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KEEPING ONION QUALITY USING TREHALOSE PRIOR TO DRYING

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ABSTRACT

Onion samples were immersed in different trehalose solutions (1.00; 0.50; 0.25 and 0.00 g/L) for 5; 10; 15; 25 and 30 min. at room temperature, then oven dried at 60°C. Sensory attributes (colour, flavour by mouth and odour); dry matters; total sulphur and pyruvic acid contents of fresh and dried onions were investigated. Sensory attributes scores revealed that trehalose concentration had remarkable effects on the colour; flavour by mouth and odour of the dried onions. Using trehalose solution at 1.0 g/L for 5 min prior to drying of onions showed the best sensory results as well as the highest total sulphur and pyruvic acid contents as compared to the other concentrations used. The dry matter contents of onions were neither affected by trehalose concentrations nor by the time of soaking. Dried onions that soaked in trehalose solutions (1.0 g/L for 5 min; 0.50 g/L for 15 min and 0.25 g/L for 30 min.) were stored in glass bottles at room temperature up to 6 months. Results revealed that the concentration and the time of storage affected the quality of dried onions. Onions soaked in trehalose solution at 1.0 g/L for 5 min greatly retained both flavour by mouth and odour of fresh onions with acceptable colour for 6 months. The total sulphur and pyruvic acid contents obtained supported the sensory results. Meanwhile, samples soaked in trehalose solutions at 0.50 or 0.25 g/L for 15 and 30 min prior to drying could be stored for 4 and 2 months, respectively, with acceptable sensory and chemically qualities. Using trehalose solutions prior to drying of foods opens a new era in food drying process as it is very cheap, simple and keeps the freshness characteristics of the food after rehaydration.

INTRODUCTION

Vegetables and fruits spoiled soon after harvesting or picking unless treated or stored under suitable conditions. The postharvest losses of these commodities in developing countries are very high mainly due to lack of storage and processing facilities. More than 25-30% of perishable food crops are lost during storage (Kader, 1992).

Refrigeration is one of the most popular methods of preservation for storage. It is, however, energy consuming and emits environmentally harmful greenhouse gases (Colaco and Roser, 1994). The drying of foodstuffs presents an alternative method especially in the developing countries. Air-drying is the most energy and cost efficient method of drying foods. As a method of food preservation, it has additional advantages over the refrigeration methods that foods are stable at ambient temperature and can be stored for long periods of time. The main disadvantage of this method is the significant loss of nutritive values of the dried foods (Somogyi and Miller, 1989) due to the Maillard reaction in the dried foods (Erbersdobler, 1989 a and b). Therefore, any modification in air-drying foodstuffs with preservation of nutritive and keeping the freshness of food would be of great value. Such a process would be particularly attractive as an efficient and cost-effective alternative to current

methods of preservation. It would completely eliminate the current need for refrigeration or freeze- drying- methods.

Trehalose, -D glucopyranosyl (1---1) - D glucopyranoside, a non toxic disaccharide, occurs naturally in many widely consumed foods, such as mushrooms (Birch, 1970), yeast products such as bread (Oda, *et al*., 1987) and in honey (Bogdanov and Baumann, 1989). When added to foods prior to drying, trehalose completely protects the foods from denaturation and also prevents loss of the characteristic aromas and flavours of the fresh foods. Furthermore, it results in inhibition of Maillard reactions during the processing and storage of dried food products (Colaco and Roser, 1994). They added that fresh fruit purees containing trehalose could easily be dried to yield shelf-stable dry powders.

Onion (*Allium cepa*) is a relatively poor source of certain nutrients (e.g. fat, carbohydrate and protein) but is widely used to flavour foods. In addition to their flavouring application, medicinal properties have been known for centuries (Block *et al*., 1986 and Bayes *et al.,* 1989).

The objectives of this study were to investigate the effect of using trehalose solution as a new food additive for maintaining onion quality after drying and to study the effect of storage time on the quality of trehalose-dried onions.

MATERIALS AND METHODS

Materials:

Trehalose was purchased from (Merck, Darmstadt, Germany). New fresh bulb onions (*Allium cepa*) were purchased at a local market, Alexandria, Egypt.

Samples preparation:

After removal of the dry outer scales, onion bulb samples (250 g each) were initially immersed separately in trehalose solutions of different concentrations (1.00, 0.50, 0.25 and 0.00 g/L) for 5 min in order to keep the onion quality. Onion bulbs were, then, cut into small pieces and immersed again in their trehalose solutions for 5, 10, 15, 20, 25 and 30 min at room temperature. Samples were oven dried at 60°C. The dried samples were ground to powders. Onion powders were rehydrated in sufficient equal amounts of water and then sensory evaluated and chemically analyzed.

Dry weight determination:

Dry weight of onion was determined by heating the sample at 60°C in an air-circulating oven.

Sensory evaluation:

Fresh, dried and rehydrated onion samples were sensory evaluated for colour; flavour by mouth (taste) and odour using the comparison of sensory difference testing technique (O'Mahony and Odbert, 1985 and Barbary *et at*., 1993). Judges were used as instrumental tools to investigate the differences exist in a sensory attribute due to the different treatments. Judges had been taught the appropriate behavioral technique of sensory clues (Barbary *et al.,*

1993). Only those who showed sensitivity in discrimination were used to perform tests under controlled conditions (Barbary *et al*., 1993).

Steam distillation of onion:

Fresh and dried onions were steam distillated for 4 hr. The steam volatile oils were obtained by extraction the distillate with ether and concentrated by evaporating the ether using a rotary evaporation. The yields were dark brown oils with sulphur odour. The volatile oils were treated with 5% Na HCO_3 solution, then with 5% NaOH solution and separated into 3 fractions: neutral, phenolic and acidic (Iida, *et al*., 1983).

Total sulphur determination:

Total sulphur content in the neutral fractions of dried onion samples was determined using the titrimetric method according A.O.A.C. (1980).

Pyruvic acid (PA) content determination:

The content of PA was used as a measure of pungency of onions and determined according to Lin *et al*., 1995). Samples of onion powders (10g each) were mixed with equal amount of distilled water and blended for 40 sec. Samples were let to stand 10 min to allow the formation of PA. The onion juice was then filtered into a test tube through #4 filter paper. Two ml of filtrate was diluted to 100ml with distilled water and shaken. Two ml of the dilute solution was placed into a test tube. DNPH (1ml) (0.00125% 2,4-dintrophenyl hydrazine in 2N HCL) was added. Test tubes were placed into a 37°C water bath. After exactly 10 min, 5 ml of 0.6N NaOH was added to each tube to stop the reaction. The samples were then allowed to stand for 5 min for colour development. Absorbence was measured with a spectrophotometer set at 420 nm, using a reagent blank set at 0 absorbance (2ml-water 1 ml DNPH+ 5ml NaOH). A standard curve for calibration was obtained by using sodium pyruvate as a reagent with gradient concentration of PA. Absorbance was read to get a standard curve of PA for transforming the spectrophotometer reading into PA concentration.

Effect of storage on onion powders

Onion powders that showed best sensory and chemical results were stored in glass bottles at room temperature. Samples of trehalose-dried and rehydrated onions were sensory and chemically analyzed every month in order to determine the shelf life and to investigate the effect of storage on the quality of the dried onions.

RESULTS AND DISCUSSION

Dry Matter content:

Table (1) shows the effect of soaking time on the dry matter contents of onion soaked in different concentrations of trehalose solutions. Results revealed that time of soaking or using different trehalose concentrations had no significant differences in the dry matter percents of onions. Dry matter contents (consisting mostly of fiber, starch and sugar) is an important quality

factor determines bulb uses. Common onion cultivars range from 5 to 20 % solids content (Somogyi and Luh, 1988). High dry matters in onions are required for dehydration (Grieg and Marine, 1965) and have better storage quality. The cost of processing per pound of dehydrated product is largely determined by the total solids content (Somogyi and Luh, 1988). The structure and function of food molecules are completely preserved when dried in trehalose (Colaco, *et al.,* 1992).

Table (1): Effects of soaking time and trehalose concentration on dry matter content of onion.

Dry matter%	Time of soaking (min.)					
Trehalose conc. (g/L)	**5**	**10**	**15**	**20**	**25**	**30**
0.00	15.36^{ab}	15.36^{ab}	15.38^{ab}	15.35^{ab}	15.37^{ab}	15.36^{ab}
0.25	15.37^{ab}	15.38^{ab}	15.40^{ab}	15.37^{ab}	15.42^{ab}	15.38^{ab}
0.50	15.39^{ab}	15.40^{ab}	15.37^{ab}	15.38^{ab}	15.39^{ab}	15.42^{ab}
1.00	15.40^{ab}	15.39^{ab}	15.38^{ab}	15.42^{ab}	15.41^{ab}	15.39^{ab}
Fresh	15.42^{ab}	15.39^{ab}	15.39^{ab}	15.40^{ab}	15.42^{ab}	15.43^{ab}

Each value is a mean for three replicates, means within column followed by the same letters not significantly different (P>0.05).

Sensory evaluation of dried onion:

Dried onion powders that previously soaked in different concentrations of trehalose solutions for different times were sensory evaluated compared. Figures (1, 2 and 3) show the effect of soaking time on the sensory attributes (colour, flavour by mouth and odour) of dried onions, respectively.

Colour scores of dried onion powders revealed that trehalose concentration had a potential effect on the colour of dried onions. Generally, the higher the concentration, the better the colour within the time of soaking. The results also showed that time of soaking greatly affected the colour of onions after drying. Onions soaked in 1g/L trehalose solution gave the highest colour score in 5 and 10 minutes. The colour scores, then started to decrease after 15 min and reached the minimum colour score after 30 minutes of soaking. Meanwhile the colour of onions soaked in a 0.50 or in a 0.25 g/L trehalose solution improved as the time of soaking continued for 20 and 30 min, respectively. The improvement, however, was augmented with the 0.25 g/L trehalose solution. It is interesting to note that onions soaked in different concentrations showed the same colour scores at 30 min of soaking. These results showed that soaking onions in trehalose solution at 0.50 g/L for 15 min gave as equal colour scores as those soaked at 1.0 g/L for 15 min.

Also onions soaked in the 0.25 g/L trehalose solution showed the same colour score as those soaked either at 1.0 or 0.50 g/L for 30 min.. The differences in colours were clearer when dried powders redehydrated with equal amount of water. The control sample (onions soaked in water only) gave a brown crispy product which did not rehydrate, whereas the trehalose dried onion samples easily rehydrated with different colours. Colaco and Roser (1994) obtained similar results. They found significant decrease in the amounts of the degradation compounds, furfural and a- humulene, produced in the trehalose-dried mango. They also added that these products are formed due to Maillard reaction between the naturally occurring sugars and proteins in mango and concluded that trehalose inhibited this reaction during drying process.

Flavour by mouth (taste) scores of dried onions revealed that trehalose concentration affected the taste of dried onion powders. The higher the trehalose concentration, the stronger the flavour by mouth obtained. Time of soaking also increased the flavour by mouth. Onions soaked in 1.0 g/L trehalose solution for 10 min showed the best and natural flavour by mouth as compared to the taste of fresh onions and other treatments. The taste was then not affected after then by increasing the time of soaking. Onions soaked in 0.50 g/L trehalose solution were the most affected by the time of soaking as the flavour by mouth improved as the time of soaking increased. Meanwhile, the flavour of onion soaked in 0.25 g/L became stronger up to 20 min of soaking then decreased again. It is worth noting that the flavours by mouth of onion samples were more difficult to be detected on dry onion powders but the characteristic flavours by mouth of onions were regained when the powders rehydrated with water and easily detected and distinguished by all sensory judges. It is known that the volatile components of raw and cooked onions are rich in sulphur compounds. Mastication of raw onion bulb induces complex sensory effects which Schwimmer (1968) has described as consisting of lachymatory effect, a burning astringency on the tongue accompanied by the typical aroma of onion, followed later by an intensely bitter taste (Freeman and Mossadeghi, 1970).

Odour and smell of dried onions showed similar results to those obtained for flavour by mouth. Odour and smell of trehalose dried onions also increased when rehydrated. The dry onions powders themselves had very little smell and certainly did not smell like the fresh onions. However, when water was added the odour and smell returned after a short time, and the samples began to emit the unique odour of onions. Colaco and Roser (1994) reported similar sensory results on some fruits such as banana and mango. It is interesting to say that sensory judges found it easier to distinguish the odours of onions in the rehydrated state than the flavour by mouth and accurately located the differences in odours caused by different treatments.

Sulphur content:

Fig (4) shows the effect of soaking time on sulphur content of dried onion soaked in different trehalose concentrations. Results showed that the sulphur contents of dried onion increased as both the concentrations of trehalose and the soaking time increased. Sulphur content (44 ppm) obtained for dried onions that soaked in the 1g/L trehalose solution for 30 min was closer

to that of fresh onion (47 ppm) suggesting that trehalose, at this concentration, retained the volatile molecules responsible for the characteristic odour and flavour of onions. The ability of trehalose to retain and maintain the volatile molecules responsible for flavour of fresh fruits and vegetables opens a new era in food drying technology. This process provide a means of supplying convenient, stable instant versions of perishable foods

Pyruvic acid (PA) content:

Onion pungency is difficult to measure by taste because of the accumulative effect of successive tasting and can be more accurately determined by analysis of biochemical components. It has been shown that the (PA) is highly related to degree of onion pungency (Lin *et al.,* 1995). Fig. (5) shows the effect of soaking time on PA content of dried onions after soaking in different trehalose concentrations. Results revealed that the trehalose concentration, again, affected the PA content of dried onions. Soaking onions in 1 g/L trehalose solution showed the highest content of PA in 10 min of soaking. The PA was, then, not affected as time of soaking continued. The PA contents of onions soaked in a 0.50 g/L trehalose solution increased with increasing the time of soaking for 15 min, while the PA contents of onion powders soaked in 0.25 g/L trehalose solution increased for 20 min. These results support the sensory results obtained for flavour by mouth.

Effect of storage on sensory properties of onion powders:

Figures (6, 7 and 8) show the effect of storage time on the sensory attributes (colour; flavour by mouth and odours, respectively) of rehaydrated onion powders. The sensory attribute scores at zero time were recorded as perceived by the sensory judges for each concentration and sensory attribute obtained. Colour scores revealed that the concentration of trehalose had a pronounced effect on the storability of onion powders. However, all the samples were affected by the time of storage. The colour scores decreased as the time of storage increased. The results showed that dried onions which soaked in trehalose solutions (0.25 for 30 min; 0.50 for 15 min and 1.0 g/L for 5 min) could be stored up 2; 4 and 6 months, respectively, with acceptable colours as compared to the colour of fresh onions. Certainly, dried onions would go discoloration on exposure to air as a result of preoxidase activity as will the fresh onions (Roser, (1994).

Flavour by mouth scores showed as similar results as those obtained for colours but were more pronounced. Results revealed that dried onions soaked in 1 g/L trehalose solution for 5 min could be stored for 6 months at room temperature with noticeable natural onion taste. Whereas those soaked in 0.25 or 0.50 g/L trehalose solutions could be stored for 2 and 3 months, respectively.

Odour and smell scores of rehydrated onion powders showed similar results to those obtained for colour and taste attributes. Results revealed that onions soaked in 1g/L trehalose solution for 5 min greatly retained the freshness odour of onion after 6 month of storage as compared to the fresh onion tested at the same time, especially when rehydrated with water.

Nevertheless, the other two samples (0.25 and 0.50g/L) retained odour up to a month and 3 months, respectively. Colaco and Roser, (1994) found that trehalose added to purees of fruits, before drying, retained and preserved the volatile responsible for their characteristic aromas and flavours in the dried products. However, they did not reveal the effect of storage on the trehalose-dried products they studied.

Effect of storage on sulphur content of dried onion:

Fig. (9) shows the effect of storage time on the sulphur contents of dried onions soaked in different concentrations of trehalose solutions. Results revealed that the sulphur contents of dried onions decreased as the time of storage increased. The sulphur content of onions soaked in 1.0 g/L trehalose solution was the highest and slightly affected by the storage time even in those stored for 6 months. Sulphur content decreased from 38 ppm at zero time to 34 ppm after 6 months of storage. Meanwhile, the sulphur contents of dried onions that soaked in (0.25 and 0.50 g/L) trehalose solutions decreased from 36 to 22 ppm after 2 and 4 months, respectively. These results support the sensory results obtained for odour.

Effect of storage on PA content of dried onion:

Fig. (10) shows the effect of storage time on the PA contents of dried onions that soaked in different concentrations of trehalose solutions. Results revealed that the PA dried onions decreased as the time of storage increased. However, the PA content of onions soaked in 1.0 g/L trehalose solution was the highest even in those stored for 6 months. Meanwhile, the PV contents of dried onions soaked in (0.25 and 0.50 g/L) trehalose solutions decreased to the minimum after 2 and 4 months, respectively.

The above mentioned results revealed that using the comparison difference testing technique in the present study showed very close sensory results comparing to those obtained by chemical methods.

Good-quality bulbs can be kept in common storage for 2 or 3 months with a minimum of rot, shrinkage or sprouting (Somogyi and Luh, 1988). Desired storage conditions of onions are 0-4.5°C and a maximum relative humidity of 75%, although steady maintenance of these conditions may be economically difficult to justify. Therefore, soaking a product in 1g/L trehalose solution for a short time as 5 min before drying can solve all the above problems. Such a cheap, simple and speed method with keeping the food characteristics makes drying process particularly attractive as an efficient and cost-effective alternative to current methods of preservation. It would eliminate the need for refrigeration. The detailed mechanism, however, of the protective action of trehalose has not yet been cleared. Three theories have been introduced: water replacement hypothesis (Crowe *et al*., 1983 and Clegg, 1986); glass transformation hypothesis (Burke, 1989 and; and chemical stability hypothesis (Green and Angell, 1989). Non of these hypotheses could give fully explanation to the protective action of the trehalose solutions. More works are needed to explore this protective action of trehalose during drying process.

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حفظ جودة البصل باستخدام التريلوز قبل التجفيف

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تم غمر عينات بصل فى محاليل سكر التريلوز بتركيزات (١,٠ ، ٠,٥٠ ٠,٢٥ وصفر جرام / لتر) لمدة ٥ ، ١٠ ، ١٥ ، ٢٠ ، ٢٥، و٣٠ دقيقة تحت درجة حرارة الغرفة ثم تم تجفيفها بعد ذلك على درجة حرارة ٦٠°م. تم فحص عينات البصل المجففة حسيا من حيث اللون ، الطعم والرائحة وتم تقدير المواد الصلبة والمحتوى الكلى للكبريت وحامض البيروفيك لهذه العينات. ولقد أوضحت النتائج الحسية ان تركيز التريلوز له تأثير واضح على لون وطعم ورائحة البصل المجففة وان استخدام محلول التريلوز بتركيز ١ جم / لتر لمدة ٥ دقائق قبل تجفيف عينات البصل قد أعطت افضل النتائج الحسية بالإضافة إلي أعلى محتوى للكبريت وحامض البيروفيك بالمقارنة بالتركيزات الأخرى المستخدمة. أما محتوى المواد الصلبة للعينات المجففة فلم تتأثر سواء بتركيز سكر التريلوز أو بوقت الغمر. تم تخزين عينات البصل المجففة (التي سبق غمرها فى محاليل التريلوز بالتركيزات التالية١جم/ لتر لمدة ٥ دقائق، ٠,٥٠ جم/ لتر لمدة ١٥ دقيقة و ٠,٢٥ جم/ لتر لمدة ٣٠ دقيقة) في زجاجات بعيدة عن الهواء تحت درجة حرارة الغرفة لمدة تصل إلي ٦ أشهر. ولقد أوضحت النتائج ان جودة عينات البصل المجففة قد تأثرت بتركيز التريلوز وأيضا بزمن التخزين . فالعينات المجففة والتي سبق غمرها في محلول التريلوز بتركيز ١ جم / لتر لمدة ٥ دقائق قد احتفظت بدرجة فائقة بالطعم والرائحة المميزة للبصل الطازج وبدرجة لون مقبولة لمدة ٦ اشهر وقد أيد ذلك المحتوى الكلى للكبريت و حامض البيروفيك لهذه العينات ، وفى نفس الوقت فأن العينات المجففة و التي سبق غمرها فى محاليل التريلوز بتركيزات ٠,٢٥ أو ٠,٥٠ جم / لترقد احتفظت بخواصها الحسية لمدة ٢ أو ٤ اشهر على الترتيب وبدرجة لون مقبولة. لقد أوضحت النتائج ان استخدام محاليل التريلوز قبل تجفيف المواد الغذائية يفتح عصر جديد لعملية تجفيف المنتجات الغذائية نظرا لرخصها وسهولتها بألآضافة إلى المحافظة على الخواص الطازجة للمنتجات المجففة بعد إعادة ذوبانها في الماء مرة أخرى.