

Rehydration characteristics of dried summer onion

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ABSTRACT

In this research, different reconstitutive properties of summer onion were studied. During rehydration quality test for both samples (mechanical and solar dried) it was observed that the rehydration ratio (RR) was higher for mechanical dried onion than that of solar dried counterparts and RR was also higher for blanched sample rather than unblanched sample for both the drying method. The coefficient of reconstitution (CR) is found to be highest for mechanical dried blanched onion and was followed by mechanical unblanched, solar blanched and unblanched dried onion. It is also seen that both RR and CR of osmosed onion (55/15% sugar-salt, 60% sugar and 25% salt) showed better reconstitution properties than nonosmosed onion.

Key words-

Summer onion; mechanical and solar drying; rehydration ratio; coefficient of reconstitution; blanched and osmosed

1. INTRODUCTION

Rehydration is the replacement of water in dehydrated food and is also termed as synonymous terms are “refreshing”, “recover”, “restoration” and “reconstitution”. In the process of rehydration, a large percentage of the original water present is assimilated and thus the dehydrated product is ready for cooking and/or eating. All products cannot be reconstituted to 100 percent of their original weight because of inherent differences in their chemical and physical properties. Rate of drying as well as drying and storage temperature also has an important impact on the extent of rehydration of dehydrated vegetables ⁷.

The removal of moisture from plant cells changes the cells' physical properties, which affects rate of rehydration of dried products due

to (a) loss of osmotic pressure, (b) change of permeability in the protoplasmic membrane, (c) crystallization of polysaccharide gels in the cell wall, (d) coagulation of proteins, (e) shape of pores, and (f) change of pH ²⁰.

Drying or dehydration increases the crystallization of polysaccharide gels by bridging reactive polymer groups closer together. In fresh vegetables the free hydroxyl groups of polysaccharides have a secondary valence, which is almost completely fulfilled by water. These hydroxyl groups lose their noncovalently bound water due to dehydration. The shrinkage of the plant cells enables the adjacent polysaccharide molecules to be drawn together and thus fulfill the hydroxyl group's valence ¹¹.

Drying results in toughened skins making it difficult for the water to penetrate into dried foods. Pretreatments for drying are usually designed to improve rehydration properties. In case of green peas pricking prior to dehydration helps in quick dehydration and better rehydration and the advantage of pricking depends on the pea variety and also varies with pea maturity ²³.

The success of drying largely depends on the reconstitution properties of the dried products. Since the dried product becomes acceptable as food only if it get back a good colour, flavour, texture and nutritive value when it is reconstituted with water. The parameters influencing drying and reconstitution procedures must be carefully chosen to do as little injury to these qualities as far as possible. There are

many factors, which affect the quality of dried fruits and vegetables during reconstitution. Pre-treatment before soaking, period of soaking, temperature of soaking water, ratio of water to dried products, rate of heating and length of cooking are some of the important factors. Differential effect on reconstitution properties of certain fruits and vegetables were observed by addition of several concentrations of certain salts²⁵.

Blanching pretreatment to drying causes loss in solids, enzyme denaturation, air removal from tissues, hydrolysis and solubilisation of structural polymers such as protopectin¹⁴. It will also cause starch granules to gelatinise, influencing the water binding capacity of the rehydrated product, as the gelatinised form would hold more water than the crystalline raw starch. Moreover, it expands intracellular air which flows through the intracellular lamella. It had been shown that blanching increased the rate of drying in carrots¹⁵ and in mint¹². Mate *et al.*¹⁴ and Marousis *et al.*¹³ however, observed a more compact (higher shrinkage), less porous product, with lower effective water diffusivity (lower drying rate) of blanched potato as compared to unblanched potato.

Mujumdar¹⁹ showed that rate of rehydration is an important quality parameter for dried products. From theoretical viewpoint, if there are no adverse effects on the integrity of the tissue structure, dried product should absorb the water to the same moisture content as the initial product prior to drying. The nature of internal porous structure, and mechanical and elastic properties of the dried material, would however influence the rate and amount of moisture uptake during rehydration.

Mudahar *et al.*¹⁴ while studying the rehydration characteristics of dried potatoes showed that the drying temperature had a significant roll on rate of rehydration of dried product. Karathanos *et al.*⁸ informed from the rehydration kinetics of celery at different stages of drying showed that the rehydration ability is reduced as the product gets drier. This behaviour is attributed to the increased loss of

porosity or the collapse of the cellular structure as the drying progressed. Puffing of the particles while drying (also high temperature process) reduced the bulk density but improves its rehydratability¹⁷.

Kareem *et al.*⁹ in a study on rehydration rate of five tomato varieties, China Pearson, Roma, Ace, and found that the best rehydration conditions were product to water ratio 1:8, and 40-60 min. soaking in water at 80-85⁰C.

Shams-Ud-Din *et al.*²⁴ in a study on rehydration properties of dried cauliflowers showed that cauliflower dried in a mechanical dryer, the dehydration ratio, the rehydration ratio and the moisture content of rehydrated material (% wb) were 15.2, 5.25 and 80.95 respectively, while for solar-dried cauliflower, these values were 14.8, 2.75 and 63.64 respectively.

Iqbal⁶ found higher rehydration ratio of dried cauliflower and cucumber for mechanically dried blanched (5.69 for cauliflower and 5.47 for cucumber) sample than solar dried blanched (3.94 for cauliflower and 3.27 for cucumber) counterparts. It was also found that blanched samples give higher rehydration ratio than unblanched sample.

Thus, different products behaved differently as to rehydration characteristics depending on pretreatments prior to drying, rate of drying, as well as method of drying, rehydration method/ condition. The aim of this study was to asses the rehydration quality of the dehydrated products.

2. MATERIALS AND METHODS

Freshly harvested summer onions were procured from the Spices Research Center (SRC) farm of Bangladesh Agricultural Research Institute (BARI), Bogra. Onions were cleaned and washed with tap water and spread on a plastic filter basket to drain out excess water. Onions were transversely cut into 5 mm thick slices using slicer. Fifty percent cut samples were blanched for 3 min. All blanched and unblanched samples were soaked in 1500

ppm potassium metabisulphite ($K_2S_2O_5$) solution for 20 min. The treated slices were divided into four samples for four treatments. The treatments were T₁ (Blanched mechanical drying), T₂ (Unblanched mechanical drying), T₃ (Blanched solar drying) and T₄ (Unblanched solar drying). Samples were dried in the solar (45-50°C) and mechanical drier (60°C).

For another experiment the 5 mm thick raw onion slices were osmosed for 24 hr in 25% salt solution (T₅), 55/15% sugar- salt solution (T₆) and 60% sugar solution (T₇) and dried in a cabinet dryer at 60°C.

After cooling in the room temperature, all the dried samples were packed quickly in different foil packet (130µm) and heat sealed. The samples were stored at room and refrigeration temperature. After twelve months of storage, the dried samples were taken for rehydration studies.

About 500 ml capacity beakers were taken and 150 ml of water and 2 g of dried sample were poured into each. After quick blotting with the filter paper weight of the reconstituted samples were taken each after 15 min. interval and selected the optimum textural condition of pre-soaked samples up to 60 min. The samples were subsequently boiled in the same pre-soaked water for 3, 7, 10, 13, 15, 18 and 21 minute as per Sarker and Setty²² and counting of time began after heating started. After expiry of the specific boiling time, the liquid portion was drained off while the solid content was transferred to a funnel covered with a coarsely porous filter paper. Gentle suction was applied and drained with careful stirring for one-half to one min. or until the drip from the funnel has almost stopped. The rehydrated samples were removed from the funnel and weighed individually. The dehydration ratio, rehydration ratio and co-efficient of reconstitution were calculated using following formula³.

Dehydration ratio (DR) =

$$\frac{\text{weight of prepared material before drying}}{\text{weight of dried material}} \text{-----(i)}$$

Rehydration ratio (RR) =

$$\frac{\text{weight of rehydrated material}}{\text{weight of dehydrated material}} \text{-----(ii)}$$

Co-efficient of reconstitution (CR) =

$$\frac{\text{Rehydration ratio}}{\text{Dehydration ratio}} \text{-----(iii)}$$

The percent water in rehydrated material was determined as per methods of Ranganna²¹.

% Water in rehydrated material =

$$\frac{(\text{Drained wt. of rehydrated material}) - (\text{Dry matter content in sample taken for rehydration})}{\text{Drained wt. of rehydrated material}} \text{-----(iv)}$$

3. RESULTS AND DISCUSSTION

To investigate the rehydration characteristics two sequential steps were followed. Firstly, soaking was done to asses the most favorable textural criteria of the osmosed, non osmosed, blanched and unblanched dried onion at room temperature (25-28°C). Pre-soaked products were then boiled for final reconstitution. It was found that there are significant differences among the rehydration characteristics of treated and untreated products even when the products were dried by identical drying method.

3.1 Reconstitution characteristics of non-osmosed onion

From Table-1, it is found that mechanically dried onion gave higher rehydration ratio (RR) than solar dried onion. For example, the RR is 6.85 for mechanical dried blanched onion while RR is only 3.34 for blanched solar dried onion. It is also seen that mechanically dried blanched product gave

higher RR (6.85) than unblanched onion (RR=3.7). Similarly it is also noted (Table-1) that solar dried blanched product gave slightly higher RR (3.34) than solar dried unblanched onion (3.29). From table-1, another important parameter CR ratio is found to be the highest for mechanically dried blanched onion (0.829) and was followed by mechanical unblanched, solar blanched and unblanched dried onion each with RR =0.44.

Apart from traditional way of presentation of rehydration characteristics by using RR and CR values (Table-1 and equations 1-7), data analyzed to predict rehydration behaviour by first order reaction kinetics^{5,26} also shows (fig.1) that highest reaction rate constant (0.0192) is given by mechanically dried blanched onion which was successively followed by mechanically dried unblanched (0.0157), solar dried blanched (0.0152), while solar dried unblanched onion gave the lowest (0.0149) rate constant during the entire period of rehydration (Figure and equation for soaking and boiling shown in below). The rate constants along with the equations (1 to 4) for the above mentioned mechanical and solar dried onion (blanched and unblanched) are given below:

$$Y = 1.6086e^{0.0192x}, \text{ (For mechanically dried blanched onion)} \text{-----(1)}$$

$$Y = 1.0713e^{0.0157x}, \text{ (For mechanically dried unblanched onion)} \text{----- (2)}$$

$$Y = 0.937e^{0.0152x}, \text{ (For solar dried blanched onion)} \text{-----(3)}$$

$$Y = 0.9039e^{0.0149x}, \text{ (For solar dried unblanched onion)} \text{-----(4)}$$

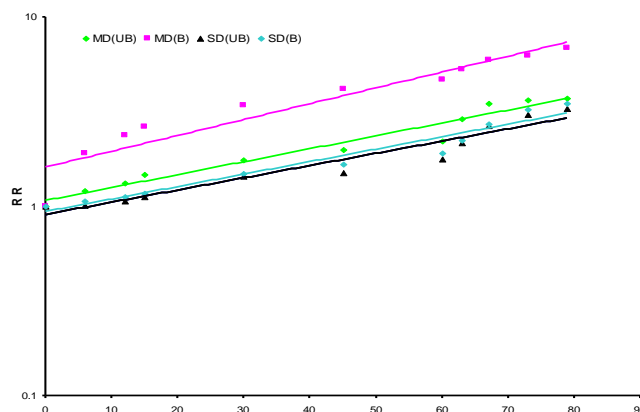


Fig. 1 Rehydration of mechanical and solar dried blanched and unblanched onion

The observed higher RR value and rate constant of mechanically dried blanched onion compared to those of unblanched dried onion and very little difference in RR value and rate constant between solar dried blanched and unblanched onion may be attributed to chemical and physical changes due to blanching, rate of drying etc. which stop enzymatic action on structural matrix. Higher rate of drying of already hot blanched product in mechanical dryer compared to the unblanched and solar dried might be responsible for higher RR, CR and rate constant obtained. The solar drying being a low temperature and low air flow slow drying process does not give much advantage out of blanching. Kueneman¹⁰ and Ardsel *et al.*⁴ observed that slower drying (such as solar drying) results in lower rehydration ratio compared to faster drying (as in mechanical drying). Iqbal⁶ reported that rehydration ratio of blanched and unblanched sample was 5.695 and 5.26 for couliflower while for cucumber 5.47 and 5.24 respectively, when both were mechanically dried. Abbasi *et al.*¹ observed that higher drying temperatures resulted in higher rehydration ratio and shrinkage in dehydrated onion slices. Moreno-Perez *et al.*¹⁶ and Marousis *et al.*¹³ stated that the pretreatments (blanching, freezing, high pressure and mechanical compression) affect the skin permeability due to cuticle layer removal or internal cellular damage or changes in the permeability of the cell wall due to the change

in the cell structure. Rahman ²⁰ also observed that blanching may affect the rehydration of fruits and vegetables. Akbari *et al.* ² however, showed that the rehydration ratio of onion decreased with an increase in drying air temperature and the predicted value of rehydration ratio was 5.87 at 540C drying air temperature for 3.7 mm thick onion slices. The highest coefficient ratio (0.829) given by mechanically dried blanched onion is an indication of its excellent reconstitution properties among the samples tested. This behavior is due to similar reason as noted for rehydration ratio (i.e blanching, drying rate etc.)

3.2 Reconstitution characteristics of osmosed onion

It was of interest to determine the rehydration ratio of dried osmosed onion. Thus 55/15% sugar-salt osmosed, 60% sugar osmosed and 25% salt osmosed dried onions were rehydrated as per method given in previous section. The results are shown in Table-2 and Fig-2. It is seen that of 55/15 % sugar-salt osmosed and dried (SSO) onion gave the highest rehydration ratio (RR) (6.22) and was successively followed by 60% sugar osmosed and dried (5.79) and 25% salt osmosed and dried onion (5.01). From Table-2 another important parameter, co-efficient of reconstitution (CR) is also found to be the highest for SSO (3.221) and was followed by 60% sugar osmosed and dried (2.438), while 25% salt osmosed and dried onion gave the lowest CR value (1.406). Prediction of rehydration behaviour by first order reaction kinetics (Fig. 2 and equation 5 to 7) shows that the highest reaction rate constant (0.022) is given by 60% sugar osmosed dried onion and was closely followed by 55/15 % sugar-salt osmosed and dried onion (0.021), while the lowest rate constant (0.016) was given by 25 % salt osmosed and dried onion during the entire period of rehydration.

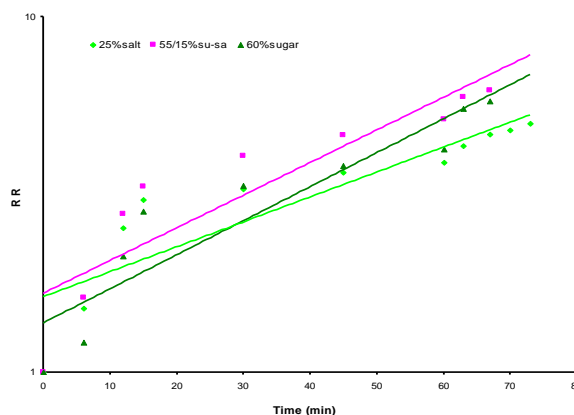


Fig. 2 Rehydration kinetics of different osmosed and mechanically dried onion

$$Y = 1.6288e^{0.016x}, \text{ (For 25\% salts osmosed mechanically dried onion)} \text{----- (5)}$$

$$Y = 1.6664e^{0.021x}, \text{ (For 55/15\% sugar-salt osmosed mechanically dried onion)} \text{----- (6)}$$

$$Y = 1.3749e^{0.022x}, \text{ (For 60\% sugar osmosed mechanically dried onion)} \text{----- (7)}$$

The observed differences in RR and rate constant of 25% salt, 60% sugar and 55/15 % sugar-salt osmosed dried onion may be attributed to differences in drying rate due to type and amount of solute uptake during osmosis prior to drying. 25% salt osmosed product with the highest salt concentration following osmosis and drying results in the slowest drying rate among the osmosed rehydrated product and thus it gives the lowest RR and rate constant for similar reason (i.e. salt content) 55/15 % sugar/salt osmosed and dried onion gave 2nd highest rate constant.

The rehydration ratios of osmosed dehydrated onions were higher than solar dried and unblanched mechanical dried onion but were lower than mechanically dried blanched onion (cf. previous section) due to lower drying rate following osmosis. The lowering of rehydration ratio due to osmosis has also been reported by Mazza ¹⁵. Kalbarczyk *et al.* ⁷ found that the amount of water in convectionally dried carrot after rehydration is about twice as high as in the samples dried osmotically. Simson *et al.* ²⁵ stated that addition of several concentrations of certain salts, different effect on reconstitution properties was observed.

Table-1 Effect of drying method on rehydration characteristics of dried onion

Drying method	Type of product	Moisture content %		Wt. of prepared raw materials for drying (gm)	Wt of dehydrated material (gm)	Dehydration ratio	Wt. in gm of rehydrated samples after boiling for (min)						RR	CR
		Fresh	Dried				3	7	10	13	15	18		
Mechanical	T ₁ (B)	88.887	10.558	100	12.1	8.264	10.540	11.870	12.445	12.57	13.059	13.70	6.850	0.829
	T ₂ (UB)	88.887	11.209	100	11.9	8.403	5.787	6.955	7.10	7.30	7.40	7.409	3.704	0.441
Solar	T ₃ (B)	88.887	11.508	100	13.125	7.619	4.442	5.432	5.912	6.202	6.357	6.520	3.344	0.439
	T ₄ (UB)	88.887	12.335	100	13.510	7.502	4.321	5.332	5.90	6.101	6.201	6.320	3.287	0.438

B=Blanched, UB = Unblanched, DR= Dehydration ratio, CR= Co-efficient of reconstitution

Table-2 Effect of drying method on rehydration characteristics of different dehydrated osmosed onion

Drying method	Type of product	Moisture content %		Wt. of prepared raw materials for drying (gm)	Wt of dehydrated material (gm)	Dehydration ratio	Wt. in gm of rehydrated samples after boiling for (min)					RR	CR
		Fresh	Dried				3	7	10	13	15		
Mechanical	T ₅ (25% salt)	88.059	8.413	97.7	27.4	3.566	3.655	3.958	4.060	4.242	4.135	5.014	1.406
	T ₆ (55/15% sugar-salt)	88.059	8.374	69.1	35.8	1.930	4.782	4.993	4.669	4.659	4.184	6.218	3.221
	T ₇ (60% sugar)	88.059	8.085	83.4	35.1	2.376	4.915	5.162	5.086	5.077	4.978	5.793	2.438

4. CONCLUSION

This study shows that time, temperature, blanching and their combined effect have a reasonable impact on the rehydration of dried onion. With increasing drying time and temperature, contractile stresses occur in the cell wall structure since the amount of heat given to food material increases. Thus, the porosity of the dried samples increases leading to an increase in shrinkage and rehydration value. Reconstitutive properties of dried onion depended on the method of drying. Blanched sample shows always higher rehydration ratio (RR). The longer time of rehydration was, the higher losses of dry substances were caused by dilution of soluble compounds.

5. ACKNOWLEDGEMENT

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