.,* 2004).

Antioxidant activity:-

Table (4) showed the pattern of antioxidant activity, the highest antioxidant activity was found in 100% sucrose. It seems that at 100% sucrose, the antioxidant activity could be preserved. The data also showed an inversely proportional relationship between Na cl concentration and antioxidant activity, adding sucrose with small levels in 5%, 10% causes a preservative effect. These data are confirmed with those presented by Azoubell and Murr, 2003, Tonon *et al.,* 2008 and Ali *et al.,* 2010, who reported that lower redness value a* could be used as a useful indicator for correlating it with lower a* value.

Table (1): Rehydration of Banana rings as a function of different osmotic solutions.

	Banana rings rehydration time (min)					
	0	30	60	90	120	180
100% sucrose 30:70	0	0.441	0.636	0.854	1.037	1.054
100% sucrose 50 : 50	0	0.47	0.729	0.962	1.062	1.360
100% sucrose 30:70	0	0.533	0.812	0.988	0.110	1.650

Table (2): Rehydration of Tomato rings as a function of different Na cl osmotic solutions.

	Tomato Halves rehydration time (min)					
	0	30	60	90	120	180
5% Na cl	0	1.246	1.670	2.08	2.561	3.04
10% Na cl	0	0.909	0.909	1.187	1.811	1.95
20% Na cl	0	0.531	0.767	0.939	1.108	1.42
30% Na cl	0	0.501	0.721	0.893	0.969	1.01

Table (3): Rehydration of Tomato rings as a function of different sucrose: salt ratio.

	Tomato Halves rehydration time					
	0	30	60	90	120	180
Sucrose: salt 5%	0	1.304	1.852	2.111	2.642	3.07
Sucrose: salt 10%	0	1.347	1.749	2.414	2.134	2.439
Sucrose: salt 20%	0	0.861	1.136	1.461	1.525	1.726
Sucrose: salt 30%	0	0.639	0.986	1.112	1.125	1.386

Table (4): Antioxidant activity of Banana and Tomato rings as affected by different osmotic solutions

Treatments	samples	A_{234}.min	Antioxidant Activity %
control	Banana Rings	0.002	0
100 % sucrose	Banana Rings	0.006	83.3
50:50 Glucose: Sucrose	Banana Rings	0.011	45.4
30:70 glucose: Sucrose	Banana Rings	0.32	25
5% Na Cl	Tomato halves	0.005	90.5
10% Na Cl	Tomato rings	0.007	71.42
20% Na Cl	Tomato rings	0.007	62.50
30% Na Cl	Tomato rings	0.068	67.50
Sucrose : Salt 5%	Tomato halves	0.10	67.50
Sucrose : Salt 10%	Tomato rings	0.010	56.5
Sucrose : Salt 20%	Tomato rings	0.009	4..5
Sucrose: salt 30%	Tomato rings	0.009	4.5

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