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RESEARCH ARTICLE

Several Parameters of Blanching and Drying Influencing to Quality of Dried Pumpkin

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Abstract

Is one such plant that is frequently being used as food as well as traditional medicine for long days. It is a large climbing herb, annual or perennial, for use as vegetable as well as medicine. It contains several phytochemicals including alkaloids, flavanoids, phenols, carbohydrates, tannins, saponins, terpenoids and proteins. The presence of these phytochemicals has been found to possess various medicinal functional functions which are essential in the management of various diverse ailments. Pumpkin has gained a considerable attention in recent years for its nutritional and health promoting values. Drying is a relatively simple process in which water activity in food is reduced, minimizing or inhibiting the chemical and enzymatic reactions and microbial growth that are responsible for its deterioration. Therefore, objective of this study focused on the effect of blanching temperature and time; heat pump drying temperature and storage condition to ß-caroten (mg/100), vitamin C (mg/100g), rehydration capacity (kg moisture/kg d.s.), sensory score of the dried pumpkin *(Cucurbita spp.)*. Results showed that pumpkin *(Cucurbita spp.)* should be blanched in hot water 95^{o}C at 10 seconds in the present of citric acid 4g/l and then beeing dried by heat pump dryer at 50^{o}C until 12% moisture. Blanching is carried out to improve food quality by inactivating enzymes, reducing microorganisms and preserve the natural color when pumpkin after blanching is subjected to drying. The final dried pumpkin was shelf-stable for a period of 12 weeks at ambient temperature without any appreciable adverse changes in physico-chemical as well as sensory quality characteristics of the dried products.

Keywords: *Pumpkin, Blanching, Drying, β-caroten, Vitamin C, Rehydration capacity.*

Introduction

Cucurbita (Pumpkin) is one of the underutilized crops which belong to the family, cucurbitaceae. Pumpkin is a creeping or climbing plant, monoecious, annua. It is famous for its edible seeds, fruit and greens. The pulp is used to relieve intestinal inflammation or enteritis, dyspepsia and stomach disorders [1].

Pumpkin fruit is an excellent source of pro-vitamin A which the body needs for proper growth, healthy eyes and protection from disease.

It is also rich in vitamin C, vitamin E, lycopene, dietary fibre though it contains low amounts of fibre and fat [2, 3]. Pumpkin (*Cucurbita* sp.) seeds are a key food source for humans. Pumpkin seed extract is useful for immunomodulation, reproductive health and therapeutic advantage over a wide range of disease conditions [4].

The intake of a whole extract of pumpkin seeds has been correlated with reduced benign prostate hyperplasia-associated symptoms.

The antioxidative property of pumpkin seed extract could also improve fertility, and it helps to prevent arteriosclerosis, high blood pressure and heart diseases; it also stimulates metabolism of accumulated fats [5, 6]. Pumpkin pulp contains several phyto-constituents belonging to the categories of alkaloids, flavonoids, and palmitic, oleic and linoleic acids [7, 8].

Various important medicinal properties including anti-diabetic, antioxidant, anti-carcinogenic, anti-inflammatory and others have been well documented [9]. The unripe fruit is eaten as a boiled vegetable, while the flesh of the ripe fruit is used to prepare sweets and soft or slightly alcoholic drinks. Pumpkin fruits on ripening accumulated considerable amount of carotenoids, vitamin C and proteins along with carbohydrates.

Due to enhanced activities of amylase and invertase during ripening of pumpkin fruit, starch degradation occurred concomitantly with the increasing pattern of reducing sugars and total sugars. ß- galactosidase and cellulase enzymes actively involved in cell wall degradation than that of pectin methylesterase (PME) and polygalacturonase (PG), while the activities of antioxidant enzymes exhibited declining pattern towards its maturation and ripening [10].

Pumpkins are cooked and consumed in many ways, and most parts of the pumpkin are edible, from the fleshy shell to the seeds. Pumpkin flesh is consumed in soups and juices, or it is incorporated into various foods, such as rice cakes, candies, and breads [3].There were several studies mentioned to pumpkin processing. A study was designed to elucidate the effects of osmotic dehydration of pumpkin slice prior to hot-air drying [11].

The study was aimed at assessing the quality of pumpkin *(Cucuribita Spp.)* slices that were subjected to pre-drying treatments and drying using two drying methods (uncontrolled sun and oven) fruit accessions [12]. A research was to study the influence of blanching as a pretreatment on the drying rate, color and rehydration rate of pumpkin slices (*Cucurbita maxima*) dried in a convective dryer at 50, 60 and 70C [14]. Effect of pretreatments on air-drying pattern and color of pumpkin slices was investigated [15].

A study was designed to elucidate the effects of osmotic dehydration of pumpkin slice prior to hot-air drying [16]. The effects of pretreatment on convective drying of pumpkin (*Cucurbita maxima*) at air temperature of 55 °C and 65 °C was examined [17]. Effect of drying method on nutrient integrity of selected components of pumpkin (*Cucurbita moschata* duch.) fruit flour was mentioned [18].

An investigation was to evaluate the properties of pumpkin (*Cucurbita maxima* L.) exposed to convective air drying and freeze-drying [19]. The effect of drying and long-term storage on colour and carotenoids content of giant pumpkin (*Cucurbita maxima*) was examined [20]. A study was to investigate the influence of microwave vacuum drying on carotenoids in pumpkin (*Cucurbita maxima* L.) slices [21].

The effects of zein film coating along with benzoic acid on the quality of sliced pumpkin samples, which were packaged with different techniques, were investigated [22]. The application of appropriate technologies to preserve pumpkin nutritional properties is one of the ways to supply the population with healthy and nutritious processed foods. Therefore, objective of this study focused on the effect of blanching temperature and time; heat pump drying temperature and storage condition to ß-caroten (mg/100g), vitamin C (mg/100g), rehydration capacity (kg moisture/kg d.s.), color (sensory score) of the dried pumpkin *(Cucurbita spp.)*.

Materials and Method

Material

We collected pumpkin *(Cucurbita spp.)* in Hau Giang province, Vietnam. They must be cultivated following VietGAP to ensure food safety. After collecting, they must be conveyed to laboratory within 4 hours for experiments. They were washed under tap water to remove foreign matters.

The samples were then washed with Perasan to avoid contamination. After removing the superficial green portion, the fruits were subsequently blanched and dried. Besides pumpkin *(Cucurbita spp.)* we also used another material during the research such as Citric acid. Lab utensils and equipments included digital weight balance, cooker, and heat pump dryer.

Figure 1: Pumpkin *(Cucurbita spp.)*

Researching Procedure

Effect of Blanching Temperature and Time to β-caroten (mg/100g), Vitamin C (mg/100g), Rehydration Capacity (kg moisture/kg d.s.), and Color (Sensory Score) in the Dried Pumpkin (Cucurbita spp.)

Raw pumpkin *(Cucurbita spp.)* was blanched in water solution with 4 g/l Citric acid at different temperature and time (100°C, 5 second; 95°C, 10 seconds; 90°C, 15 seconds; 85°C, 20 seconds). Then they were dried by heat pump at 50°C until 12% moisture. All samples were analyzed ß-caroten (mg/100g), vitamin C (mg/100g), rehydration capacity (kg moisture/kg d.s.), color (sensory score) to validate the appropriate blanching condition.

Effect of Drying Temperature by Heat Pump to β-caroten (mg/100g), Vitamin C (mg/100g), Rehydration Capacity (kg moisture/kg d.s.), and Color (Sensory Score) in the Dried Pumpkin (Cucurbita spp.)

Raw pumpkin *(Cucurbita spp.)* was blanched in water solution with 4 g/l Citric acid at 95°C in 10 seconds. Then these samples would be dried under heat pump dryer at different temperature (30°C, 35°C, 40°C, 45°C, 50°C, 55°C) until 12% moisture. All samples were analyzed ß-caroten (mg/100g), vitamin C (mg/100g), rehydration capacity (kg moisture/kg d.s.), color (sensory score) to validate the appropriate drying temperature.

Effect of Storage Condition to Vitamin C (mg/100g) and β-caroten (mg/100g) in the Dried Pumpkin (Cucurbita spp.)

After completion of drying treatment, the dried pumpkin *(Cucurbita spp.)* was subjected to storage. They were kept in PA (vaccum) bag at different 4°C, 28°C. The vitamin C (mg/100g) and ß-caroten (mg/100g) will be analyzed in 3 weeks interval for 12 weeks.

Nutritional, Physico-chemical and Sensory Analysis

Nutritional composition of the pumpkin pulp was determined using the AOAC methods [23]. Vitamin C and ß-carotene contents of dried fruit samples were determined by titration method of Osborne and Voogt (1978) and spectrophotometric method based on Ultraviolent (UV) inactivation respectively as described by Onwuka (2005) [24, 25]. Rehydration capacity was measured as follow: About 1 g of dried mushrooms were soaked in water at 25 °C. After a specific time interval, the mushrooms were removed and excess water gently blotted out with paper towel. The samples were weighed and then placed back into water.

The time interval used for repeated determinations in hot-air dried and vacuum-dried mushrooms was 2 min, while for the freeze-dried mushrooms was 5 sec. Readings were taken until there was no further change in weight, at which time the mushrooms were considered to have reached full rehydration capacity. Rehydration capacity was calculated as the maximum amount of water absorbed (kg) per kg of dry material as determined at the end of the rehydration time experiment [26]. Color (sensory score) of pumpkin (*Cucurbita spp.)* was assessed by a group of panelist. They were required to evaluate the odour, colour, taste, sweetness and overall acceptance using the 9-point hedonic scale (1 = dislike extremely, 9 = like extremely).

Statistical Analysis

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Statgraphics Centurion XVI.

Result & Discussion

Nutritional Composition in Raw Pumpkin (*Cucurbita spp*)

Nutritional Composition in Raw Pumpkin was Analyzed Table 1.

Table 1: Proximate composition of the fresh pumpkin pulp %

Criteria	Protein (%)	Moisture (%)	Carbohydrate (%)	Fibre (%)	Ash (%)	Fat (%)	Vitami)n C (mg/100g	β-caroten (mg/100g)
Value	3.45 ±0.02	85.12 ±0.01	7.49 ±0.00	1.74 ±0.01	1.04 ±0.03	1.16 ±0.02	3.44 ±0.03	37.29 ±0.01

Note: the values were expressed as the mean of three repetitions

The nutritional potential of thirteen varieties of *Cucurbita* fruits collected from selected regions of Kenya were evaluated for their proximate values, mineral and ß-carotene content. The results indicated that the moisture content was high and it varied significantly ($p<0.05$) among the groups. Ash values were significantly different at ($p<0.05$) and ranged from 0.63 to 1.67%, crude protein was low in all the pumpkin groups and varied from 0.93 to 2.09%.

The pumpkins also varied significantly ($p<0.05$) in crude fibre content (0.47- 1.95) among the groups. Potassium and sodium were the most prevalent minerals potentially useful amounts of potassium (199-172.3 mg/100g), sodium (56.39-118.28 mg/100g) and other essential minerals [2]. According to another research proximate composition of the pumpkin pulp varied between 75.8 and 91.33% moisture, 0.2 and 2.7% crude protein, 0.47 and 2.1% crude ash and 3.1 and 13% carbohydrate content [27].Meanwhile, in another research, the pulp was found to be a rich source of ß-carotene (142.38 mg/100 gm) [28].

Effect of Blanching Temperature and Time to β-caroten (mg/100g), Vitamin C (mg/100g), Rehydration Capacity (kg moisture/kg d.s.) and Color (Sensory Score) in the Dried Pumpkin *(Cucurbita spp.)*

Pumpkins are consumed as freshly boiled and steamed or in processed form like soup and curry. It is high in ß-carotene, which gives it yellow or orange color. Beta-carotene in plants that have a pleasant yellow-orange color is a major source of vitamin A [29]. Consumption of carotene containing foods helps in the prevention of dermatological ailments, eye disorders and certain cancers [30].During the fruit drying process, changes in appearance and color may occur and compromise the product acceptance. These changes occur through the action of the polyphenol oxidases enzymes that are present in the fruits, leading to the formation of melanins (dark pigments) from the oxidation of phenols to o-quinones [31].

Pretreatments are usually performed precede drying of fruits in order to minimize the adverse changes occurring during drying and subsequent storage. Pretreatments are recommended techniques used to enhance quality of dried fruits. This is because they prevent darkening of the cut fruit surface and cause the destruction of pathogens that could cause foodborne illness [32]. Raw pumpkin *(Cucurbita spp.)* was blanched in water solution with 4 g/l Citric acid at different temperature and time (100oC, 5 second; 95oC, 10 seconds; 90oC, 15 seconds; 85oC, 20 seconds).

Then they were dried by heat pump at 50oC until 12% moisture. All samples were analyzed ß-caroten (mg/100g), vitamin C (mg/100g), rehydration capacity (kg moisture/kg d.s.) color (sensory score) to validate the appropriate blanching condition. Results were mentioned in table 1. From table 1, the pumpkin *(Cucurbita spp.)* should be blanched at 95oC in 15 seconds to maintain the most ß-caroten (mg/100g), rehydration capacity (kg moisture/kg d.s.), and sensory score in the dried *pumpkin (Cucurbita spp.)*

Table 2: Effect of blanching and time to β-caroten (mg/100g), vitamin C (mg/100g), rehydration capacity (kg moisture/kg d.s.) and color (sensory score) in the dried pumpkin *(Cucurbita spp.)*

Blanching	β-caroten (mg/100g)	Vitamin C (mg/100g)	Rehydration capacity (kg moisture/kg d.s.)	Sensory score
100°C, 5 seconds	34.21±0.03^{b}	2.69±0.02^{b}	4.35±0.01^{ab}	6.37±0.01^{c}
95°C, 10 seconds	35.75±0.01^{a}	3.35±0.03^{a}	4.93±0.02^{a}	7.39±0.01^{a}
90°C, 15 seconds	32.11±0.01^{c}	2.38±0.00^{c}	4.11±0.01^{ab}	7.01±0.02^{b}
85°C, 20 seconds	31.33±0.02^{d}	2.27±0.02^{d}	4.02±0.03^{b}	5.84±0.00^{d}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

The study was aimed at assessing the quality of pumpkin *(Cucuribita Spp.)* slices that were subjected to pre-drying treatments and drying using two drying methods (uncontrolled sun and oven) fruit accessions. Pre-drying had significant ($P \leq 0.05$) effect on the quality of dried pumpkin slices. 10 % salt solution dipped pumpkin fruit slices had good chemical quality. Salt dipping treatment combined with low temperature (60 °C) oven air circulation drying is recommended to maintain quality of dried pumpkin slices [12].

The influence of blanching on the decrease in equilibrium moisture was very small compared to the fresh samples and it was related to the loss of soluble solids during the pre-treatment [13]. A research was to study the influence of blanching as a pretreatment on the drying rate, color and rehydration rate of pumpkin slices (*Cucurbita maxima*) dried in a convective dryer at 50, 60 and 70C.

The rehydration rate of the dried sample, which was found to be influenced by drying temperature but not by the pretreatments, reached about 2 kg water/kg dry solid in about 150 s in boiling water. Samples dried at 70°C without pretreatments presented color parameter values very similar to those of the fresh sample [14]. Effect of pretreatments on air-drying pattern and color of pumpkin slices was investigated.

Fresh, sulfited (1,000 ppm), blanched (100C for 3 min) and osmotically pretreated pumpkins (40, 50 and 60 °Brix) were air dried at 50-80C [33]. A study was designed to elucidate the effects of osmotic dehydration of pumpkin slice prior to hot-air drying. Increasing temperature caused the deterioration of colour and aroma. Longer immersion time was found to increase shrinkage, sweetness and overall acceptability of the fnal product. The optimum osmotic dehydration pretreatment was predicted as immersion using 57.8˚Brix sucrose solution at 58.3˚C for 146.7 minutes [16].

Effect of drying temperature by heat pump to β-caroten (mg/100g), vitamin C (mg/100g), rehydration capacity (kg moisture/kg d.s.) and color (sensory score) in the dried pumpkin *(Cucurbita spp.)*

Drying is one of the oldest methods for the preservation of food products and it is the process of removing water from food by circulating hot air through it to reduce the moisture content to a level which prohibits the growth of microorganisms. Drying of food materials has advantages such as control of product quality, achievement of hygienic conditions, and reduction of product loss [34].From Table 3, the appropriate drying temperature should be conducted at 50°C.

Table 3: Effect of drying temperature by heat pump to β-caroten (mg/100g), vitamin C (mg/100g), rehydration capacity (kg moisture/kg d.s.) and color (sensory score) in the dried pumpkin *(Cucurbita spp.)*

Drying temperature	β-caroten (mg/100g)	Vitamin C (mg/100g)	Rehydration capacity (kg moisture/kg d.s.)	Sensory score
30°C	35.79±0.01[a]	3.38±0.03[a]	4.96±0.02[a]	7.41±0.01[a]
35°C	35.78±0.01[a]	3.38±0.03[a]	4.96±0.02[a]	7.41±0.01[a]
40°C	35.78±0.01[a]	3.38±0.03[a]	4.95±0.02[a]	7.40±0.01[a]
45°C	35.76±0.01[a]	3.37±0.03[a]	4.95±0.02[a]	7.40±0.01[a]
50°C	35.75±0.01[a]	3.35±0.03[a]	4.93±0.02[a]	7.39±0.01[a]
55°C	34.41±0.02[b]	2.18±0.01[b]	3.14±0.01	6.02±0.01[b]

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

A study was designed to elucidate the effects of osmotic dehydration of pumpkin slice prior to hot-air drying. The optimum osmotic dehydration pretreatment was predicted as immersion using 57.8˚Brix sucrose solution at 58.3˚C for 146.7 minutes [11].The effects of pretreatment on convective drying of pumpkin (*Cucurbita maxima*) at air temperature of 55 °C and 65 °C was examined. The moisture content in raw pumpkin was 89.13 %, while in dried material, moisture content ranged from 10.46 % to 18.25 %.

Better preservation of pumpkin pieces was achieved by conduction drying at air temperature of 55 °C. The rehydration degree reached the optimal values at air temperature of 65 °C [17].An investigation was to evaluate the properties of pumpkin (*Cucurbita maxima* L.) exposed to convective air drying and freeze-drying. It was concluded that the freeze drying and the air drying at 40 ºC produced smaller changes in the colour while the drying in the tunnel originated more intense colour changes.

With respect to texture, it was possible to deduce that the pulp in the fresh product at 2 cm off from the skin is harder than the pulp at 4 cm off from the skin. Hardness varied from 75 % in the drying in chamber at 40 ºC to 90 % in the tunnel drying, when compared to the fresh product. As to springiness, it was changed more in the drying at 40 ºC, while cohesiveness showed the higher change in the freeze drying treatment [19].

Effect of Storage Condition to Vitamin C (mg/100g) and β-catoten (mg/100g) in the Dried Pumpkin *(Cucurbita spp.)*

Loss of nutrients, such as vitamin C and carotenoids, may occur during storage, thus reducing the nutritional value of dried fruit. Degradation of these nutrients depends on factors such as pH, oxygen exposure, presence of light, metals, enzymes, temperature and the drying methods used [35, 36]. In addition to the nutritional aspects, sensorial attributes must be evaluated in order to determine the quality of dried fruits. The aroma and flavor may be altered due to loss of volatiles during drying and storage of the dried fruits, leading to lower product acceptance [37].

After completion of drying treatment, the dried pumpkin *(Cucurbita spp.)* was subjected to storage. They were kept in PA (vaccum) bag at different 4°C, 28°C. The vitamin C (mg/100g) and ß-caroten (mg/100g) will be analyzed in 3 weeks interval for 12 weeks. Dried pumpkin *(Cucurbita spp.)* should be stored under vacuum in PA bag at 4°C to maintain vitamin C (mg/100g) and ß-catoten (mg/100g) for 12 weeks.

Table 4: Vitamin C (mg/100g) and β-catoten (mg/100g) in dried pumpkin *(Cucurbita spp.)* by the effect of packaging material and storage temperature

Storage time (week)	Vitamin C (mg/100g) in dried pumpkin *(Cucurbita spp.)* by the storage temperature (°C) kept in PA (vaccum)		β-caroten in dried pumpkin *(Cucurbita spp.)* by the storage temperature (°C) kept in PA (vaccum)	
	4 °C	28 °C	4 °C	28 °C
0	3.35±0.03^{a}	3.35±0.03^{a}	35.75±0.01^{a}	35.75±0.01^{a}
3	3.24±0.00^{ab}	3.21±0.02^{ab}	35.68±0.01^{ab}	35.64±0.01^{ab}
6	3.20±0.03^{b}	3.17±0.00^{b}	35.58±0.02^{b}	35.53±0.00^{b}
9	3.14±0.01^{bc}	3.08±0.01^{bc}	35.49±0.02^{bc}	35.41±0.01^{bc}
12	3.09±0.02^{c}	3.01±0.02^{c}	35.37±0.03^{c}	35.24±0.02^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

The drying operation reduces the moisture content of solids to a condition favorable for safe storage without deteriorations. The most significance reason for the popularity of dried products is that in dehydrated foods, microorganisms practically do not grow due to the presence of a minimum amount of water and thus they are immune to enzymatic reactions that could provoke alterations or spoilage in the food [38, 40]. The effect of drying and long-term storage on colour and carotenoids content of giant pumpkin (*Cucurbita maxima*) was examined.

Pumpkin were dried at five different temperatures (40°C, 50°C, 60°C, 70°C, 80°C) using three different drying methods (forced convection in tunnel dryer, natural convection in chamber dryer and hybrid drying which combined a tunnel drying and fluidized-bed drying. The three subsequent highest scores were obtained for samples of Ambar cultivar; dried using hybrid drying at 40, 60 and 80°C [20]. A study was to investigate the influence of microwave vacuum drying on carotenoids in pumpkin (*Cucurbita maxima* L.) slices. It was shown that compared with hot air drying, microwave vacuum drying inhibited color changes and significantly ($p < 0.05$) improved total carotenoid retention (89.1%) in pumpkin slices. During the microwave vacuum drying process, microwave power had an important effect on total carotenoid and *all-trans* carotenoids. As microwave power increased, the total carotenoid content significantly decreased ($p < 0.05$), and the levels of individual carotenoids.

In addition to the degradation induced by microwave energy, isomerization was considered to be responsible for the loss of *all-trans* carotenoids [21].The effects of zein film coating along with benzoic acid on the quality of sliced pumpkin samples, which were packaged with different techniques, were investigated. According to color analysis, the L* value was observed to have signifcantly decreased in the processed and packaged samples in comparison with the control group. Besides, a* and b* values increased in all groups.

It was determined that zein flm alone did not exhibit the expected effectiveness against moisture loss in the samples. According to the results of microbiological analysis, a final decrease at approximately 1.00 log levels was determined in total count of mesophilic aerobic bacteria (TMAB) in the group which was vacuum packaged in PVDC with zein coating when compared with the initial TMAB. Furthermore, no molding occurred in zein-coated group on the last day of the storage period, while massive mold growth was noted in the group which was packaged without any pretreatment procedure [22].

Conclusion

Nutritional and health protective value of pumpkin draws considerable attention of food scientists in recent years. Pumpkin is one of the well-known edible plants and has substantial medicinal properties due to the presence of unique natural edible substances. Pumpkin is regarded as valuable vegetables primarily because of the high carotenoid content, the low energetic value, high in carbohydrates and minerals. The pumpkin is excellent source of protein and also has pharmacological activities such as antidiabetic, antifungal, antibacterial, anti-inflammation activities and antioxidant effects. Pumpkin pulp serves as a good nutrious food and help in promoting good health. Pre-drying treatments could be used to preserve color and flavor, minimize nutrient loss, stop decomposition (enzyme action), and ensure more even drying and to extend storage the shelf life of pumpkin.

The dried pumpkin can be stored for a long period of time due to low activities of microorganisms and enzymes resulting from lower water activities in the final dehydrated products compared to fresh once.

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