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RESEARCH ARTICLE

Technical Factors Affecting to Production of Dried Roasted Pumpkin *(Cucurbita)* Seed

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Abstract

Pumpkin seeds are covered by a white husk. Pumpkin seeds are subtly sweet and nutty with a malleable, chewy texture. The seeds of pumpkin are rich in oil and nutrients. Pumpkin seed has been considered as beneficial to health because it contains various biologically active components. It lowers cholesterol level in blood. Drying and roasting are the most important processes giving neccessary alterations to the product. Roasting can enhance flavour through caramelization on the surface of the food. There was no any research mentioned to varify the change of antioxidant (tocopherol) during infrared drying as well as storage. So the objective of the present study was to identify the effect of temperature in infrared drying, roasting condition, packaging and storage to antioxidant (tocopherol) in the dried Pumpkin (*Cucurbita)* seed. Results demonstrated that drying temperature (42 ^{o}C), roasting (155 ^{o}C in 4 min), vaccum packing in polyethylen (PA) bag and keeping in 4 ^{o}C were recommended to maintain the tocopherol, total phenolic and antioxidant activity in the final products for 12 weeks. The effect of drying, roasting temperature and time were clearly demonstrated to produced dried roasted pumpkin seed.

Keywords: *Pumpkin, Drying, Roasting, ANTIOXIDANT, tocopherol, Vaccum.*

Introduction

Cucurbita sp. (family: Cucurbitaceae) is a trailing annual herb, widely cultivated throughout Vietnam and in most warm regions of the world, for used as vegetables as well as medicines. It is a large climbing herb, annual or perennial. Its aerial part consists of flexible succulent stem with trifoliate leaves. The waste generated during processing of pumpkin is in the form of peel and pulp [1].

Seed of *Cucurbita* sp. reveals the presence of alkaloids, flavanoids, phenolics, carbohydrates, tannins, saponins, terpenoids and proteins [2, 3]. Cururbita maxima seed oil is a rich source of linoleic acid, which is useful in human body.4 Pumpkin (*Cucurbita sp*.) seeds are a good source of essential micro-elements such as K, Na, Cr, Mg, Zn, Cu, Mo and Se. Seeds are valued for their high protein amount (30 - 37%) with presence of all 9 essential amino acids, as well as for their high quantity of lipids (40 - 50%) containing essential fatty acids, especially alpha linoleic acid (omega-6) [5, 11].

Pumpkin seed extract is useful for immunomodulation, reproductive health and therapeutic advantage over a wide range of disease conditions. 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 [12]. Many pharmacological studies have demonstrated hepatoprotection, inhibit benign prostatic hyperplasia, hypoglycemic agent, antioxidant, anticancer, antimicrobial, anti-inflammatory, anti-diabetic, and antiulcer activities supporting its traditional uses [13, 14]. There were several researchs mentioned to processing of pumpkin seed. A study on extraction of oil from *Pumpkin seed* using sun drying and hot air oven drying was observed [15]. The potential of squash pumpkin by-products (seeds and shell) as sources of antioxidant and bioactive compounds was evaluated [16].

A study was to investigate how roasting pumpkin seeds influences the physicochemical properties of cold-pressed oils [17]. Oxidation stability and compositional characteristics of oils from microwave roasted pumpkin seeds during thermal oxidation was mentioned [18]. The effect of roasting on the chemical composition and oxidative stability of pumpkin oil was indicated [19]. However, there was not any research examined the change of tocopherol, total phenolic and antioxidant activity during infrared drying, roasting as well as storage. So the objective of the present study was to identify the effect of temperature in infrared drying, roasting condition, packaging and storage to tocopherol, total phenolic and antioxidant activity in the dried Pumpkin (*Cucurbita)* seed.

Materials & Method

Material

We collected Pumpkin (*Cucurbita*) in Tien Giang province, Vietnam. They were cultivated following VietGAP to ensure food safety. After harvesting, collected seeds were stored at a temperature of 4˚C and they were conveyed to laboratory within 8 hours for experiments. These seeds were tumbled thoroughly under turbulent moving to remove dirt, dust and adhered unwanted material.

The seeds were sorted to obtain the uniform size and defect-free ones. Before roasting process, pumpkin seeds were soaked in 25% (w/w) salt solution for 20 min. Then, the excess water of sieved seeds was removed using cloth. Beside pumpkin (*Cucurbita**)*** we also used other materials during the research such as PA bag, NaCl, HCL, Na_2CO_3, Folin-Ciocalteau**.** Lab utensils and equipments included weight balance, infrared dryer, and spectrophotometer and vaccum machine.

Figure 1: Pumpkin (*Cucurbita*)

Researching Procedure

Chemical Compositions in Fresh Pumpkin (Cucurbita) Seed

The chemical compositions including protein (g/100g), lipid (g/100g), tocopherol (mg/100g), and moisture content (%), total phenolic (mg/ 100g) and antioxidant activity (IC50, mg/ ml) in fresh Pumpkin (*Cucurbita*) were analyzed. Protein (by Kjeldahll), lipid (by Soxhlet) and moisture (drying to constant weight) were applied. Tocopherol analysis would be performed by HPLC.

Stable 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical was used to determine the antioxidant activity. 0.5 mL of the DPPH solution was diluted in 4.5 mL of methanol, and 0.1 mL of a methanolic solution of the extract was added. The concentration of DPPH solution was about 50 mg/100 mL. The mixture was shaken vigorously and was placed in dark allowed to stand for 45 min.

The decrease in absorbance was measured at 515 nm against a blank (without extract) with a spectrophotometer.

Total phenolics were determined colorimetrcially using Folin- Ciocalteau reagent. Extract (150mg) was dissolved in methanol (10 mL) and 2 mL of this solution was filled up with 0.3% HCl to 5 mL. A 100-µL aliquot of the resulting solution was added to 2 mL of 2% Na_2CO_3 and after 2 min 100 µL of Folin-Ciocalteau reagent was added. After a further 30 min the absorbance was measured at 750 nm using a spectrophotometer.

Effect of Infrared Drying Temperature to Tocopherol, Total Phenolic and Antioxidant Activity in Dried Pumpkin (Cucurbita) Seed

In order to verify the effect of infrared drying temperature to tocopherol, total phenolic and antioxidant activity in dried Pumpkin (*Cucurbita*) seed, the tocopherol, total phenolic and antioxidant activity will be analyzed before drying (fresh Pumpkin (*Cucurbita*) and after drying in different infrared drying temperature (38 °C, 40 °C, 42 °C and 44 °C).All sample analysis would be performed by HPLC.

Effect of Roasting Conditions on Tocopherol, Total Phenolic and Antioxidant Activity in the Dried Pumpkin (Cucurbita) Seed

After completion of drying treatment, the dried seeds were subjected to roasting at different conditions (150 °C for 6 min, 155 °C for 4 min, and 160 °C for 2 minutes).

The tocopherol, total phenolic and antioxidant activity will be analyzed to verify the appropriate roasting condition. All sample analysis would be performed by HPLC.

Effect of Storage Temperature to Tocopherol, Total Phenolic and Antioxidant Activity in Dried Pumpkin (Cucurbita) Seed

The dried roasted Pumpkin (*Cucurbita*) seeds were kept in PA bag in different 4°C, 28°C. The tocopherol, total phenolic and antioxidant activity will be analyzed in 3 weeks interval for 12 weeks. All sample analysis would be performed by HPLC.

Statistical Analysis

The Methods 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.

Results & Discussion

Chemical Compositions in Fresh Pumpkin (*Cucurbita*)

The chemical compositions in fresh Pumpkin (*Cucurbita*) seed were analyzed.

Table 1: The chemical compositions in fresh Pumpkin (*Cucurbita*) seed

Parameter	Protein (g/100g)	Lipid (g/100g)	Tocopherol (mg/100g)	Moisture (%)	Total phenolics (mg/100g)	Antioxidant activity DPPH (IC50) (mg/ml)
Value	20.31±0.01	62.03±0.00	236.14±0.01	21.35±0.01	2425.11±0.02	50.49±0.03

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%)

Pumpkin (*Cucurbita* sp.) seeds are a key food source for humans because they are a very good source of proteins (24−36.5%) and oil (31.5−51%) [12].

Effect of Infrared Drying Temperature to Tocopherol, Total Phenolic and Antioxidant Activity in Dried Pumpkin (*Cucurbita*) Seed

Generally drying of hygroscopic materials takes place in two or three stages. First stage is called as constant rate stage, second and third stages are falling rate stages. At the end of the first stage of drying, drying rate starts to decrease, because it takes time for moisture to reach to surface of the material where evaporation occurs. In order to verify the effect of infrared drying temperature to tocopherol, total phenolic and antioxidant activity in dried Pumpkin (*Cucurbita*) seed; the tocopherol, total phenolic and antioxidant activity will be analyzed before drying (fresh Pumpkin (*Cucurbita*)) and after drying in different infrared drying temperature (38 °C, 40 °C, 42 °C and 44 °C). From table 2, the Pumpkin (*Cucurbita*) should be dried at

below 42°C to maintain the highest amount of tocopherol (mg/100g), total phenolic (mg/100g) and antioxidant activity (IC50, mg/ml).

Table 2: Tocopherol (mg/100g), total phenolic (mg/100g) and antioxidant activity (IC50, mg/ml) in dried Pumpkin (*Cucurbita*) seed by the effect of infrared drying temperature (°C)

Parameter	Fresh Pumpkin (*Cucurbita*) before drying	Dried Pumpkin (*Cucurbita*) seed by the effect of infrared at drying temperature (°C)			
		38	40	42	44
Tocopherol content (mg/100g)	236.14±0.01[a]	225.46±0.02[b]	223.19.±0.01[bc]	217.35±0.02[bc]	2015.77±0.01[c]
Total phenolic (mg/100g)	2425.11±0.02[a]	2389.75±0.00[b]	2376.45±0.01[bc]	2360.22±0.01[bc]	2345.01±0.03[c]
Antioxidant activity (IC50, mg/ml).	50.49±0.03[a]	48.63±0.02[ab]	47.15±0.01[ab]	46.29±0.03[ab]	45.89±0.01[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%)

A study on extraction of oil from *Pumpkin seed* using sun drying and hot air oven drying was observed. The oil extracted from pumpkin seeds has physical and chemical properties as other vegetable oils have [15]. The potential of squash pumpkin by-products (seeds and shell) as sources of antioxidant and bioactive compounds was evaluated. In this study they aimed to evaluate the potential of these wastes as sources of beneficial and bioactive compounds (antioxidants and antimicrobials), studying the effect of different extraction solvents and drying methods.

The samples (fresh and cooked) were freeze-dried and oven-dried followed by extraction with different solvents that revealed the following decreasing order of efficiency: 70 % ethanol, 70 % methanol, 70 % acetone, ultra-pure water and 100 % dichloromethane.

The oven-dried samples showed higher values of antioxidant activity and phenolic content, with exception of the values of phenolics for the seeds material. The shell samples presented higher values (1.47 – 70.96 % inhibition) of antioxidant activity and total phenolic content (2.00 – 10.69 mg GAE/g DW) [16].

Effect of roasting conditions on tocopherol, total phenolic and antioxidant activity in the roasted dried Pumpkin (*Cucurbita*) seed

Roasting is the key process in the production of value-added nuts having better taste, aroma, and a crunchy texture and exhibit enhanced crispiness. One of the common treatment methods is dry roasting. In this process, the nuts are heated applying the conventional thermal treatment, such as air convection and pan or sand roasting at 250–300°C for a short time [20, 22].

Due to the strong bitter taste, pumpkin seeds are usually consumed after roasting, which also contributes to the elimination of antiseedrients. After completion of drying treatment, the dried seeds were subjected to roasting at different conditions (150 oC for 6 min, 155 oC for 4 min, and 160 oC for 2 minutes). The tocopherol content (mg/100g), total phenolic (mg/ 100g) and antioxidant activity (IC50, mg/ml) will be analyzed to verify the appropriate roasting condition. Results were elaborated in table 3. Pumpkin (*Cucurbita*) seed should be roasted at 155 oC for 4 min to preserve tocopherol (mg/100g), total phenolic (mg/100g) and antioxidant activity (IC50, mg/ml) at utmost level.

Table 3: Effect of roasting conditions on tocopherol (mg/100g), total phenolic (mg/100g) and antioxidant activity (IC50, mg/ml) in the roasted dried Pumpkin (*Cucurbita*) seed

Roasting conditions	150 °C for 6 min	155 °C for 4 min	160 °C for 2 min
Tocopherol content (mg/100g)	217.35±0.02[b]	231.40±0.02[a]	220.64±0.02[ab]
Total phenolic (mg/100g)	2360.22±0.01[ab]	2371.52±0.00[a]	2341.38±0.03[b]
Antioxidant activity (IC50, mg/ml).	46.29±0.03[ab]	47.19±0.03[a]	55.10±0.02[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%)

The oxidative stability and compositional characteristics of the pumpkin seed oil (PSO) exposed to microwaves were studied during heating at 170°C. The oxidative indices such as free fatty acid (FFA), peroxide value (PV), *p*-anisidine value (*p*-AV), TOTOX,

specific extinctions and thiobarbituric acid (TBA) value of oils were significantly increased, and the increments were found to be significantly higher ($P < 0.05$) in unroasted seed oil as compared to roasted seed oil. The relative contents of polyunsaturated fatty acids (PUFAs) were decreased to 84.7%, and saturated fatty acids (SFAs) were increased to 119.5% in unroasted sample, after 9 h of heating. On the other hand, in 12 min roasted samples, the relative contents of PUFAs were decreased to 97.0%, and SFAs were increased to 102.6% after 9 h of heating. The triacylglycerol species LLL and OLL levels were decreased as a consequence of increased heating time, and the reduction tended to be significantly higher in unroasted samples as compared to roasted ones [18].

The effect of roasting on the chemical composition and oxidative stability of pumpkin oil was indicated. This study was concerned with the effect of the process of roasting of naked pumpkin seeds prior to their pressing on the chemical composition and oxidative stability of the extracted oil. Ground seeds were roasted at temperatures of 90, 110, and 130°C for 30 and 60 min, according to the traditional technology of production of roasted pumpkin oil.

Depending on the roasting conditions of the seeds, this treatment resulted in a significant increase of the contents of phospholipids (from 0.005 to 0.463%), total phenolic compounds (from 4.63 to 19.60 mg/kg), and total tocopherols (from 265.79 to 350.98 mg/kg) in oil. Higher contents of these minor components enhanced the oxidative stability of the oil, i.e., increased the induction period (from 4.50 to 12.93 h). However, at the same time, the applied thermal treatment generated an increase in the primary and secondary oxidation products, resulting in higher Totox values that could lower the quality of the oil [23]. Influence of roasting temperature of pumpkin seed on PAH and aroma formation was mentioned. After roasting at about 110°C, the pumpkin seeds are squeezed into dark green oil with typical flavor and aroma. During roasting, polycyclic aromatic hydrocarbons (PAHs) can form. In this study, the aroma composition and PAH formation in oil samples from seeds roasted at different temperatures were determined. Seeds were roasted at temperatures ranging from 90 to 200°C.

At 150°C, the formation of PAHs was detected. Light PAHs prevailed, especially phenanthrene. Increasing roasting temperature also significantly changed the composition of volatile compounds composition. Aldehydes and alcohols prevailed at low roasting temperatures. High temperature caused the formation of different pyrazines, which possess a roasted aroma [24].

Effect of Packaging Material and Storage Temperature To Tocopherol, Total Phenolic And Antioxidant Activity in Dried Pumpkin (*Cucurbita*) Seed

After completion of drying treatment, the dried seeds were subjected to roasting at 155°C for 4 min and storage. The dried Pumpkin (*Cucurbita*) seeds were kept in PA (vaccum) bag at different 4°C, 28°C. The tocopherol, total phenolic and antioxidant activity will be analyzed in 3 weeks interval for 12 weeks. From table 4, the roasted dried Pumpkin (*Cucurbita*) seed should be kept in PA (vaccum) bag at 4 °C so that the tocopherol (mg/100g), total phenolic (mg/100g) and antioxidant activity (IC50, mg/ml) could be maintained for 12 weeks of storage.

Table 4: Tocopherol (mg/100g), total phenolic (mg/100g) and antioxidant activity (IC50, mg/ml) in dried Pumpkin (*Cucurbita*) seed by the effect of packaging material and storage temperature

Storage time (weeks)	Dried Pumpkin (*Cucurbita*) seed kept in PA (vaccum) at 4°C			Dried Pumpkin (*Cucurbita*) seed kept in PA (vaccum) at 28°C		
	Totopherol (mg/ 100g)	Total phenolics (mg/100g)	Antioxidant activity (IC50, mg/ ml)	Totopherol (mg/ 100g)	Total phenolics (mg/100g)	Antioxidant activity (IC50, mg/ml)
0	231.40 ±0.02^{a}	2371.52 ±0.00^{a}	47.19 ±0.03^{a}	231.40 ±0.02^{a}	2371.52 ±0.00^{a}	47.19 ±0.03^{a}
3	230.14 ±0.01^{ab}	2368.45 ±0.02^{ab}	47.10 ±0.02^{ab}	229.12 ±0.02^{ab}	2366.42 ±0.03^{ab}	46.50 ±0.1^{ab}
6	227.35 ±0.01^{b}	2361.29 ±0.02^{b}	46.65 ±0.01^{b}	225.44 ±0.03^{b}	2359.12 ±0.02^{b}	46.12 ±0.01^{b}
9	223.78 ±0.03^{bc}	2357.45 ±0.02^{bc}	45.94 ±0.01^{bc}	218.11 ±0.03^{bc}	2351.04 ±0.01^{bc}	45.78 ±0.02^{bc}

12	218.64 ±0.01^{c}	2350.21 ±0.03^{c}	45.77 ±0.02^{c}	214.20 ±0.02^{c}	2346.25 ±0.01^{c}	45.41 ±0.03^{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%)

A study was to investigate how roasting pumpkin seeds influences the physicochemical properties of cold-pressed oils. The results of this study indicate that the seed-roasting and storage process have no effect on the fatty acid composition of pumpkin seed oils, but does affect phytosterols and tocopherols. The carotenoid content decreased after storage. The colour of the roasted oil was darker and changed significantly during storage [17].

Conclusion

Pumpkin seeds have long been valued as an important natural food for human health. Pumpkin seed is considered to be safe in when taken in food amounts and possibly safe when taken in amounts that produce medicinal effects. Drying and roasting are among the common preservation techniques of food stuff. During drying and roasting process not only product quality but also energy economy should be taken into account. Roasting of pumpkin seeds can cause polycyclic aromatic hydrocarbon formation and significantly influences on aroma composition of pumpkin seed.

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