Nutritional Study during Drying and Storage of Dehydrated Summer Onion

Md. Masud Alam[1] and Md. Nazrul Islam[2]

1 (Spices Research Centre, Bangladesh Agricultural Research Institute, Bogra, Bangladesh)

2(Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh, Bangladesh)

ABSTRACT

The present study was undertaken to observe the nutritive value of fresh, dehydrated, osmosed and sulphited summer onion. Nutrient content of fresh and dehydrated onion on dry weight basis showed that there are least losses of nutrients during the drying process. The percent of moisture content, protein, fat, minerals, and carbohydrate of dehydrated osmosed and sulphited onion were initially 9.08, 5.48, 0.55, 57.51, 36.47 and 10.04, 10.67, 0.99, 3.91, 84.43 and 9.10, 5.43, 0.49, 57.49, 36.58 and 10.05, 10.35, 0.96, 3.79, 84.89 percent respectively after one year storage at room temperature (RT, 25-30oC). The vitamin C content in osmosed and sulphited onion was initially 76.36 and 82.76 mg/100g and 6.89 and 21.09 mg/100g respectively after one year storage.

Key words- *Nutritive value, summer onion, dehydrated, osmosed and sulphited*

1. Introduction

Summer onion is cultivated all the year round as a major spice crop in Bangladesh. It is used as vegetables only in some special circumstances and occasionally used as salad to increase the palatability of meal. Summer onions are 8-10 times big in seize than winter onion but very perishable in nature.

Osmotic dehydration preceding air drying decreases colour changes and increases flavour retention in dried fruits and vegetables [8,5]. The resulting product has generally better quality than the dried one without pretreatment. Stafford *et al.* [17] showed that sulfur dioxide preserves the texture, flavor, vitamins content and color of food. Sulphiting is widely used in the food industry to reduce fruit darkening during drying and storage.

In developed countries such as USA, Japan about 45% of entire output of fresh onion is dehydrated and sold to the food processors for use in salad, tomato products, biryani and in several meal preparation [12]. Further more, raw onion is used for the manufacture of onion powder, onion chip, onion fry, onion bread, onion becon etc. which are being increasingly available in the American and Asian market. It is also being used in different food preparation notably in chutney, pickles, curried vegetables, meat preparation, tomato ketchup and the like [12].

Yoo [20] reported on the studies of onions at temperature between 1 to 34°C and indicated that the optimum storage temperature should be less than 13°C. The water loss and decay rate increased with increasing storage temperature. Decrease in fructose and glucose contents and an increase in sucrose content were noticed at high storage temperature but these changes were reversible when the onions were transferred to 27°C.

The detailed proximate composition along with mineral and energy content of fresh and dried onion as reported by Pandey *et al.* [11] is shown in Table 1. From this Table it is seen that onions energy (50-59 kcal), solid content are quite high (13.4 to 15.7) and vitamin C content varied from 2 to 11 mg % in fresh onion , while

in dried onion it was 147 mg %. In shade dried coriander leaves (an important spice) Sangwan (2011) found 66.87 mg vitamin C per 100g and that was the maximum value when compared to other drying methods.

Table 1: The chemical composition of fresh and dried onion are given in the following

Particulars	Big onion	Small onion	Dehydrated onion
Moisture (g)	86.6	84.3	4.6
Protein (g)	1.2	1.8	10.6
Fat (g)	0.1	0.1	0.8
Minerals (g)	0.4	0.6	3.5
Fibre (g)	0.6	0.6	6.4
Carbohydrate (g)	11.1	12.6	74.1
Energy (k cal)	50.0	59.0	-
Calcium (mg)	46.9	40.0	300.0
Phosphours (mg)	50.0	60.0	290.0
Iron (mg)	0.6	1.2	2.0
Carotene (µg)	-	15.0	-
Thiamin (mg)	0.08	0.08	0.42
Riboflavin (mg)	0.01	0.02	0.06
Niacin (mg)	0.4	0.5	-
Folic acid (mg)	6.0	-	-
Vitamin C (mg)	11.0	2.0	147.0
Magnesium (mg)	16.0	-	-
Sodium (mg)	4.0	-	40.0
Potassium (mg)	127.0	-	1000.0
Copper (mg)	0.18	-	-
Manganese (mg)	0.18	-	-
Molybdenum (mg)	0.03	-	-
Zinc (mg)	0.41	-	-

2. Materials and methods

The experiment was conducted jointly in the laboratories (Central laboratory and Food Technology and Rural Industries laboratory) of Bangladesh Agricultural University (BAU), Mymensingh and the Department of Soil Resource Developement Institute (SRDI), Dhaka. Moisture, fat, protein, fibre, vitamin C and ash/minerals of fresh and dehydrated onion were determined according to reported procedure of Rangana [14]. The main aim of this experiment was to determine and compare the nutrient content of fresh, dehydrated, osmosed and sulphited onion.

2.1 Moisture content

At first, the weights of 3 empty dry crucibles were taken and 5 g of samples were taken in each dried crucible. Then the crucibles with samples were dried in a hot air oven at 55^0C till constant weight obtained. The crucibles were then cooled in desiccators and weighed soon after reaching room temperature. The losses in weight were taken as the moisture loss of the samples and the percent of moisture in the samples were calculated as follows:

$$\%\,\text{Moisture} = \frac{\text{Loss of weight}}{\text{Weight of samples}} \times 100 \quad \text{----------(1)}$$

2.2 Fat Content

The dried sample remaining after moisture determination was transferred to a thimble and plugged the top of the thimble with fat free cotton. The thimble was dropped into the fat extraction tube of a Soxhlet apparatus. The bottom of the extraction tube was attached to a Soxhlet flask. Approximately 75 ml or more of anhydrous ether was poured into the flask. The top of the fat extraction tube was attached to the condenser. The sample was extracted for 16 hours or longer on a water bath at 70 to 80^0C. The water bath was regulated so that the ether which volatilized was condensed and dropped continually upon the sample without any appreciable loss. At the end of the extraction period, the thimble was removed from the apparatus and most of the ether was distilled off by allowing it to collect in the Soxhlet tube. The ether was poured off when the tube was nearly full. When the ether was reached a small volume, it was poured into a small, dry (previously weighed) beaker through a small funnel containing plug cotton. The flask was

rinsed and filtered thoroughly using ether. The ether was evaporated on a steam bath at low heat. It was then dried at 100^0C for 1 hour, cooled and weighed. The difference in the weights was the ether-soluble material present in the sample. This process was followed for the determination of fat content of all types of samples.The percent of crude fat was expressed as follows:

$$\%\,\text{Crude fat} = \frac{\text{Weight of the ether} - \text{Soluble material}}{\text{Weight of sample}} \times 100$$

----------(2)

2.3 Protein Content

Reagent required: Concentrated H_2SO_4 (Nitrogen free), Digestion mixture (Potassium Sulfate = 100g, Copper sulfate = 20g and Selenium di-oxide = 2.5 g), Boric acid solution = 2% solution in water, Alkali Solution = 500g sodium hydroxide dissolved in water and diluted to 1 liter, Mixed indicator solution = Bromocresol green 0.1 g and Methyl red 0.02 g dissolved in 100 ml ethyl alcohol, Standard HC1= 0.01 N

About 2 g of sample was taken in three 250 ml Kjeldahl flask. 2 g of digestion mixture and 25 ml of concentrated sulfuric acid (H_2SO_4) were added in each flask. The flasks were placed in inclined position on the stand in digestion chamber and were heated continuously until frothing ceased and then simmered briskly. The solutions became clear in 15 to 20 min., continued heating for 45 min. After cooling, 100 ml water was added in both flasks. Enough NaOH solutions were added gently down the side to form precipitates at cupric hydroxide and immediately connected to a stream-trap and condenser. In each of three 500 ml conical receiving flasks, 50 ml of boric acid solution, 50 ml distilled water and 5 drops of indicator solution were added. Positioning the condenser, distillation was carried out for 40-50 min. or until about 250 ml of distillate was obtained for each sample. The contents of the receiving were titrated against hydrochloric acid solution, the end points were marked by a pink color and the readings for blank sample was also determined and deducted from the titration.

A Protein conversion factor was used to calculate the per cent protein from nitrogen determination. Percentage of nitrogen and protein calculated by the following equation:

$$\%\,\text{Nitrogen} = \frac{(Ts - Tb) \times \text{Normality of HC1} \times \text{M. of } N_2}{\text{Weight of Sample (in g)}} \times 100$$

----------(3)

Where,

T_s = Titer volume of the sample (ml), T_b = Titer volume of the blank (ml), $M_{eq.}$ of N_2 = 0.014, % Protein = % Nitrogen × Protein factor

2.4 Fibre

About 2.0 g weighed sample was taken into a 1000 ml conical flask. 200ml boiling H_2SO_4 solution was added and connected with a reflux condenser and heated. The volume of content of the flask was marked with a glass pencil to observe any loss in volume and to recover this volume by adding water. The conical flask was heated to boil the content exactly for 30 minutes. At the expiration of 30 minutes, the flask was removed and the content was immediately filtered through a filter paper and washed with boiling water until the washing were acid free. The residue was transferred into the 1000 ml conical flask by making a hole in the filter paper and then washing the residue with 200ml of boiling NaOH solution. The flask was connected with reflux condenser and the content boiled exactly for 30 minutes. Proper care was taken so that there was no loss of volume of the content. After the end of alkali digestion, the content of the flask was immediately filtered through gooch crucible (using buchner funnel) with thin but close layer of asbestos. After thorough washing with boiling water, the residue was also washed with alcohol (3 times) and ether (2 times). The gooch crucible was heated in an oven at 100^0C for 4 hrs, cooled in desiccators and weighed. The material was again heated at 55^0C for 4 hrs. and weighed. The drying and weighing process was continued until constant weight was achieved.

$$\%\,\text{Fibre} = \frac{\text{Loss in weight noted}}{\text{Weight of sample taken}} \times 100$$ ----------

----------(4)

2.5 Vitamin C

About 10 g samples was blended and homogenized in a blender with 3% metaphosporic acid solution. The homogenized liquid was transferred to a 100 ml volumeric flask and made to volume 100ml with metaphosphoric acid solution. Content of the flask was then thoroughly mixed and filtered. Then 5ml of the aliquot was taken in a flask and titrated with 2-6 dichlorophenol indophenol dye. The dye had been standardized with vitamin C solution to find an equivalent dye factor. The ascorbic acid content of the samples was calculated from the following formula: mg vitamin C/ 100g

$$= \frac{TDV_1}{V_2 W} \times 100$$ ----------(5)

Where, T = Titre, D = Dye factor, V_1 = Volume made up, V_2 = Aliquot of extract taken for estimation, W = Weight of sample taken for estimation

2.6 Ash/Minerals Content

About 2 gm of each sample were taken in dry, clean porcelain dishes and weighed accurately. Moistures of each sample were removed using hot air oven method. Then the samples were burnt on an electrical heater. These were done to avoid the loss of sample in the muffle furnace under higher temperature. Then the samples were transferred into the muffle furnace and burnt at 550^0C temperature for 4-6 hours and ignited until light gray ash resulted (or to constant. weight). The samples were then cooled in desiccators and weighed. The ash contents were expressed as:

$$\%\,\text{Ash} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$ ------(6)

2.7 Minerals analysis

Preparation of samples: About 1 g sample was taken and then ground and poured in digestion tube. 5ml analytical grade H_2O_2 and 5ml HNO_3 were added and the sample was allowed to stand overnight. The following day, the tube was placed on a heating block and heating was continued for 2-4hr and the temperature was slowly raised to 125^0C. In some cases more time is required for clear solution. Thereafter, the tube was allowed to cool at room temperature. After cooling the volume was made 100 ml with distilled water and then stored in plastic bottle.

Plant Properties	Method
Na, K	Digesting the samples in di-acid mixture (HNO_3- $HClO_4$) and determined directly by flame photometer [21].
P	Digesting the samples in di-acid mixture (HNO_3- $HClO_4$) and determined colorimetrically using molybdovanadate solution yellow colour method [21].
Zn, Fe	Digesting the samples in di-acid mixture (HNO_3- $HClO_4$) and determined directly by atomic absorption spectrophotometer [21].
Ca, Mg	Ca, Mg concentration in the extract were determined by flame photometer as outlined by [7].

2.8 Total Carbohydrate Content

Total carbohydrate content of the samples were determined as total carbohydrate by difference, that is by subtracting the measured moisture, fat, protein, fibre and ash/minerals content from 100.

3. Results and discusstion

The present investigation was carried out to evaluate and compare chemical composition of dehydrated onion with fresh sample of the same variety. The dehydrated onion includes osmosed, nonosmosed and sulphited onion. The product was analyzed for moisture, protein, fat,

fibre, ash/minerals, carbohydrate and vitamin C. As from nutritional point of view, vitamin C is one of the most important water soluble nutrients, it would be analyzed in depth particularly from kinetic viewpoint during both drying and storage.

3.1 Chemical composition of fresh and dehydrated summer onion

The chemical composition of fresh and dehydrated summer onion are shown in Table - 2.

3.1.1 Moisture

The moisture content of fresh and dehydrated summer onion were found 86.285 and 9.750 %. The value of fresh onion was lower and dehydrated onion was higher than those found by Pandey *et al.* [11] and Pruthi [12]. They reported that fresh and dehydrated onion contain 86.6 to 86.8 and 4.6, percent moisture respectively. Watt and Merrill [19] found that dehydrated onion contained 4% moisture. The variations in moisture content may be due to differences in variety and region.

3.1.2 Protein

The protein content of fresh and dehydrated onion was 1.38 and 9.07 % which is closer to the values reported by Pandey *et al.* [11] and Pruthi [12]. They showed that the protein content of fresh and dehydrated onion were 1.38, 1.2 and 9.89, 10.6 % respectively. Watt and Merrill [19] found that dehydrated onion contain 10.8% protein. This small variation in protein content of onion in present study may be due to same reason explained earlier for moisture content. The dry weight basis calculation (Table-1) shows that protein content in fresh and dried product is almost similar indicating that drying process did not result in any loss of protein and is in agreement with Okos *et al.* [9], Hosain [6], Sangwan *et al.* [16] and Roy [15].

3.1.3 Fat

The fat content of fresh and dehydrated onion were calculated and found to be 0.13 and 0.80 %. This value is an agreement with literature Pandey [11] and Pruthi [12]. Dry weight basis calculation (Table-1) shows only slight loss in fat which may be due to oxidation during air drying [9].

3.1.4 Fibre

The fibre content of fresh and dehydrated onion was 0.7 and 4.55 % which is closer to the values reported by Bose *et al* [2] and Pruthi [12]. Bose *et al.* [2] found that the fresh onion contained 0.6g /100g fibre and Pruthi [12] stated that onion powder contained 8.4% fibre. The variation may be attributed to soil condition, variety, maturity, climatic condition etc.

3.1.5 Ash/ Minerals

The ash content of fresh and dehydrated onion were found 0.5 and 3.2 which is closer to those found by Pandey *et al.* [11] who reported 0.4 and 3.5 % respectively. Ash is composed of all mineral salts. The Na, K, Mg, Zn, Ca, P, Fe in fresh and dehydrated were 5, 130, 15, 0.5, 49.8, 52.4, 0.74 and 32.8, 845, 97.25, 3.10, 325, 340, 4.80 mg/100g respectively. These values are an agreement with literature of Pandey *et al.* [11]. They reported that Na, K, Mg, Zn, Ca, P, Fe in fresh onion are 4, 127, 16, 0.41, 46.9, 50 and 0.6 respectively and in dehydrated onion Na, K, Ca, P, Fe are 40, 1000, 300, 290, 2 mg/100g respectively. Bose *et al.* [2] reported that fresh onion bulb contain 180, 50 and 0.7 mg/100g Ca, P, Fe respectively. Pruthi [12] showed that onion powder contain 3.5% mineral matter (total ash) and 300 mg Ca, 290 mg P, 40 mg Na, 1000 mg K, 2 mg Fe per 100g onion powder. Watt and Merrill [19] found that dehydrated onion contain 3.9% ash and 168 mg Ca, 273mg P, 3.4 mg Fe per 100g product. The plants get this mineral from soil. The physiological characters of plants varieties dictate the uptake of nutrient from the soil. Hence, the variety of onion and the soil where it grows may affect its chemical composition. Furthermore the slight variation in ash/minerals content of fresh and dehydrated products (3.64 vs 3.54 % on dry weight basis)

might be due to variation in maturity of onion, experimental error etc.

3.1.6 Total carbohydrate

Total carbohydrate content of fresh and dehydrated onion was determined by difference, that is by subtracting the measured protein, fat , ash, minerals and moisture from 100 and found 11 and 72.63 % respectively, while on dry weight basis carbohydrate content in fresh and dried onion was almost similar (80.24 vs 80.48). Pruthi [12] reported that fresh onion bulb contains 11.6% and onion powder contains 74.1% carbohydrate. Pandey [11] showed that fresh big onion contained 11.1 % and dehydrated onion contains 74.1 % carbohydrate. Watt and Merrill [19] found that dehydrated onion contained 80.2% carbohydrate. The difference in carbohydrate content between the current study and the literature value is very little and may be attributed to, among others, sample to sample variations due to variety, maturity, weather conditions as well as moisture content of dried onion.

3.1.7 Vitamin C/Ascorbic acid

Vitamin C, a water soluble vitamin is involved in tissue development and repair and it prevents scurvy and acts as antioxidant [4]. This important vitamin is moderately available in fresh and dried onion (12 mg and 77.18 mg/100g fresh and dried onion) and this vitamin can be easily analyzed in laboratories in Bangladesh. Furthermore, it is easily destroyed during processing (such as drying) and storage. Thus vitamin C content in fresh onion and dried onion was determined and found to be 12 and 77.18 mg/100 g on wet weight basis when the corresponding dry weight mg percentages were 87.5 and 85.52 (Table-1) respectively. Bose [2] reported that fresh onion contained 11.0 and Pandey [11] stated that dehydrated onion contained 147 mg/100g sample. The differences in vitamin C content in fresh and dehydrated onion may be due to differences in variety , climatic conditions, experimental procedures, moisture content of fresh and dried onion as well as drying conditions such as temperature, air velocity etc.

It is a well known fact that vitamin C is sensitive to heat and oxidation, and its protection is particularly difficult to achieve especially when products are air dried. Other important factors include water activity or product moisture content, PH and metal traces such as copper and iron [18].

Table 2 : The chemical composition of fresh and dehydrated onion

Particulars	Fresh onion		Dehydrated onion	
	Wet basis	Dry basis	Wet basis	Dry basis
Moisture %	86.28	629.13	9.75	10.80
Protein %	1.38	10.1	9.07	10.05
Fat %	0.13	0.95	0.80	0.89
Fibre %	0.7	5.10	4.55	5.04
Minerals %	0.5	3.64	3.20	3.54
Carbohydrate %	11.00	80.24	72.63	80.48
Vitamin C (mg)/100g sample	12.0	87.50	77.18	85.52
Na (mg/100g)	5.0	36.46	32.80	36.34
K (mg/100g)	130	947.87	845.0	936.29
Mg (mg/100g)	15	109.37	97.25	107.76
Zn (mg/100g)	0.50	3.64	3.10	3.43
Ca (mg/100g)	49.8	363.11	325.0	360.11
P (mg/100g)	52.4	382.06	340.0	376.73
Fe (mg/100g)	0.74	5.39	4.80	5.318

In general nutrient content of fresh and dehydrated onion as seen in Table-2 on dry weight basis showed that there are least losses of nutrients during the drying process. This behavior might be due to use of low air dry bulb temperature during drying process. Increasing amount of protein, fat, ash and carbohydrate in dried sample on wet weight basis can be attributed to evaporation of moisture during drying.

3.2 Chemical composition of dehydrated onion with pretreatments

In order to determine effect of pretreatment on nutrient content of dehydrated onion, osmosed dried onion and sulplhited dried

onion were analyzed for moisture, protein, fat, minerals, carbohydrate and vitamin C following drying and after one year storage at room temperature (RT, 25-28^{0}C).

From the results (Table-3) it is seen that % of moisture, protein, fibre and carbohydrates at initial condition and after one year in osmosed dehydrated onion were less compared to dehydrated sulphited onion and there was very little change in the major nutrients in either osmosed or sulphited dried product during one year storage except fat.

It is also noted that ash/minerals content was higher in dehydrated osmosed onion than sulphited dried onion both initially and after one year storage. The mineral content in both samples, however did not change over the storage period (one year). Vitamin C content was initially lower in osmosed dried onion (76.36 mg %) than sulphited dried onion (82.76mg %), though salt free basis calculation shows that osmosed onion (salt free) cotained higher mg% of vitamin C (159 mg/100g). After one year storage at room temperature vitamin C was drastically reduced in both samples, though sulphited sample retained higher vitamin C compared to osmosed one (25% vs 9%).

Lower nutrient content (protein, fat, carbohydrate) and higher minerals content found in osmosed dried product is due to the added solutes (here salt) during osmosis. In fact salt free basis calculation showed almost similar nutrient content in both samples. Slight loss in fat during storage may be due to oxidation at lower moisture content than that corresponding to aw 0.3 to 0.4 at which lipid oxidation is minimum [1,9]. Lower, ascorbic acid content in osmosed dried onion is due to added salt and the higher retention of the vitamin in sulphited dried product (as compared to osmosed dried product) upon one year storage may be due to sulphiting as sulphite protects vitamin C [1]. The drastic reduction in vitamin C in one year storage period for both osmosed and sulphited dried products is due to oxidation at RT over the long storage period. In fact degradation reaction follows first order reaction kinetics according to which vitamin C decreases exponentially with time [13,18,3]. Thus in the next sections degradation of vitamin C as affected by process parameters and storage conditions will be analyzed in details.

Table -3 The chemical composition of dehydrated osmosed and sulphited onion

Particulars	Dehydrated Osmosed Onion			
	Initial		After one year	
Methods	Wet basis	Dry basis	Wet basis	Dry basis
Moisture %	8.33	9.08	8.34	9.10
Protein %	5.02	5.48	4.98	5.43
Fat %	0.50	0.55	0.45	0.49
Minerals %	52.72	57.51	52.70	57.49
Carbohydrate %	33.43	36.47	33.53	36.58
Vitamin C mg/100g	70.00	76.36	6.32	6.89
Particulars	Dehydrated Sulphited Onion			
	Initial		After one year	
Methods	Wet basis	Dry basis	Wet basis	Dry basis
Moisture %	9.13	10.04	9.14	10.05
Protein %	9.70	10.67	9.40	10.35
Fat %	0.90	0.99	0.87	0.96
Minerals %	3.55	3.91	3.45	3.79
Carbohydrate %	76.72	84.43	77.14	84.89
Vitamin C mg/100g	75.21	82.76	19.16	21.09

4. Conclusion

Overall nutritional study indicates that there is minimum loss of nutrient in onion during drying process and storage, up to one year. So dehydrated onion (sulphited, osmosed and without pretreatment) have great potential to use throughout the year for several types of food preparations like canned soup, salads, hamburgers, pizzas and other fast food preparations. Dried onions are also useful during scarcity of fresh onion. Drying of

summer onion and making them use for future open up new vistas in the field of food technology as curry mix and other condiments.

5. Acknowledgement

The authors gratefully acknowledged to Bangladesh Agricultural Research Council (BARC), Bangladesh Agricultural Research Institute (BARI) and Bangladesh Agricultural University, Mymensingh for their technical and financial support.

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