Nguyen Phuoc Minh et al /J. Pharm. Sci. & Res. Vol. 11(3), 2019, 930-934

ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in

Effect of Drying, Roasting and Preservation on Antioxidant of Cashew *(Anacardium Occidentale)* Nut

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Abstract.

Cashew nuts are a rich source of tocopherols and total phenols and contain a wide variety of flavonoids and proanthocyanidins. Cashew nut is the main product traded in international market and is widely consumed as roasted, fried, salted or sugared snacks, as material for confectionery, bakery products and as a food ingredient. Cashews are more prone to become rancid due to fat degradation and protein coagulation. 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 Cashew (*Anacardium occidentale)* nut. Results demonstrated that drying temperature (35 ^{o}C), roasting (125 ^{o}C in 25 min), vaccum packing in laminated material (PET/AL/PE bag) and keeping in 4 ^{o}C were recommended to maintain the tocopherol content in the final products for 12 months. The effect of drying, roasting temperature and time were found to be more significant than time on the force needed to break cashew kernel.

Keywords: *Cashew, drying, roasting, antioxidant, tocopherol, vaccum*

I. INTRODUCTION

Anacardium occidentale L. commonly known as Cashew tree is well known species of Anacardium family.[1] Being a rich source of several essential vitamins and minerals, mono- and polyunsaturated fatty acids, and fiber, cashew nuts provide an array of phytochemicals that may contribute to the health benefits. These phytochemicals have been shown to possess a range of bioactivity, including antioxidant, antiproliferative, anti-inflammatory, antiviral, and hypocholesterolemic properties.[2] The biological properties of cashew nut also includes larvicidal, molluscidal, antimicrobial, antitumour activity, antidiabetic, and analgesic effects.[3-9] A study investigated the nutritional characteristics of raw, dry-roasted, and skin-on cashew products. These products were found to contain bioactive compounds including mono- and poly-unsaturated fatty acids, phytosterols, arginine, magnesium, tocopherols, and phenolic compounds. All the types of cashews exhibited higher levels of phytosterols than the amounts reported for other tree nuts. The skin-on cashews had higher levels of phenolic compounds compared to the other cashew varieties tested.[10]

There were several studies mentioned to processing of cashew nut. The effects of various conventional shelling methods (oil-bath roasting, direct steam roasting, drying, and open pan roasting) on the levels of bioactive compounds of cashew nut kernels were investigated.[11]

A comprehensive study on the effect of roasting and frying on fatty acids profiles and antioxidant capacity of almonds, pine, cashew, and pistachio was investigated.[12] A research was to design and fabricate a low-cost, simple to operate mini cashew nut roaster, which would be applicable for small scale cashew nut processors.[13] A study was to determine the effect roasting temperature (100-160°C) and time (20-60 min) on colour parameters (L*, a*, and b*-values), Browning Index (BI), Hardness, consumer acceptability and moisture content of both whole cashew-kernel and cashew nut paste.[14] A study investigated effect of period of steaming (20, 30 and 40 min) and drying temperature (50, 60 and 70°C) on the chemical properties of cashew nut.[15] A survey to investigate storage practices of roasted cashew nuts was conducted along the Coastal regions. Physicochemical properties (moisture content and pH values) of roasted cashew nuts from processors and vendors were also evaluated.[16] The effect of roasting temperature on the nutritional quality of cashew nut was investigated.[17] The effect of moisture content (MC), nut size and roasting time (RT) on the whole kernel out-turn (WKO) of cashew nuts during shelling was investigated.[18] The effect of roasting on the content of phenolic compounds and antioxidant properties of cashew nuts and testa was studied.[19] The effect of roasting as pre-treatment on shelling capacity shows that the roasting can increase the shelling capacity.[20] A study was carried out to determine the effects of pre-treatment by hot oil roasting and steam boiling on the physical properties of cashew nut.[21] The effect of relative humidity, thickness of polythene packaging material and duration of storage on the shelf life of roasted cashew was determined to provide information for packaged roasted cashew nuts marketers.[22] Effect of storage temperatures and humidity on proximate composition, peroxide value and iodine value of raw cashew nuts was investigated.[23]

However, there was not any research examined 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 Cashew (*Anacardium occidentale)* nut.

II. Materials And Method

2.1 Material

We collected Cashew (*Anacardium occidentale*) in Binh Phuoc province, Vietnam. They were cultivated following VietGAP to ensure food safety. After harvesting, collected nuts were stored at a temperature of 4˚C and they were conveyed to laboratory within 4 hours for experiments. These fruits were tumbled thoroughly under turbulent moving to remove dirt, dust and adhered unwanted material. Beside Cashew (*Anacardium occidentale)* we also used other materials during the research such as PET/AL/PE bag**.** Lab utensils and equipments included weight balance, heat pump dryer, and vaccum machine.

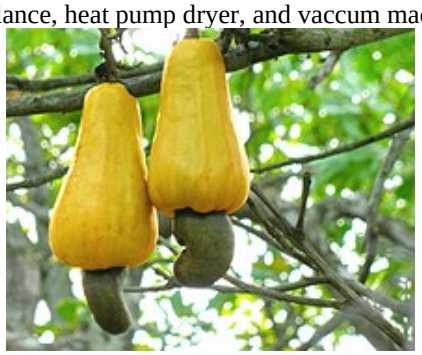

Figure 1. Cashew (*Anacardium occidentale*)

2.2 Researching procedure

2.2.1 Chemical compositions in fresh Cashew (Anacardium occidentale) nut

The chemical compositions including protein (g/100g), lipid (g/100g), tocopherol (mg/100g), and moisture content (%) in fresh Cashew (*Anacardium occidentale*) were analyzed. Protein (by Kjeldahll), lipid (by Soxhlet) and moisture (drying to constant weight) were applied. Tocopherol analysis would be performed by HPLC-AOCS.

2.2.2 Effect of heat pump drying temperature to tocopherol content in dried Cashew (Anacardium occidentale) nut

In order to verify the effect of heat pump drying temperature to tocopherol content in dried Cashew (*Anacardium occidentale*) nut, the tocopherol content will be analyzed before drying (fresh Cashew (*Anacardium occidentale*) and after drying in different heat pump drying temperature (25 ^{o}C, 30 ^{o}C, 35 ^{o}C and 40 ^{o}C). All sample analysis would be performed by HPLC-AOCS.

2.2.3 Effect of roasting conditions on tocopherol content in the dried Cashew (Anacardium occidentale) nut

After completion of drying treatment, the dried nuts were subjected to roasting at different conditions (120 ^{o}C for 30 min, 125 ^{o}C for 25 min, and 130 ^{o}C for 20 minutes). The tocopherol content (mg/100g) will be analyzed to verify the appropriate roasting condition. All sample analysis would be performed by HPLC-AOCS.

2.2.4 Effect of storage temperature to tocopherol content in dried Cashew (Anacardium occidentale) nut

The dried Cashew (*Anacardium occidentale*) nuts were kept in PET/AL/PE bag in different 4^{o}C, 25^{o}C. The tocopherol content will be analyzed in 3 months interval for 12 months. All sample analysis would be performed by HPLC-AOCS.

2.3 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.

III. Results & Discussion

3.1 Chemical compositions in fresh Cashew (*Anacardium occidentale*)

The chemical compositions in fresh Cashew (*Anacardium occidentale*) nut were analyzed.

Table 1. The chemical compositions in fresh Cashew (*Anacardium occidentale*) nut

Parameter	Protein (g/100g)	Lipid (g/100g)	Tocopherol (mg/100g)	Moisture (%)
Value	26.35±0.01	35.24±0.01	193.45±0.01	27.64±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%).

In this research, all fresh Cashew (*Anacardium occidentale*) nut should be stored in 4 ^{o}C and quickly transfer to laboratory within 4 hours for experiments. The raw cashew nut kernels were found to possess appreciable levels of certain bioactive compounds such as β-carotene (9.57 µg/100 g of DM), lutein (30.29 µg/100 g of DM), zeaxanthin (0.56 µg/100 g of DM), α-tocopherol (0.29 mg/100 g of DM), γ-tocopherol (1.10 mg/100 g of DM), thiamin (1.08 mg/100 g of DM), stearic acid (4.96 g/100 g of DM), oleic acid (21.87 g/100 g of DM), and linoleic acid (5.55 g/100 g of DM).[11]

3.2 Effect of heat pump drying temperature to tocopherol content in dried Cashew (*Anacardium occidentale*) nut

In order to verify the effect of heat pump drying temperature to tocopherol content in dried Cashew (*Anacardium occidentale*) nut, the tocopherol content will be analyzed before drying (fresh Cashew (*Anacardium occidentale*)) and after drying in different heat pump drying temperature (25 ^{o}C, 30 ^{o}C, 35 ^{o}C and 40 ^{o}C). From table 2, the Cashew (*Anacardium occidentale*) should be dried at below 35^{o}C to maintain the highest amount of tocopherol (mg/100g).

Table 2. Tocopherol content (mg/100g) in dried Cashew (*Anacardium occidentale*) nut by the effect of heat pump drying temperature (^{o}C)

Parameter	Fresh Cashew (*Anacardium occidentale*) before drying	Dried Cashew (*Anacardium occidentale*) nut by the effect of heat pump at drying temperature (^{o}C)			
		25	30	35	40
Tocopherol content (mg/100g)	193.45±0.01^{a}	185.34±0.02^{ab}	184.09.±0.01^{ab}	180.21±0.02^{ab}	169.40±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%).

Table 3. Effect of roasting conditions on tocopherol content in the roasted dried Cashew (*Anacardium occidentale*) nut

Roasting conditions	120 ^{o}C for 30 min	125 ^{o}C for 25 min	130 ^{o}C for 20 minutes
Tocopherol content (mg/100g)	180.21±0.02^{b}	183.11±0.03^{a}	174.02±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%).

Table 4. Tocopherol content (mg/100g) in dried Cashew (*Anacardium occidentale*) nut by the effect of packaging material and storage temperature

Storage time (months)	Dried Cashew (*Anacardium occidentale*) nut by the storage temperature (^{o}C) kept in PET/AL/PE (zipper top)		Dried Cashew (*Anacardium occidentale*) nut by the storage temperature (^{o}C) kept in PET/AL/PE (vaccum)	
	4 ^{o}C	25 ^{o}C	4 ^{o}C	25 ^{o}C
0	183.11±0.03^{a}	183.11±0.03^{a}	183.11±0.03^{a}	183.11±0.03^{a}
3	176.40±0.01^{ab}	173.39±0.01^{ab}	179.69±0.02^{ab}	175.37±0.02^{b}
6	172.69±0.01^{b}	170.04±0.01^{b}	176.22±0.01^{b}	171.34±0.00^{bc}
9	167.25±0.02^{bc}	162.77±0.01^{bc}	173.04±0.01^{bc}	164.40±0.01^{c}
12	163.30±0.01^{c}	159.34±0.02^{c}	169.64±0.02^{c}	160.79±0.02^{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%).

A study investigated effect of period of steaming (20, 30 and 40 min) and drying temperature (50, 60 and 70°C) on the chemical properties of cashew nut. Steam boiling time and drying temperatures has significant differences ($p < 0.05$) on the chemical properties of the dried cashew nuts. Cashew nuts processed by steam boiling for 40 min and dried at 70°C recorded the best quality, as it reduces both the residual CNSL and the moisture content of the kernel.[15]

3.3 Effect of roasting conditions on tocopherol content in the roasted dried Cashew (*Anacardium occidentale*) nut

Cashew nut roasting before shelling is an important treatment since this roasting operation helps to shell the nuts to extract the kernels easily without damaging the edible kernels.[13] Due to the strong bitter taste, cashew seeds are usually consumed after roasting, which also contributes to the elimination of antinutrients. After completion of drying treatment, the dried nuts were subjected to roasting at different conditions (120 ^{o}C for 30 min, 125 ^{o}C for 25 min, and 130 ^{o}C for 20 minutes). The tocopherol content (mg/100g) will be analyzed to verify the appropriate roasting condition. Results were elaborated in table 3. Cashew (*Anacardium occidentale*) nut should be roasted at 125 ^{o}C for 25 min to preserve tocopherol at utmost level.

The effects of various conventional shelling methods (oil-bath roasting, direct steam roasting, drying, and open pan roasting) on the levels of bioactive compounds of cashew nut kernels were investigated. All of the conventional shelling methods including oil-bath roasting, steam roasting, drying, and open pan roasting revealed a significant reduction, whereas the Flores hand-cracking method exhibited similar levels of carotenoids, thiamin, and unsaturated fatty acids in cashew nuts when compared to raw unprocessed samples.[11] Frying and roasting were performed according to the local Jordanian home-made cuisine, and the nuts under experiment were raw almonds, pine, cashew, and pistachio. Nuts samples were roasted at 110°C for 16 minutes and fried at 175°C for 2.5 minutes. The results show that both roasting and frying of nuts did not affect the flavonoids content except for roasted pistachios where significant rise of flavonoids content was detected. Total phenolic content showed no significant differences except for pine nuts in which it increased significantly in both roasting and frying. Oxidative stability, presented by 1,1-diphenyl-2-picryl-hydrazyl (DPPH), was significantly different in all nuts except for pistachio nuts that have shown no differences. Fatty acids profile, presented by saturated fatty acids (SFA), oleic acid (OL), and essential fatty acids (EFA), was affected significantly by roasting and frying, especially for SFA in almonds and pine nuts and α-linoleic acid (ALA) contents of pine.[12] A research was to design and fabricate a low-cost, simple to operate mini cashew nut roaster, which would be applicable for small scale cashew nut processors. A drum roaster was designed and fabricated, on which the experimental trials were conducted by varying the roasting time between 1 and 7 min to determine the best roasting time, where the drum roaster surface temperature was 275 6 25 8C. From the roasting trials, it was found that fabricated cashew nut roaster was suitable for roasting cashew nuts within 2.5 min. It was low in cost and required no skilled labors for its operation. Sensory analysis of cashew nut, roasted by developed mini cashew nut roaster was found to be acceptable.[13] The optimized processing conditions produced acceptable cashew kernel and paste of desirable colour and superior flavour quality with short processing time that will enhance direct and commercial utilization.[15]

The effect of roasting temperature on the nutritional quality of cashew nut was investigated. Roasting temperatures have a great effect on the nutritional quality of cashew nut and roasting temperature of 1900C proved to be the best for roasting cashew nut in terms of nutrient retention.[17] The effect of moisture content (MC), nut size and roasting time (RT) on the whole kernel out-turn (WKO) of cashew nuts during shelling was investigated. The nuts were subjected to roasting in hot cashew nut shell liquid at a temperature range between 180 and 190°C for 0.75, 1.00, 1.25, and 1.50 min.[18] The effect of roasting on the content of phenolic compounds and antioxidant properties of cashew nuts and testa was studied. High temperature short time roasting effectively enhances the antioxidant activity of cashew nuts (Neel Chandrasekara).[19] A study was carried out to determine the effects of pre-treatment by hot oil roasting and steam boiling on the physical properties of cashew nut. The physical properties of cashew nuts were found to be

affected by pre-treatment by hot oil roasting and steam boiling.[20]

3.4 Effect of packaging material and storage temperature to tocopherol content in dried Cashew (*Anacardium occidentale*) nut

After completion of drying treatment, the dried nuts were subjected to roasting at 125^{o}C for 25 min and storage. The dried Cashew (*Anacardium occidentale*) nuts were kept in PET/AL/PE (zipper top), PET/AL/PE (vaccum) bag at different 4^{o}C, 25^{o}C. The tocopherol content will be analyzed in 3 months interval for 12 months. From table 4, the roasted dried Cashew (*Anacardium occidentale*) nut should be kept in PET/AL/PE (vaccum) bag at 4 ^{o}C so that the tocopherol content (mg/100g) could be maintained for 12 months of storage.

The final quality of roasted cashew nut is influenced by the design of the roaster and time-temperature profile used. Roasting is the most important steps in cashew nut processing, improvement of roasting process will contribute to improvement of processed cashew nut products. Temperature and time of roasting are two of the main factors that affect industrial roasting process which affect the drying, heat transfer rate and physico-chemical changes that occurs protein and carbohydrate. The use of inappropriate temperature and time combination lead to quality defects such as short shelf life, discoloration, rancidity and poor flavor. Roasted cashew nuts are widely consumed as an appetizer and as raw materials in sweets, confectionary, chocolate and biscuits. For the processing industry and the catering business it is important to predict the roasting behaviour and the quality of cashew nut.[14] Drying temperature and packaging materials have significant effects on the chemical and storage qualities of processed cashew nut. The effect of relative humidity, thickness of polythene packaging material and duration of storage on the shelf life of roasted cashew was determined to provide information for packaged roasted cashew nuts marketers. The results of the study indicates that relative humidity, polythene thickness and duration of storage have a highly significant effect ($P<0.01$) on moisture content and quality index while for the microbial count, polythene thickness and duration of storage has significant effect ($P<0.05$) with relative humidity showing non-significance. For all levels of relative humidity and polythene thickness, moisture content and microbial count increased with increase in duration of storage while quality index decreased with increase in duration of storage. As the polythene thickness increased at constant storage duration, the moisture content decreased. The moisture content of all the samples increased with increase in duration of storage at constant polythene thickness level. As the thickness of the polythene packaging material increased, the amount of moisture absorbed over time (in days) decreases; the total fugal growth decreases, and the percentage quality index increases. It is recommended that for the packaged roasted cashew nuts industry for poverty alleviation, the most favourable polythene thickness of 0.95mm should be used. The best storage relative humidity was determined in the study to be 47.2% under which conditions, storage period should not exceed 14 days.[22] Effect of storage temperatures and humidity on proximate composition, peroxide value and iodine value of raw cashew nuts was investigated. Cashew nut kept under the humidity of 86 and 90 percentage at all studied temperatures developed mold growth within 24–48 h of time. The better storage condition assessed for raw cashew nut is 67 % of RH at 30 °C and the values obtained for EMC, proximate composition analysis, peroxide value and iodine value are within the same range as observed with harvested cashew nut.[23]

IV. Conclusion

Cashew nuts are among the richest sources of vitamin E. Consumption of cashew nut is associated with lower risk of cardiovascular disease and diabetes. The effects of roasting and drying on the aforementioned nuts species are positive for fatty acids profile and antioxidants activity. Drying and roasting affects the product quality, control of the roasting process is significant because producers of cashew considered that determination optimum conditions for drying and roasting cashew was a major problem. Hence, it is necessary to optimize the hot air drying and roasting process to provide an acceptable product with a shorter processing time. The greater value of this product is lost to spoilage after a period of time due to improper handling and storage conditions and this result in great loss of product and investment. Roasted cashew nut is vulnerable to deterioration over time and this result from improper packaging to adverse storage conditions. The rate of this spoilage is dependent on moisture content of stored nuts; relative humidity of storage environment; permeability of packaging material; ambient temperature and insect infestation. Based on these effects, roasted cashew nuts deteriorate by mould growth, rancidity and insect attack.

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