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RESEARCH ARTICLE

Effectiveness of Drying, Roasting and Preservation on Antioxidant of Dried Roasted Sunflower *(Helianthus Annuus)* Seed

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Abstract

Antioxidants are considered important nutraceuticals on account of many health benefits. Due to the high antioxidant activity, *Helianthus annuus* seeds might be considered in the management and prevention of degenerative diseases associated with free radical damage. It is the rich source of vitamins specially vitamin E. 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 heat pump drying as well as storage. So the objective of the present study was to identify the effect of temperature in heat pump drying, roasting condition, packaging and storage to antioxidant (tocopherol) in the dried Sunflower (*Helianthus annuus)* seed. Results demonstrated that drying temperature (40 ^{o}C), roasting (145 ^{o}C in 5 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 months. The effect of drying, roasting temperature and time were clearly demonstrated to produced dried roasted sunflower seed.

Keywords: *Sunflower, Drying, Roasting, Antioxidant, Tocopherol, Vaccum.*

Introduction

Sunflower (Helianthus annuus L.) is one of the most important oilseed crop grown in the world. The sunflower seed is the fruit of Helianthus annuus, belonging to the family Asteraceae. A tiny sunflower seed is a package of healthy unsaturated fats, protein, fiber and other important nutrients like vitamin E, selenium, copper, zinc, folate, iron and phytochemicals [1, 2].

The seeds of Helianthus annuus contain various chemical components such as carbohydrates, phenolics, flavanoids, tannins, alkaloids, saponins, phytosterols, steroids, triterpenoids and fixed oils[3]. It possesed many pharmacological effects included antiinflammatory, analgesic, antimicrobial, anti-plasmodial, antidiabetic, anti-ulcer, antidiarrheal, antihistaminic, reproductive, anticancer, antioxidant, anti-obesity, central nervous system effects and hepato- , nephro- and cardio- protective effects [4,9].Helianthus annuus L. (Sunflower, Asteraceae) has been an important resource of natural oil and lipid-rich nutrients for centuries [10].

These seeds are usually pressed to get the oil [11]. There were several studies mentioned to processing of sunflower seed. Effects of different air drying temperature on sunflower seeds oil and ash content were examined [12]. Microwave roasting effects on

the physico-chemical composition and oxidative stability of sunflower seed oil were indicated [13]. Effects of microwave roasting process and time on chemical composition and oxidative stability of sunflower oil were also mentioned [14]. The effect of roasting conditions, including hot air temperature (120-160°C), infrared (IR) power (400-600 W) and roasting time (3-10 min) on energy and specific energy consumption, color parameters, texture, moisture content, chemical properties (pH and total phenolic contents, peroxide value, and sensory properties of sunflower kernel were investigated [15].

Storage stability of value added products from sunflower kernels were evaluated [16]. The changes on quality of sunflower seeds, stored in different packaging types and environmental conditions, were investigated [17]. However, there was not any research examined the change of tocopherol, total phenolic and antioxidant activity during heat pump drying, roasting as well as storage. So the objective of the present study was to identify the effect of temperature in heat pump drying, roasting condition, packaging and storage to tocopherol, total phenolic and antioxidant activity in the dried Sunflower (Helianthus annuus) seed.

Materials and Method

Material

We collected Sunflower (Helianthus annuus) in Soc Trang 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 4 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, sunflower kernels were soaked in 20% (w/w) salt solution for 15 min. Then, the excess water of sieved seeds was removed using cloth. Beside sunflower (Helianthus annuus**)** 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, heat pump dryer, and spectrophotometer and vaccum machine.

Figure 1: Sunflower (*Helianthus annuus*)

Researching Procedure

Chemical Compositions in Fresh Sunflower (Helianthus annuus) 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 Sunflower (*Helianthus annuus*) were analyzed. Protein (by Kjeldahll), lipid (by Soxhlet) and moisture (drying to constant weight) were applied. Tocopherol analysis would be performed by LC-MS/MS. 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 Heat Pump Drying Temperature to Tocopherol, Total Phenolic and Antioxidant Activity in Dried Sunflower (Helianthus Annuus) Seed

In order to verify the effect of heat pump drying temperature to tocopherol, total phenolic and antioxidant activity in dried Sunflower (*Helianthus annuus*) seed, the tocopherol, total phenolic and antioxidant activity will be analyzed before drying (fresh Sunflower (*Helianthus annuus*) and after drying in different heat pump drying temperature (30 ^{o}C, 35 ^{o}C, 40 ^{o}C and 45 ^{o}C). All sample analysis would be performed by LC-MS/MS.

Effect of Roasting Conditions on Tocopherol, Total Phenolic and Antioxidant Activity in the Dried Sunflower (Helianthus annuus) Seed

After completion of drying treatment, the dried seeds were subjected to roasting at different conditions (140 ^{o}C for 3 min, 145 ^{o}C for 5 min, and 150 ^{o}C for 7 minutes). The tocopherol, total phenolic and antioxidant activity will be analyzed to verify the appropriate roasting condition. All sample analysis would be performed by LC-MS/MS.

Effect of Storage Temperature to Tocopherol, Total Phenolic and Antioxidant Activity in Dried Sunflower (Helianthus annuus) Seed

The dried Sunflower (*Helianthus annuus*) seeds were kept in PA bag in different 4^{o}C, 28^{o}C. The tocopherol, total phenolic and antioxidant activity will be analyzed in 3 months interval for 12 months. All sample analysis would be performed by LC-MS/MS.

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 Sunflower (*Helianthus annuus*)

The chemical compositions in fresh Sunflower (*Helianthus annuus*) seed were analyzed.

Table 1: The chemical compositions in fresh Sunflower (*Helianthus annuus*) seed

Parameter	Protein (g/100g)	Lipid (g/100g)	Tocopherol (mg/100g)	Moisture (%)	Total phenolics (mg/100g)	Antioxidant activity DPPH (IC50) (mg/ml)
Value	22.48±0.02	69.75±0.01	341.20±0.02	20.17±0.01	3219.35±0.01	64.12±0.02

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%)

Sunflower seeds are composed of approximately 20% protein, seed storage proteins provide the sulfur and nitrogen needed for seedling development after germination [18]. It is a potential protein supplement for human diet, due to its good nutritional content and the absence of any antinutritional factors. Rather it is for the oil because certain attributes of sunflower seed oil are particularly attractive to the food industries. Sunflower seed contains 35-42% oil and is naturally rich in linoleic acid (55–70%) and consequently poor in oleic acid (20-25%) [19]. It is a rich source of vitamins, especially vitamin E [20]. The sunflower seed contains significantly higher amounts of vitamin E (37.8 mg/100 g), compared to linseed, sesame seed, and soy (all of which contain less than 3 mg/100 g) and even peanut (10.1 mg/100 g) [21]. Antioxidants are applied in food industry as additives limiting oxidation of food components, especially lipids. The oxidation leads to losses in food quality and shelf life [22]. The antioxidants play an important role also in living organisms since they prevent excessive free radical formation in cells. The extent of free radicals may cause disruption of biologically imported molecules, and in consequence the onset of various diseases [23]. Sunflower seeds are characterized by high antioxidant potential [24, 25].The antioxidant capacity of sunflower seed showed a highe antioxidant capacity value with DPPH 50.18% [26].

Effect of Heat Pump Drying Temperature to Tocopherol, Total Phenolic and Antioxidant Activity in Dried Sunflower (*Helianthus annuus*) Seed

In order to verify the effect of heat pump drying temperature to tocopherol, total

phenolic and antioxidant activity in dried Sunflower (*Helianthus annuus*) seed; the tocopherol, total phenolic and antioxidant activity will be analyzed before drying (fresh Sunflower (*Helianthus annuus*)) and after drying in different heat pump drying temperature (30 °C, 35 °C, 40 °C and 45 °C). From Table 2, the Sunflower (*Helianthus annuus*) should be dried at below 40°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 Sunflower (*Helianthus annuus*) seed by the effect of heat pump drying temperature (oC)

Parameter	Fresh Sunflower (*Helianthus annuus*) before drying	Dried Sunflower (*Helianthus annuus*) seed by the effect of heat pump at drying temperature (°C)			
		30	35	40	45
Tocopherol content (mg/100g)	341.20±0.02^{a}	295.79±0.01^{b}	250.11.±0.03^{bc}	220.47±0.01^{bc}	204.13±0.03^{c}
Total phenolic (mg/100g)	3219.35±0.01^{a}	3204.24±0.02^{b}	3178.29±0.03^{bc}	3155.29±0.02^{bc}	3120.01±0.03^{c}
Antioxidant activity (IC50, mg/ml).	64.12±0.02^{a}	62.39±0.01^{ab}	60.48±0.02^{ab}	58.33±0.03^{ab}	56.01±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%)

Effects of different air drying temperature on sunflower seeds oil and ash content were examined. The aim of this paper was to determine the impact of different air temperature (60 °C, 80 °C and 100 °C) at air drying velocity of 1.0 ms-1 during convection drying thermal process on the sunflower seeds oil and ash content [11].

3.3 Effect of roasting conditions on tocopherol, total phenolic and antioxidant activity in the roasted dried Sunflower (*Helianthus annuus*) 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 [27, 30]. Due to the strong bitter taste, sunflower 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 (140 oC for 3 min, 145 oC for 5 min, and 150 oC for 7 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. Sunflower (*Helianthus annuus*) seed should be roasted at 145 oC for 5 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 Sunflower (*Helianthus annuus*) seed

Roasting conditions	140 °C for 3 min	145 °C for 5 min	150 °C for 7 min
Tocopherol content (mg/100g)	220.47±0.01^{c}	241.22±0.02^{a}	223.64±0.02^{b}
Total phenolic (mg/100g)	3155.29±0.02^{b}	3160.29±0.03^{a}	3134.05±0.01^{ab}
Antioxidant activity (IC50, mg/ml).	58.33±0.03^{b}	60.11±0.01^{a}	59.45±0.00^{ab}

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 explore the influences of microwave heating on the composition of sunflower seeds and to extend our knowledge concerning the changes in oxidative stability, distribution of FA, and contents of tocopherols of sunflower seed oil. Roasting decreased the oil content of the seeds significantly (P<0.05). The oilseed residue analysis revealed no changes in the contents of fiber, ash, and protein that were attributable to the roasting. Analysis of the extracted oils demonstrated a significant increase in FFA, *p*-anisidine, saponification, conjugated diene, conjugated triene, density, and color values for roasting periods of 10 and 15 min. The iodine values of the oils were remarkably decreased. A significant (P<0.05) decrease in the amounts of tocopherol constituents of the microwaved sunflower oils also was found. However, after

15 min of roasting, the amount of α-tocopherol homologs was still over 76 and 81% of the original levels for the KL-39 and FH-330 varieties, respectively. In the same time period, the level of σ-tocopherol fell to zero. Regarding the FA composition of the extracted oils, microwave heating increased oleic acid 16-42% and decreased linoleic acid 17-19%, but palmitic and stearic acid contents were not affected significantly (P<0.05) [13].

In another report, effects of microwave roasting process and time on chemical composition and oxidative stability of sunflower oil were also mentioned. In this study, sunflower seeds (*Helianthus annuus*) were treated with an industrial microwave oven under 700 W for 8, 12, 16 and 20 min and oil was extracted using mechanical press technique. A suitable roasting treatment (20 min) is advantageous to oil extraction yield and tocopherol contents. The content of α-tocopherol in sunflower oil at 15 min of roasting gradually increased from 895.1 to 1108.83 mg/kg as roasting time increased [14]. The effect of roasting conditions, including hot air temperature (120-160°C), infrared (IR) power (400-600 W) and roasting time (3-10 min) on energy and specific energy consumption, color parameters , texture, moisture content, chemical properties (pH and total phenolic contents, peroxide value, and sensory properties of sunflower kernel were investigated. Roasting at 425.7 W IR power and 124.3°C for 3.7 min was found to be convenient or proper roasting conditions [15].

Effect of Packaging Material and Storage Temperature to Tocopherol, Total Phenolic and Antioxidant Activity in Dried Sunflower (*Helianthus Annuus*) Seed

After completion of drying treatment, the dried seeds were subjected to roasting at 145°C for 5 min and storage. The dried Sunflower (*Helianthus annuus*) 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 months interval for 12 months. From table 4, the roasted dried Sunflower (*Helianthus annuus*) 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 months of storage.

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

Storage time (months)	Dried Sunflower (*Helianthus annuus*) seed kept in PA (vaccum) at 4°C			Dried Sunflower (*Helianthus annuus*) 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	241.22 ±0.02^{a}	3160.29 ±0.03^{a}	60.11 ±0.01^{a}	241.22 ±0.02^{a}	3160.29 ±0.03^{a}	60.11 ±0.01^{a}
3	226.40 ±0.03^{ab}	3150.02 ±0.01^{ab}	57.65 ±0.03^{ab}	235.44 ±0.01^{ab}	3145.37 ±0.01^{ab}	57.46 ±0.02^{ab}
6	223.02 ±0.00^{b}	3131.05 ±0.01^{b}	56.41 ±0.02^{b}	226.29 ±0.00^{b}	3128.40 ±0.03^{b}	56.13 ±0.04^{b}
9	219.21 ±0.01^{bc}	3121.47 ±0.00^{bc}	55.86 ±0.00^{bc}	213.07 ±0.02^{bc}	3119.25 ±0.02^{bc}	55.69 ±0.01^{bc}
12	210.55 ±0.03^{c}	3115.64 ±0.02^{c}	55.60 ±0.01^{c}	204.35 ±0.01^{c}	3111.54 ±0.00^{c}	55.47 ±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%)

Storage stability of value added products from sunflower kernels was evaluated. . Sunflower was substituted for groundnut at three levels (0, 50 and 100 %). Products were stored up to 2 months in ambient conditions (25-30 °C; RH 40–60 %). Chikki was packed in Low density polyethylene (LDPE) and laminated pouches and oil seed butter was stored in glass and plastic jars. Products were evaluated for sensory characteristics, absence of rancidity; per cent free fatty acid and peroxide value. Stored chikki was evaluated for microbial load. Products were acceptable for sensory attributes even at the end of storage period. Product chikkistored in laminated pouches had higher per cent free fatty acid and peroxide value compared to that stored in Low density polyethylene (LDPE) pouches. Oilseed butter stored in glass jar had higher per cent free fatty acid when compared to that stored in plastic jar. Stored chikki had higher microbial load in the Low density polyethylene (LDPE) when compared to that

stored in laminated pouches. Products made with groundnut alone (control) were preferred over those made in combination with sunflower and groundnut (1:1) or sunflower alone [16].In another report, the speed on deterioration of oil-seeds depends on conditions of the storage environment and on particularities of the species, which include the seed chemical composition.

Within this study, the changes on quality of sunflower seeds, stored in different packaging types and environmental conditions, were investigated. The packaging used were multiwall Kraft paper and plastic packaging (with and without vacuum), under cold chamber and conventional storage conditions. Seed quality was evaluated by tests of: germination and accelerated aging; besides alterations on oil content, fatty acids profile, and isoenzymatic systems. The storage under cold chamber conditions was more efficient in maintaining physiological quality of sunflower seeds; and under such environment, the Kraft paper packaging was the most adequate. Under conventional storage facility, however, the plastic packaging, sealed with vacuum, has provided better maintenance of physiological quality [16].

Conclusion

Helianthus annuus seeds have radical scavenging activity and can be considered as good sources of natural antioxidants for medicinal and commercial uses. It has various alkaloid, flavonoids, volatile oils and terpenoids essential for various activities like antimicrobial activity, antitumor activity, anti oxidant activity. Due to the good nutritional content of sunflower seed, it is a potential protein supplement for human diet. Drying and roasting are very important in improving color, flavor, and taste in seeds, and the conditions of drying and roasting play an important role in the appearance of tissue and sensory response procedure.

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