PRODUCTION OF HIGH QUALITY DEHYDRATED FOOD PRODUCTS BY SIMPLE TECHNIQUE FOR SMALL PROJECTS

RADWAN, H.M., A.S. DYAB AND M.R. MASOUD

Department of Horticultural Crops Tech. Res., Food Technology Research Institute, ARC, Giza, Egypt

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Abstract

The objective of this study was to dry onion and potato with a simple technique for small projects. Both of onion and potato slices submerged in yeast (*Saccharomyces cerevisiae*) suspension for 2, 4 and 6 hours as a pretreatment and then, the samples were preheated in air ventilation oven at 120ºC for 15 mins. All samples were dried under sunlight until reached to final moisture content 9-10%. The aims of the thermal treatment (at 120ºC for 15 mins.) were sterilized, inhibition the yeast and enzymatic browning, beside, decrease the moisture content, sundried time and partial gelatinization of potato starch. The physiochemical characteristics, microbiological count and Sensory evaluation for both onions and potatoes were estimated. The results showed that, the increasing of fermentation periods led to increase the growth rate of yeast while, the pH value, total soluble solids and color index decreased. Also, the results explained that, decreased of phenol compounds, flavonoids and antioxidant activity by increasing the time of fermentation process and pungency (as pyruvic acid) for dried onion. Meanwhile, no significant difference observed in rehydration characteristics of both treated, dried onion and potato samples by increasing the time of the fermentation process. Finally the results showed that, the Samples submerged in yeast suspension for four hours, preheated at 120 ºC for 15 min. and drying under direct sunlight had high nutritional value and good quality.

Keywords: Onion, potato, yeast, fermentation and dehydration.

1. INTRODUCTION

The onion (*Allium cepa L.*) is one of the oldest cultivated vegetable crops under Allium family. Onions are a major source of flavoring in fresh and cooked food, and they also have significant therapeutic values. Onion serves as a good medicinal compound for cataract, cardiovascular disease and cancer due to its hypocholesterolemic, thrombolitic and antioxidant effects Jurgiel-Malecka *et al.*, (2015). According to FAO (2014) data Egypt production of onion is increasing in 2014 it reached 2505189 tons against 1093230 tons in 2013. New onion cultivars of various colors, shapes, odors and flavors are now available on the market. At the same time, the customers are now more health-oriented and aware of healthy eating habits and pay attention not only to the appearance of onion but also to its nutritional prophylactic and medicinal values. There is great potential in the cultivation of onion crop, farmers often incur losses due to low prices during the glut, lack of sufficient market outlets and other infrastructure facility in the marketing system. The storage losses of onion ranges from 30 to 60% due to various factors such as physiological weight loss (25-30%), rotting due to fungal diseases (10-15%) and sprouting of bulbs (10-15%) Goudra *et al.*, (2014).

Potato (*Solanum tuberosum*) is the world's fourth largest food crop and is a stable in many diets around the world. In addition to being a source of highly digestible carbohydrate and nutritionally complete protein, the potato is also an excellent source of other essential nutrients. It is a balanced food containing high energy, nutritional quality protein, essential vitamins and minerals. Nowadays, potato has become high yielding carbohydrate enrich vegetable containing phytochemicals and minerals. Potato is grown in nearly all parts of the tropical and subtropical world and in warmer areas of the temperate regions. It has remained for centuries an important staple for many tropical communities. According to FAO (2014) data Egypt production of potato is increasing in 2014 it reached 4611065 tons against 4265178 tons in 2013. Potatoes are most important vegetable crop in the world and the main utilization of processed potatoes includes table stock (31%), frozen French fries (30%), chips (12%), and dehydrated items (12%) Miranda and Aguilera (2006).

Yeast is made up of many tiny, single-celled plants, which grow by budding, each bud breaking away from the parent cell and forming new buds. The conditions required for growth are warmth (optimum 25-30^{o}C), moisture and food (starch plus a small amount of sugars). When the yeast is used, the conditions and the utensils should be kept lukewarm to obtain the best results. As soon as the yeast has been used, the yeast begins to feed on the starch in the mixture, forming sugars, alcohol and carbon dioxide Ali *et al.*, (2012).

New and innovative techniques that increase the drying rate and enhance the product quality have achieved considerable attention in the recent past. Combination of air drying and sun drying were one of them, which are gaining popularity because of its inherent advantages over conventional heating, such as reducing the drying time of biological material without quality loss.

Thus the main objective of this work aims to develop and use a simple technique for drying process of onion and potato on village level to reduce post-harvest losses and to generate extra income for the farmer. Preparation of onion and potato drying products during peak season is one way to overcome the problem of its consumption throughout year. Powder also assists to reduce bulk for storage and transportation with few physiological and biochemical changes.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Sample preparation.

The onion (cv. Giza 20) and potato (cv. Spunta) used in this study were purchased from the Horticultural Research Institute, Agriculture Research Center, Giza, Egypt. Instant dry yeast (*Saccharomyces cerevisiae*) type was obtained from Akmaya Co., Turkey. The onion and potatoes were washed, peeled and cut into slices. All slices from each variety were divided into 5 parts as follows.

- The first part (T1) control was dried in an air ventilation oven at 60ºC±5.
- The second part (T2) was dried under direct sunlight.
- The third part (T3) was submerged in activated yeast suspension (*Saccharomyces cerevisiae*) for two hours at room temperature.
- The fourth part (T4) was submerged in activated yeast suspension (*Saccharomyces cerevisiae*) for four hours at room temperature.
- The fifth part (T5) was submerged in activated yeast suspension (*Saccharomyces cerevisiae*) for six hours at room temperature.

From The third to the fifth part both onion and potato slices were drained to remove surface moisture. Then the treated samples were spread on stainless steel trays and dried as follows.

2.1.2 Drying processes.

Samples were subject to combined two different drying methods as follow:

a) **Oven drying (OD)** (First drying stage)**.**

Treated onion and potato slices were distributed on stainless steel trays and pre-heated in an air ventilation oven at 120ºC±5 for 15 min.

b) **Sun drying (SD)** (Second drying stage)**.**

All treatments after pre-heated (at 120ºC±5 for 15 min), were dried under direct sunlight at temperatures between 35 - 40ºC until reached to a final moisture content of 9 - 10%. Dried potatoes were milled in a Laboratory mill (IKA-Laboratechnic, Janke and Kunkel Type: MFC, Germany) to obtain fine powder (315 micron) and kept until analysis.

2.2 Analytical methods:

2.2.1 Chemical analysis:

Moisture, total soluble solids (T.S.S), pH, ash, total sugars and reducing sugars were determined according to the methods of AOAC (2010). Non-enzymatic browning and rehydration ratio were determined according to the method of Ranganna (1977). Total carbohydrate was determined by phenol sulphuric acid method as described by

Dubois *et al.*, (1956). Total phenolic content were determined using Folin-Ciocalteu reagent as described by Singleton and Rossi (1965). Total flavonoid was determined according to the method described by Zhuang *et al.*, (1992). Pungency in onion was determined as pyruvate analysis which was performed according to Schwimmer and Weston (1961).While the ability of the extracts to scavenge 2,2 Diphenyl-1- Picryl-Hydrazyl (DPPH) free radicals was determined by the method described by Brand-williams *et al.*, (1995).

2.2.2 Microbiological enumeration.

Malt extract agar medium was used as a selective medium for the detection and enumeration of yeast and moulds according to Galloway and Burgess (1952).

2.2.3 Sensory evaluation of Dehydrated

Potato powder which obtained from dried potato was cooked by boiling with sufficient amount of salt, spices and distilled water for 10 min. The obtained paste was shaped to bars, then fried at 170 ±°C/6 min using sunflower oil in deep fryer (Tiba, Sasho, Mod. SH311, power 1300-1500W made in china). Sensory evaluation of reconstituted onion and fried potato, the sensory quality of the developed samples in respect of color, appearance, taste, texture and overall acceptability was judged by panelists. Using 9 point hedonic scale (Steel *et al.*, 1997).

2.2.4 Statistical analysis

The results were analyzed by analysis of variance (ANOVA) using the procedure by statistical analysis system (Costate) program. Significant differences were determined at the level P = 0.05.

3. RESULTS AND DISCUSSION.

3.1. Physicochemical properties of fresh onion and potato.

Results of the physicochemical properties in investigated sample materials are given in Table (1). Physicochemical properties, moisture content, total carbohydrates, total sugars, reducing sugars, ash, total phenolic compound, total flavonoid, color index and antioxidant activity of fresh onions and potatoes were determined. The moisture content of fresh onion is found to be 86.15%. The total carbohydrates, total sugars and reducing sugars contents of fresh onions were found to be 82.77, 43.04 and 19.71 %, respectively (Jurgiel-malecka *et al.*, 2015). As for ash, total phenolic compound and total flavonoid they were 4.15%, 74.82 and 7.99 mg/gm (Rodríguez Galdón *et al.*, 2008). Color index and DPPH free radical scavenging activity (AOA) of onion are presented in Table (1), recorded 0.097 and 78.84%. Pungency was 6.95 (μmol/g, as pyruvic acid), these results are in agreements with (Gordon and Diane, 2003) who reported that the pungency of white onion was 6.98 ± 0.69 μmol/g, as pyruvic acid.

Also, data in Table (1) show that the moisture content, total carbohydrate, total sugars, reducing sugars and ash of fresh potatoes (*Solanum tuberosum L.*) spunta are 82.55%, 83.78%, 2.98%, 1.95% and 4.94% of dry weight basis, respectively. This result is nearly the same as that found by (Basuny *et al.*, 2009). The total and reducing sugars content are in agreement with that of (Gumul *et al.*, 2011) they reported that the total and reducing sugars content ranged from 1.4 to 6.3% and 0.2 to 1.26% respectively for five varieties of potatoes.

Table 1. The Physicochemical composition of fresh onion and potato (on dry weight basis*).

Properties	Fresh onion	Fresh Potatoes
Moisture %	86.15±0.85	82.55±0.92
Total carbohydrates* %	82.77±1.32	83.78±1.18
Total sugars* %	43.04 ±1.22	2.98±0.18
Reducing sugars* %	19.71 ±0.75	1.95±0.50
Ash* %	4.15±0.15	4.94±0.26
Pungency*(µmol/g, as pyruvic acid).	6.95±0.35	---
Toal phenolic compound* (as gallic acid) mg/g	74.82±1.75	4.86±0.24
Total flavonoid* (as quresetien acid) mg/g	7.99±0.42	2.10±0.12
Color index at (420)	0.097±0.002	0.085±0.005
Antioxidant activity (AOA) %	78.84±2.15	62.36±1.42

All values are means of three replicates ±stander deviation (SD)

The data in Table (1) show that, the total phenolic and total flavonoid content of fresh potato was 4.86 and 2.10 mg/g, respectively. These results in agreement with those obtained by (Jesus *et al.*, 2015) who reported that maximum values in flesh tissues of 60 varieties of potato were 3.6 mg/g (as gallic acid equivalents) for total phenolics and 2.3 mg/g catechin equivalents for total flavonoids on a dry weight basis. The data in Table (1) show that the color index and antioxidant activity (AOA) of fresh potato were 0.085 and 62.36 %, respectively.

3.2 Effect of fermentation on some characteristics.

It is well established that yeasts are very important to both academic research and biotechnological industries. Supreme among these is the budding yeast *Saccharomyces cerevisiae*.

Table (2) shows the recorded changes in pH, TSS, and the growth rate of bakery yeast *Saccharomyces cerevisiae* during fermentation process in yeast suspension and the other treatments during 2,4 and 6 hours.. The TSS is a way to quantify the total sugars of the samples. During fermentation periods, the yeasts that convert starch and sugars into Co2 and H2o are observed. In this first phase of fermentation, the TSS, pH and colony forming units (CFU) of used yeast suspension were 0.4%, 5.23 and $11x10^{14}$ respectively.

The Brix refers to the total soluble solids content (TSS), mainly sugars and acids present in the fruit. From the same Table (2) it could be seen that T.S.S in activated yeast suspension of both varieties was higher than other ones. It was decreased from 1.82 to 0.58 in submerged onion suspension for 6 hours. As well as T.S.S it was also decreased from 1.08 to 0.47 in submerged potato suspension for 6 hours of fermentation at 35 ºC. Data in the same table show that, pH value was 4.41 and 4.72 in activated yeast suspension for submerged onion and potato samples after 2 hours, respectively. While, it was decreased to 4.23 and 4.59 in submerged onion and potato suspension, respectively for 6 hours of fermentation.

Results showed that the growth rate (CFU) of yeast *Saccharomyces cerevisiae* during fermentation process increased from 24.33 to 1385 and from 56.0 to 1252 (CFU×10^{14}) of submerged onion and potato slices respectively after 6 hours.

Table 2. Effect of fermentation process on total soluble solids (TSS), pH value and CFUx10^{14} in submerged onion and potato suspension.

Frmentation periods	Yeast suspension					
	TSS		pH		CFUx10^{14}	
Zero time	0.4		5.23		11	
	Fresh onion			Fresh potato		
	TSS	pH	CFUx10^{14}	TSS	pH	CFUx10^{14}
After 2 hrs.	1.82	4.41	24.33	1.08	4.72	56
After 4 hrs.	1.15	4.29	324.7	0.82	4.68	507
After 6 hrs.	0.58	4.23	1385	0.47	4.59	1252

3.3. Influence of different fermentation times of total carbohydrates, total and reducing sugars content.

During fermentation process yeast consumes the sugars and converts them into alcohol, (ethanol), CO2 and hundreds of secondary end products. The utilization of sugars is an important parameter which decides the performance of the yeast culture. The amount of fermentable reducing sugars during the fermentation process using the bakery yeast *Saccharomyces cerevisiae* type is shown in Table (3).

Table 3. Effect of fermentation process on total carbohydrates, total and reducing sugars content in submerged onion and potato (on dry weight basis*).

Fermentation time (hr)	Total carbohydrate* %		Total sugars* %		Reducing sugars* %	
	Onion	Potatoes	Onion	Potatoes	Onion	Potatoes
0	82.77±1.32	83.78±1.18	43.04±1.22	2.98±0.18	19.71±0.75	1.95±0.50
2hr	82.67±0.11	83.63±0.41	42.95±0.20	2.82±0.21	19.53±0.59	1.72±0.47
4hr	82.31±0.39	83.54±0.42	42.18±0.76	2.65±0.12	19.12±0.23	1.45±0.27
6hr	82.01±0.92	83.32±0.13	42.01±0.24	2.59±0.34	18.92±0.30	1.32±0.23

All values are means of three replicates ±stander deviation (SD),

Values in the same column with different letters are significantly different (P =.05).

At the beginning of the fermentation process higher levels of reducing sugars were detected. During the fermentation process, their content increases especially in the first hour of fermentation. The fermentation of glucose and fructose occurs within the first hour to second hour. In the following hour, the content of reducing sugars decreased, this decrement may be related to consumption by the yeast. Data in the same table showed that the reducing sugars decreased from 19.71 to 18.92 and 1.95% to 1.32% of submerged onion and potato slices respectively after 6 hours.

3.4. Effect of drying on the chemical compounds of onion and potato.

The moisture content reduced rapidly at the beginning and then decreased slowly with increasing in drying time. The drying rates were higher in the beginning of the drying process and gradually reduced as the drying process progressed. This was because of more heat energy which is absorbed by the water at the product surface initially, resulting into faster drying, and with the product surface drying out subsequently, heat penetration though the dried layer decreased thus retarding the drying rates. It is also well known that the increase of the drying temperature in the first drying stage (120ºC±5 for 15 min) results in the reduction of the drying time, specific energy input and employing 120°C temperature removing moisture up to 50% and in the second stage removing the remaining moisture these result was agreement with Jayeeta *et al*., (2012).

Data in table (4) showed that the moisture content of onions and potatoes were got reduced exponentially. The initial moisture content of fresh onion and potato slices was observed to be 86.15% and 82.55%, respectively. The final moisture contents of dried onion and potato slices ranged from 8.57 to 9.71% and 8.41 to 9.93%, respectively.

Table 4. Influence of different fermentation times and drying process on moisture, ash and color index (on dry weight basis*).

Sample	Moisture %		Ash* %		Color index	
	Onion	Potatoes	Onion	Potatoes	Onion	Potatoes
T1	9.46^{a}±0.189	9.73^{a}±0.234	4.07^{a} ±0.110	4.48^{a} ±0.114	0.258^{a} ±0.015	0.172^{a} ±0.06
T2	9.71^{a}±0.192	9.93^{a}±0.157	3.98^{a} ±0.054	4.60^{a} ±0.098	0.234^{b} ±0.015	0.154^{b} ±0.01
T3	8.95^{b}±0.168	8.41^{b}±0.251	3.79^{b} ±0.118	4.14^{b} ±0.062	0.195^{c} ±0.03	0.127^{c} ±0.09
T4	8.73^{b}±0.520	8.64^{b}±0.148	3.82^{b} ±0.065	4.16^{b} ±0.102	0.162^{d} ±0.06	0.118^{c} ±0.018
T5	8.57^{b}±0.145	8.65^{b}±0.096	3.62^{b} ±0.127	4.19^{b} ±0.044	0.121^{e} ±0.012	0.104^{d} ±0.021

All values are means of three replicates ±stander deviation (SD), Values in the same column with different letters are significantly different (P =.05).

T1: Control dried in an air ventilation oven at 60ºC±5.,

T2: Samples dried under direct sunlight.,

T3: submerged in yeast suspension for two hrs./ 120ºC±5 for 15 min / dried under direct sunlight.

T4: submerged in yeast suspension for four hrs./ 120ºC±5 for 15min / dried under direct sunlight.

T5: submerged in yeast suspension for six hrs./120ºC±5 for 15min / dried under direct sunlight

As for moisture content, there is no significant different could be detected between the two aforementioned varieties in case of drying either in an air ventilation oven at 60ºC±5 or by the direct sunlight. Meanwhile, there were significant differences in moisture content of dried submerged activated yeast in both varieties than these untreated.

The total ash contents of the dried onion and potato slices were among a range of 3.62 - 4.07% and 4.14 - 4.60%. The result of the total ash content of the samples showed that there were a significant differences betweenT1, T2 and all treatments. The differences may be attributed to the submerged in fermentation solution. The ash content decreased in due to the water solubility of the some minerals.

Color is among the most prominent quality attributes of dried vegetables, and alters during drying as a consequence of some chemical and biochemical reactions. The color index is an important factor in the study of quality preservation while drying the product. This index determines that how much the color of product has been changed. Analysis disclosed that temperature influence on the color index was significant and that increment in temperature caused the color index rise. Dried onion and potato without pretreatment, T1 and T2 the highest changes were observed on color index compared with fresh sample, that is to say there was a significant difference between them. On the other hand, the maximum amount of color index was related to thermal treatment and enzymatic browning. The least changes in dried sample color observed at T5 followed by T4 and T3 and also the highest rate of drying was achieved in T1 and T2. Fermentation convert reducing sugars in vegetables to lactic acid, thus lowering pH reduces sugars levels, amounts of Maillard products, including acrylamide and, consequently, burnt taste and color of deep fried potato products. Also, Yu and Ying (2007) reported that the extensive fermentation with yeast may be one of possible ways to reduce acrylamide content in products. Free asparagine and sugars are both important precursors for acrylamide formation in cereal based products. In general, most of the asparagine was utilized after 2 h of fermentation with yeast.

3.5. Influence of drying process on total carbohydrate, total sugars and reducing sugars.

The total carbohydrates contents of the fresh onion and potato (82.77 and 83.78%) were higher than those of dried treatments. The results showed that there were significant differences between T1 and all treatments for dried onion and potato in total carbohydrates. Oven hot air-dried samples relatively lost more carbohydrates than all the other samples. This decreased in carbohydrate content probably occurred as a result of Millard reaction. The differences in the carbohydrate contents may be attributed to the effect of the drying temperature.

Table 5. Influence of different fermentation times and drying process on total carbohydrates, total sugars and reducing sugars (on dry weight basis).

Sample	Total carbohydrate%		Total sugars %		Reducing sugars %	
	Onion	Potatoes	Onion	Potatoes	Onion	Potatoes
T1	77.62^{b} ±1.60	79.11^{b} ±1.76	39.97^{d} ±1.15	1.70^{d} ±0.03	16.12^{e} ±1.25	0.27^{d} ±0.18
T2	80.40^{a} ±1.24	81.93^{a} ±1.28	41.05^{b} ±1.07	1.98^{bc} ±0.13	17.37^{d} ±1.62	0.47^{c}±0.06
T3	82.16^{a} ±1.38	83.15^{a} ±1.80	42.16^{a} ±1.20	2.38^{a} ±0.04	18.88^{a} ±1.34	1.05^{a} ±0.02
T4	81.53^{a} ±1.14	83.03^{a} ±1.74	41.36^{b} ±1.42	2.05^{b} ±0.07	18.24^{b} ±1.21	0.85^{b} ±0.03
T5	81.25^{a} ±1.54	82.66^{a} ±1.06	40.65^{c} ±1.10	1.88^{c} ±0.04	17.98^{c} ±1.50	0.55^{c} ±0.06

All values are means of three replicates ±stander deviation (SD), Values in the same column with different letters are significantly different (P =.05).

T1: Control dried in an air ventilation oven at 60ºC±5.,

T2: Samples dried under direct sunlight.,

T3: submerged in yeast suspension for two hrs./ 120ºC±5 for 15 min / dried under direct sunlight.

T4: submerged in yeast suspension for four hrs./ 120ºC±5 for 15min / dried under direct sunlight.

T5: submerged in yeast suspension for six hrs./120ºC±5 for 15min / dried under direct sunlight.

Sugars form a major part of the soluble solids of the onion, but their presence cannot be detected in the raw full-flavored or strong onion because of the over-riding effect of the sulphur-based flavor volatiles. The results showed that there were relative differences. The highest percentage of total reducing sugars was found in T3, and lowest in oven hot air-dried samples T1 for both dried onion and potato. Also, data in the same table showed that the lowest losses in total reducing sugars in treatments T3, T4 and T5 than T1 and T2 compared with fresh sample.

3.6. Influence of different fermentation times and drying process on total phenolic, flavonoid and antioxidant activity (AOA).

Phenolic compounds are commonly found in both edible and nonedible plants, and they have been reported to have multiple biological effects, including antioxidant activity. The importance of the antioxidant constituents of plant materials in the maintenance of health and protection from coronary heart disease and cancer is also raising interest among scientists, food manufacturers, and consumers as the trend of the future is moving toward functional food with specific health effects (Lo liger, 1991). Also, loss of nutrients during processing is a major concern and it is necessary to minimize nutrient losses during processing of potatoes into various products. Minimal processing such as handling, washing and cutting can cause changes in phytochemicals and can led to activation of some enzymes which modify the level of phenolic compounds (Tudela *et al.*, 2002).

Table 6. Influence of different fermentation times and drying process on total phenolic, flavonoid and antioxidant activity (AOA) (on dry weight basis*).

Sample	Phenolic compound* mg/gm		Flavonoid compound* mg/gm		Antioxidant activity (AOA%)	
	Onion	Potatoes	Onion	Potatoes	Onion	Potatoes
T1	13.51[e] ±0.21	1.40[e] ±0.32	1.03[d] ±0.08	0.53[e] ±0.11	68.31[e] ±2.87	67.72[d] ±1.47
T2	16.05[d] ±0.15	2.02[d] ±0.42	1.16[c] ±0.07	0.85[d] ±0.07	72.37[d] ±1.53	70.24[c] ±1.60
T3	33.81[a] ±0.80	3.95[a] ±0.21	2.23[a] ±0.07	1.92[a] ±0.20	81.17[a] ±1.61	76.21[a] ±0.74
T4	24.16[b] ±0.20	3.35[b] ±0.19	1.63[b] ±0.09	1.48[b] ±0.13	79.28[b] ±1.33	73.90[b] ±1.27
T5	20.02[c] ±0.17	3.10[c] ±0.18	1.45[b] ±0.20	1.12[c] ±0.11	78.01[c] ±1.42	71.27[c] ±1.27

All values are means of three replicates ±stander deviation (SD), Values in the same column with different letters are significantly different (P =.05).

T1: Control dried in an air ventilation oven at 60ºC±5.,

T2: Samples dried under direct sunlight.,

T3: submerged in yeast suspension for two hrs./ 120ºC±5 for 15 min / dried under direct sunlight.

T4: submerged in yeast suspension for four hrs./ 120ºC±5 for 15min / dried under direct sunlight.

T5: submerged in yeast suspension for six hrs./120ºC±5 for 15min / dried under direct sunlight.

The combination of hot air oven drying (120ºC±5 for 15 min), fermentation process and sun drying retained and significantly improved the release of the phenolic compounds in treatments T3, T4 and T5 respectively. The hot air oven drying (at 60°C) of the dried onion and potato T1 caused thermal degradation of phenolic compounds. Sun drying caused significant degradation of the phenolic compounds at lower rates compared with the hot air oven drying at 60°C which indicated phenolic compounds of onion and potato samples are highly susceptible to enzymes catalyzed during oxidation and high temperature treatments. The improved release of phenolic compounds observed in combination of hot air oven drying (120ºC±5 for 15 min), fermentation process and sun drying might be attributed to the inactivation of oxidative enzymes and the induced structural changes in the cell matrices, leading to improved release of extractable and non-extractable phenolic compounds. Degradation of phenolic compounds of dried samples has been associated with activities of endogenous enzymes such as polyphenol oxidase (PPO), peroxidase (POD) which catalyzes the oxidation of the phenolic compounds (Ruenroengklin *et al.*, 2009). Ambient temperatures could high favor activities of these enzymes while high temperatures could cause loss of phenolic compounds through both thermal degradation and enzymatic oxidation. Data in the same table (6) showed the similar increase or retention was reflected in flavonoids because they are sub-groups of phenolic compounds. Hot air drying treatments caused significant losses in total phenolic compounds and flavonoids. Thermal processing increased the digestibility of proteins and carbohydrates. A high temperature in the heat-drying method in sample preparation significantly reduced total phenolic, total flavonoids and their antioxidant activity.

The results showed that, the total phenolic and flavonoid contents in T3, T4 and T5 were significantly higher by fermentation method than the conventional heat-drying and sun dried methods. The phenolic acids and flavonoids are mainly in free forms, which can easily extracted using ethanol or methanol solvents. As the result, in dried samples, the higher phenolic contents exhibited the higher antioxidant activity and flavonoid compounds also contribute to the antioxidant properties of dried samples extracts.

3.7. Rehydration characteristics and Pungency.

Rehydration means refreshing the dehydrated or dried products in water. The drying procedure had a statistically significant influence on the rehydration characteristic of the onion and potato dried samples (Table 7). In the case of convective drying, with the increase of the pretreatments heating temperature (120°C/15 min) the rehydration ratio for the treated sample (T3, T4 and T5) also increased. It may have been due to the fact that the rate of the moisture removal at a higher drying temperature is very fast and causes less shrinkage of the dried samples. The rehydration ratio for dried sample (T1) with the air ventilation oven at 60ºC±5 and the samples were dried under direct sunlight (T2) was the lowest. It was also observed from the rehydration ratio of sweet potato cubes dried at lower temperature was lesser as compared to the higher temperature Singh and Pandey (2011). The lower rehydration values are evidence for product shrinkage caused by prolonged drying resulting in irreversible physic-chemical changes. During heating at (120°C/15 min) before drying the thin cell membrane ruptured and starches granules started partial gelatinization. Removal of water from a cellular structure induced variations in the physical attributes of the system. The rehydration characteristics of dried samples are illustrated in Table (7). Data showed that there were no significant differences of rehydration ratio in slices of onion and potato dried samples (T3, T4 and T5) in water.

Table 7. Rehydration Ratio and Pungency.

Sample	Rehydration Ratio		Pungency*****(µmol/g, as pyruvic acid)
	Onion	Potatoes	Onion
T1	2.79^{b} ±0.03	2.52^{ab}±0.05	2.05^{c} ±0.02
T2	2.54^{c}±0.04	2.28^{b}±0.08	2.68^{a} ±0.05
T3	3.12^{a} ±0.04	2.75^{a}±0.04	2.78^{a} ±0.04
T4	3.25^{a} ±0.10	2.83^{a}±0.09	2.43^{b} ±0.07
T5	3.18^{a} ±0.06	2.78^{a}±0.11	2.15^{c} ±0.09

(On dry weight basis*).

The outstanding characteristic of onion is its pungency, which is due to a volatile oil known as allyl-propyl disulphide. Onions give off a very strong smell when they are cut. This is due to the cellular disruption releases the enzyme allinase from the vacuoles, and disruption of sulfur-amino acids. Pyruvic acid level, as an index of onion pungency, has become a routine procedure to ensure the quality of onions for both shippers and consumers. A common assessment of pungency is made by measuring pyruvate, which is formed as a stable primary compound from the enzymatic decomposition of each of the flavor precursors. Pyruvate is produced in a mole for mole relationship with the flavor precursors. It is, however, only an indicator of pungency as pyruvate does not directly contribute to onion flavor (Teare Ketter and Randle 1998).

The results of the pungency determination of dried onion are presented in table (7). During drying onion slices pungency was decreased. It is clear from these data that temperature used for drying process is crucial for retaining of onion pungency. Drying at temperature 60ºC±5 (T1) decreased of pungency content to 2.05 µmol/g (as pyruvic acid) compared to the pungency content in fresh onion 6.95 µmol/g (as pyruvic acid). Also, a larger decline of pungency occurred in onion samples T5 recorded 2.15 µmol/g (as pyruvic acid) these results may be due to the effect of drying long time and temperature on pungency component in T1. Meanwhile, dipping T5 in yeast suspension before drying to removes mono sugars from the surface layer of onion, and decrease Millard reactions also, at the same time dipping partly removes precursors responsible for biosynthesis on onion pungency these results in agreement with Horbowicz and Bąkowski (1997). Data in the same table showed that a slight decreased occurred in T3 followed by T2 and T4 but no significant differences between T2 and T3.

3.8. Sensory evaluation of dehydrated onion and potato samples.

Sensory quality is a difficult concept to define it should be comprehended as interaction between the product and the consumer. It is necessary to establish a relationship between the physical and chemical composition of the product and its sensory attributes such as color, texture, aroma and taste, as well as between the sensory perceptions and the acceptability for the consumer. Texture has been recognized as one of the most important quality attributes in dried potatoes, which contribute to the consumer acceptance. Taste, flavor, texture and appearance are generally considered to be among the most important sensory attributes. Reconstituted of the dehydrated onion and fried potato of oven drying T1, sun drying T2 and treated drying treatments T3, T4 and T5 samples were evaluated organoleptically. The samples were graded by numerical scoring, on a nine point hedonic scale. The results of organoleptic evaluation were reported in Table (8).

The organoleptic evaluation shows, slightly reduction in the mean score for overall acceptability of dehydrated samples. T3, T4 and T5 had high taste and texture score compared with T1 and T2 because they are exposed to higher operating temperature and drying time. There were clear differences shown in mean scores of color, appearance and overall acceptability between aforementioned treatments and T1, T2. The sample T1 and T2 has a less attractive color, appearance and overall acceptability as compared to the other one that have high scores in color, appearance and overall acceptability. The poor color and appearance of open sun dehydration is due to more time exposing to light and wind as compared to combined dried methods. Regarding quality it was found out that the onion and potato processed by oven and sun drying method T1 and the other once were acceptable, while dried onion and potato powder T3, T4 and T5 were much better and typical sensory characteristics of the final product compared with fresh fruit. For all drying methods there was statistically significant difference confirmed between product obtained by drying methods and treated technique.

Table 8. Organoleptic acceptability of onion and potato prepared by different drying methods.

Sample	Sensory attributes for onion				
	Color	Appearance	Taste	Texture	Overall acceptability
Fresh onion	8.15^{a}	8.0^{a}	8.1^{a}	8.2^{a}	8.25^{a}
T1	6.12^{d}	6.55^{c}	6.15^{d}	7.21^{bc}	6.09^{d}
T2	7.22^{c}	7.14^{b}	7.11^{c}	6.00^{d}	7.23^{c}
T3	7.72^{b}	7.78^{a}	7.55^{b}	7.62^{b}	7.58^{bc}
T4	7.68^{b}	7.61^{a}	7.75^{ab}	7.55^{b}	7.95^{ab}
T5	7.80^{a}	7.80^{a}	7.10^{a}	7.85^{ab}	7.60^{bc}
Mean	7.45	7.48	7.29	7.41	7.45
Sample	Sensory attributes for potato				
	Color	Appearance	Taste	Texture	Overall acceptability
Fresh potato	8.00^{a}	8.50^{a}	7.92^{a}	7.75^{a}	8.11^{a}
T1	6.30^{c}	6.62^{c}	6.10^{c}	7.10^{b}	6.12^{c}
T2	7.10^{b}	7.70^{b}	7.15^{b}	6.92^{b}	7.15^{b}
T3	7.70^{a}	7.87^{ab}	7.76^{a}	7.82^{a}	8.00^{a}
T4	7.90^{a}	7.92^{a}	8.20^{a}	7.80^{a}	8.12^{a}
T5	8.10^{a}	7.40^{a}	8.20^{a}	8.00^{a}	8.50^{a}
Mean	7.52	7.67	7.56	7.57	7.67

All values are means of three replicates ±stander deviation (SD), Values in the same column with different letters are significantly different (P =.05).

T1: Control dried in an air ventilation oven at 60ºC±5.,

T2: Samples dried under direct sunlight.,

T3: submerged in yeast suspension for two hrs./ 120ºC±5 for 15 min / dried under direct sunlight.

T4: submerged in yeast suspension for four hrs./ 120ºC±5 for 15min / dried under direct sunlight.

T5: submerged in yeast suspension for six hrs./120ºC±5 for 15min / dried under direct sunlight.

Finally, it could be clearly concluded through this study that, it is applicably, technologically, economicly and hence successful to establish new small projects. That would be realized by applying simple untraditional new dehydration technique by utilizing *Saccharomyces cerevisiae* directly before dehydration. That would help to improve both nutritional value and palatability of organolyptic properties of the final product among the majority of consumers. From economic point of view, dehydration both of onion and potato led to decrease the cost of transportation and storage to about 1/10. Using sun drying will allow to use green market in export our products. In the case of dried potato we shall not need to store potato in refrigerators to keep it quality. Potato powder which processed by this simple technique was easy to prepare potato paste and fried potato. All these factors led to increase the add value of these crops.

4. CONCLUSION

From the results of present study it can be concluded that, the fermentation process used as pretreatment for onion and potato before drying considered more effective to eliminate the reducing sugars instead by washing process with water. The dried onion and potato produced by these techniques had acceptable characteristics and high nutritional value.

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إنتاج منتجات مجففة عالية الجودة بتقنية بسيطة للمشروعات الصغيرة

حسين محمد رضوان ، أيمن سيد دياب و محمد رمضان مسعود

قسم بحوث تكنولوجيا الحاصلات البستانية – معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية – الجيزة – مصر

تهدف هذة الدراسة لتجفيف البصل والبطاطس بتقنية بسيطة للمشروعات الصغيرة. حيث تم غمر كل من شرائح البصل والبطاطس فى معلق خميرة الخباز لمدة 2، 4 و6 ساعات كمعاملة اولية ثم تم تجفيف العينات مبدئياً فى فرن تجفيف بالهواء على درجة حرارة 120°م/15 دقيقة ثم التجفيف الشمسى الى ان تصل الرطوبة الى 9 – 10%. كان الهدف من المعاملة الحرارية (120°م/15 ق) التعقيم، تثبيط الخميرة و إنزيمات التلون بجانب خفض محتوى الرطوبة والوقت اللازم للتجفيف بالاضافة الى الجلتنة الجزئية لنشا البطاطس. كما تم تقدير التركيب الكيميائى والصفات الطبيعية والعد الميكروبى والصفات الحسية لكل من البصل والبطاطس. أظهرت النتائج أن زيادة معدل التخمر أدى الى زيادة معدل نمو الخميرة وانخفاض كل من رقم الحموضة ونسبة المواد الصلبة الذائبة وانخفاض كثافة اللون. كما أوضحت النتائج انخفاض المركبات الفينولية والفلافونيد والنشاط المضاد للاكسدة بزيادة مدة التخمر بالاضافة الى تقديرالحرافة (كحمض بيروفيك) فى البصل. ومن الناحية الأخرى لم يلاحظ أى تغيرات فى خصائص الاسترجاع لكل من البصل والبطاطس المجففة بزيادة مدة التخمر. من نتائج التقييم أظهرت النتائج أن أفضل المعاملات هى العينات المغمورة فى معلق خميرة الخباز لمدة 4 ساعات والمجففة مبدئياً على درجة حرارة 120°م/15 دقيقة ثم التجفيف الشمسى كما حازت على القيمة الغذائية والجودة العالية.