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Ascorbic Acid and Total Phenolic Contents of Dried Roasted Chestnut (*Castanea sativa*) Affected by Drying, Roasting and Preservation

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ABSTRACT

This Chestnut (*Castanea sativa*) is a gluten-free seasonal nut. Chestnut has become important composition for human diet owing to their demonstrated nutritional qualities and healthy benefits. Its seed has radical scavenging activity with a rich source of natural antioxidants for different applications. It contains various alkaloids, flavonoids, volatile oils and terpenoids essential for variety of antimicrobial, antitumor, antioxidant activities. Owing to the healthy constituents in chestnut seed, there is a potential supplement for human meal. Drying and roasting are very important in enhancing color, flavor, appearance and taste in seeds. There was not many research related to the change of antioxidant during hot air drying as well as storage. So purpose of this study was to examine the effectiveness of thermal treatment in hot air drying, roasting, packaging and storage to vitamin C and total phenolic in the dried chestnut (*Castanea sativa*) seeds. Results revealed that drying temperature (45 ^{o}C), roasting (135 ^{o}C in 10 min), packing in polyethylene bag and keeping in dry cool place were suitable to preserve the vitamin C, total phenolic contents in the samples for 12 months. The drying, roasting temperature and duration were thoroughly identified to manufacture the dried roasted chestnut seeds.

KEY WORDS: *CHESTNUT, DRYING*, ROASTING, PRESERVATION, VITAMIN C, PHENOLIC.

INTRODUCTION

Chestnut (Castanea sativa Mill) belongs to the family Fagaceae. This nut has a smooth and coriaceous epicarp, which can be light brown or deep brown in colour with more or less evident stripes, (Kosnovska,2013). It's nutritionally rich with high content of sugar, starch, dietary fibre, high quality protein, low lipids, rich in vitamins and minerals, good source of fatty acids and antioxidants (Chenlo F. et al., 2007; Borges et al., 2007; Kunsch et al., 1999; Vasconcelos et al., 2007). There were several studies mentioned to processing of chestnut. Effects of roasting on chemical composition and quality of different chestnut (*Castanea sativa Mill*) varieties were examined (Kunsch et al., 2001). The total vitamin C content and antioxidant activity of raw and cooked chestnuts was evaluated. The cooking process significantly changed the antioxidant activity of the chestnuts. A significant decrease in the vitamin C content of the chestnuts was observed (Barros et al., 2011). The effects of pan and microwave roasting on physicochemical, functional, rheological and antioxidant properties of sweet chestnut were compared.

Roasting increased the water absorption capacity and oil absorption capacity of chestnut flours making them potentially useful in flavor retention and improvement

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of palatability. Roasted flours had higher TPC and antioxidant activity. The gelatinization temperatures were higher in roasted flours while as their viscoelastic behavior was lower as compared to the native flour. Roasting also improved the flavor of chestnuts with microwave roasted chestnuts expressing better aroma as compared to the pan roasted (Wani et al., 2017). The effect of hot air convective drying on the organic acid profile of chestnut was evaluated (Delgado et al., 2018). Most studies conducted on hot air drying of chestnuts have examined various technological varibale such as chemical parameters (Correia, et al., 2009, 2012; Moreira et al., 2013; Zhang et al., 2011), temperature effect on morphological and rheological attributes of chestnut flours, rehydration effect (Attanasio et al., 2004; Moreira et al., 2008; Moreira et al., 2011), energetic requirements (Koyuncu et al., 2004), drying kinetics (Cletus et al., 2008; Delgado et al., 2014; Guiné et al., 2006; Moreira et al., 2005). Purpose of the this study was to identify the efficacy of thermal treatment in hot air drying, roasting, packaging and preservation to vitamin C, total phenolic in the dried Chestnut (*Castanea sativa*) seed.

MATERIAL AND METHODS

Materials: Chestnut, Castanea sativa was collected from Tien Giang province, Vietnam. They were cultivated following VietGAP without using pesticide or insecticide to ensure food safety. After collecting, harvested seeds were preserved at dry cool place and conveyed to laboratory as soon as possible for experiments. These seeds were cleaned thoroughly by air blowing to remove foreign matters. The seeds were sorted to get the uniformity and defect-free ones. Before roasting treatment, chestnut kernels were submersed in 15% (w/w) salt solution for 30 min. Then, the draining water of sieved seeds was removed. Apart from chestnut, Castanea sativa, we also used other materials during the research such as NaCl, HCl, Na2CO3, Folin-Ciocalteau. Lab utensils and equipment included weight balance, hot air dryer and spectrophotometer.

Phytochemical constituents inside fresh Chestnut (*Castanea sativa*) seed: The phytochemical constituents such as protein (%), fat (%), moisture (%), vitamin C (mg/g), total phenolic (mg/g) in fresh Chestnut (*Castanea sativa*) were measured as follows: Protein (by Kjeldahll), fat (by Soxhlet) and moisture (drying to constant weight) were used. Vitamin C (mg/g) were performed by a validated hydrophilic interaction chromatography method (Barros et al., 2010). Total phenolic (mg/g) was determined colorimetrically using Folin- Ciocalteau reagent by spectrophotometer. Efficacy of hot air drying temperature to vitamin C, total phenolic in dried Castanea sativa seed: In order to examine the efficacy of hot air drying temperature to the dried Chestnut (*Castanea sativa*) seed, the vitamin C, total phenolic were measured before and after drying in different hot air drying temperature (35 °C, 40 °C, 45 °C, 50°C). Efficacy of roasting conditions on vitamin C, total phenolic in the dried Chestnut (Castanea sativa) seed: At the end of drying treatment, the dried seeds were roasted at different conditions (130 °C for 15 min, 135 °C for 10 min, and 140 °C for 5 minutes). The vitamin C (mg/g), total phenolic (mg/g) were analyzed to determine the optimal roasting condition. Efficacy of storage temperature to vitamin C, total phenolic in dried Chestnut (Castanea sativa) seed. The dried Chestnut (Castanea sativa) seeds were preserved in PA bag in 4°C, 30°C. The vitamin C (mg/g), total phenolic (mg/g) were monitored in 3 month-interval for 12 months. Statistical analysis: All experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Statgraphics Centurion XVI.

RESULTS AND DISCUSSION

Phytochemical constituents in raw Chestnut (*Castanea sativa*). The phytochemical constituents in raw Chestnut (*Castanea sativa*) seed were analyzed. The present results revealed that raw chestnut seed has high content of vitamin C and total phenolic (Table 1).

Table 1. The phytochemical constituents in raw Chestnut (*Castanea sativa*) seed

Variables	Protein (%)	Fat (%)	Moisture (%)	Vitamin C (mg/g)	Total phenolic (mg/g)
Value	24.76± 0.01	6.25± 0.00	57.38± 0.03	12.63± 0.01	49.28± 0.00

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%)

Efficacy of hot air drying temperature to vitamin C, total phenolic contents in dried Chestnut seeds: Convective drying depended on different variables such as temperature, relative humidity and velocity of the drying air; size, shape and loading density of the samples (Moreira et al., 2015). In order to examine the efficacy of hot air drying temperature to the dried Chestnut (*Castanea sativa*) seed, the vitamin C, total phenolic was measured before and after drying in different hot air drying temperature (35 °C, 40 °C, 45 °C, 50°C). From table 2, the Chestnut (*Castanea sativa*) was dried at 45oC to preserve the highest amount of vitamin C (mg/g), total phenolic (mg/g). In another report, the thermal process at 50°C caused equivalent losses of ascorbic acid (Delgado et al., 2018). Roasting, boiling and frying procedures lead to significant reduction of total organic acids contents (Barbara Ribeiro et al., 2007). Fresh chopped chestnuts were dried using a hot air convective tray dryer at different temperatures (45, 65 and 85°C) and loading densities (2.5 and 6.3 kg/m2). Total and damaged starch varied significantly with drying temperature and loading density (Moreira et al., 2015).

Efficacy of roasting conditions on vitamin C, total phenolic in the dried Chestnut (Castanea sativa) seed:

Chestnut has the high proportion of tannins in the inner shell. Tannins are known for their astringent bitter taste that reduce the palatability. Roasting before their utilization is a normal handling to enhance the color and flavor. The thermal treatment received during roasting changes the nutritional compositions of chestnuts by increasing the antioxidant activity and reducing the anti-nutritional factors such as tannins (Chang et al., 2016). 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 (Demir et al., 2002; 2005;Schlörmann et al., 2015; Sharma et al., 2011).

In this research, at the end of drying treatment, the dried seeds were roasted at different conditions (130 °C for 15 min, 135 °C for 10 min, and 140 °C for 5 minutes). The vitamin C, total phenolic were analyzed to determine the optimal roasting condition. Results were elaborated in table 3. Chestnut (Castanea sativa) seed must be roasted at 135 °C for 10 min to preserve vitamin C (mg/g), total phenolic (mg/g) at the highest level. In another research, the effects of roasting on starch, sugars and fatty acid composition and on chestnut quality were verified. Weight loss of chestnut by roasting from 23-30% while causing little change in composition (Kunsch et al., 2001).

Roasting reduced the anti-nutritional factors in chestnut. Protein, fat, and ash contents displayed insignificant variation upon roasting. Significant increase in water absorption capacity, oil absorption capacity, and antioxidant properties was observed following roasting. Flour obtained from roasted chestnuts exhibited a significant decrease in light transmittance, foaming, and pasting properties. Higher gelatinization temperatures and lower enthalpies were reported in microwave and pan roasted chestnut flours. Roasting also reduced the viscoelastic behavior of native sweet chestnut and

Table 2. Vitamin C (mg/g), total phenolic (mg/g) in dried Chestnut (*Castanea sativa*) seed by the effect of hot air drying temperature (°C)

Parameter	Raw Chestnut (*Castanea sativa*) before drying	Dried Chestnut (*Castanea sativa*) seed by the effect of hot air at drying temperature (°C)			
		35	40	45	50
Vitamin C (mg/g)	12.63±0.01^{a}	9.37±0.00^{b}	9.13±0.02^{bc}	9.04±0.00^{bc}	8.35±0.00^{c}
Total phenolic (mg/g)	49.28±0.00^{a}	31.53±0.01^{b}	31.05±0.02^{bc}	30.48±0.01^{bc}	29.74±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%).

Table 3. Efficacy of roasting conditions on vitamin C (mg/g), total phenolic contents (mg/g) in the roasted dried Chestnut (*Castanea sativa*) seed

Roasting conditions	130 °C for 15 min	135 °C for 10 min	140 °C for 5 min
Vitamin C (mg/g)	7.15±0.03^{ab}	7.94±0.00^{a}	6.84±0.03^{b}
Total phenolic (mg/g)	26.49±0.00^{ab}	27.81±0.02^{a}	25.70±0.00^{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 4. Vitamin C (mg/g), total phenolic (mg/g) in dried Chestnut (*Castanea sativa*) seed by the effect of storage temperature

Storage duration (months)	Dried Chestnut (*Castanea sativa*) seed stored in PA bag at 4°C		Dried Chestnut (*Castanea sativa*) seed stored in PA bag at 30°C	
	Vitamin C (mg/g)	Total phenolic (mg/g)	Vitamin C (mg/g)	Total phenolic (mg/g)
0	7.94±0.00^{a}	27.81±0.02^{a}	7.94±0.00^{a}	27.81±0.02^{a}
3	7.83±0.02^{ab}	27.24±0.03^{ab}	7.74±0.03^{ab}	27.19±0.00^{ab}
6	7.59±0.03^{b}	27.03±0.00^{b}	7.50±0.03^{b}	26.95±0.01^{b}
9	7.48±0.00^{bc}	26.86±0.02^{bc}	7.39±0.01^{bc}	26.77±0.01^{bc}
12	7.39±0.01^{c}	26.50±0.01^{c}	7.31±0.02^{c}	26.39±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%).

changed the transmittance of identical functional groups (Wani et al., 2017).

Efficacy of storage temperature to vitamin C, total phenolic in dried Chestnut (*Castanea sativa*) seed: Roasting also improved the digestibility and stability of chestnut (Wani et al., 2017). The dried Chestnut (Castanea sativa) seeds were preserved in PA bag in 4°C, 30°C. The vitamin C, total phenolic were monitored in 3 month-interval for 12 months. From table 4, the roasted dried Chestnut (Castanea sativa) seed must be stored in PA (vaccum) bag in dry cool place so that the vitamin C (mg/g), total phenolic (mg/g) could be preserved for 12 months.

CONCLUSION

Antioxidants are valuable phytochemical elements contributing to our health benefits. Owing to the high antioxidant capacity as well as a rich source of vitamins, Castanea sativa seeds were demonstrated to prevent degenerative diseases associated with free radical damage. Drying and roasting are very important steps showing significant alterations in the manufacturing of value-added nuts with better taste, aroma, texture, crispiness. Especially, roasting can improve color and aroma through caramelization on the surface of the dried chestnut

REFERENCES

Attanasio, G.; Cinquanta, L.; Albanese, D.; Matteo, M. D. (2004). Effects of drying temperatures on physico-chemical properties of dried and rehydrated chestnuts (Castanea sativa). Food Chemistry 88: 583–590.

Barbara Ribeiro, Joana Rangel, Patrıcia Valentao, Paula B. Andrade, Jose Alberto Pereira, Hanna Bolke, Rosa M. Seabra (2007). Organic acids in two Portuguese chestnut (Castanea sativa Miller) varieties. Food Chemistry 100: 504–508.

Barros, A I Fernando M. Nunes, Berta Gonçalves, Richard N. Bennett, Ana Paula Silva (2011). Effect of cooking on total vitamin C contents and antioxidant activity of sweet chestnuts (Castanea sativa Mill.). Food Chemistry 128: 165–172.

Barros, A. I., Silva, A. P., Gonçalves, B., & Nunes, F. M. (2010). A fast, simple, and reliable hydrophilic interaction liquid chromatography method for the determination of ascorbic and isoascorbic acids. Analytical and Bioanalytical Chemistry 396: 1863–1875.

Borges O.B., Carvalho J.S., Corriera P.R., Silva A.P. (2007). Lipid and fatty acid profiles of Castanea sativa Mill. Chestnuts of 17 native Portuguese cultivars. J Food Compos Anal. 20: 80–89.

Chang S.K., Alasalvar C., Bolling B.W., Shahidi F. (2016). Nuts and their co-products: the impact of processing (roasting) on phenolics, bioavailability, and health benefits – a comprehensive review. J Funct Foods. 26: 88–122.

Chenlo F., Moreira R., Pereira G., Silva C.C. (2007). Evaluation of the rheological behaviour of chestnut (Castanea sativa mill) flour pastes as function of water content and temperature. Electron J Environ Agric Food Chem. 6: 1794–1802.

Cletus, A. B.; Carson, J. K. (2008). Drying curves and apparent diffusivity of New Zealand chestnut variety 6666666gy1015. Journal of Food Engineering 85: 381–386.

Correia, P.; Beirão-da-Costa, M. L. (2012). Effect of drying temperatures on starch-related functional and thermal properties of chestnut flours. Food and Bioproducts Processing 90: 284–294.

Correia, P.; Leitão, A.; Beirão-da-Costa, M. L. (2009). The effect of drying temperatures on morphological and chemical properties of dried chestnuts flours. Journal of Food Engineering 90: 325–332.

Delgado T, Elsa Ramalhosa, José Alberto Pereira, and Susana Casal (2018). Organic acid profile of chestnut (Castanea sativa Mill.) as affected by hot air convective drying. International Journal of Food Properties 21: 557–565.

Delgado, T.; Pereira, J. A.; Baptista, P.; Casal, S.; Ramalhosa, E. (2014). Shell's influence on drying kinetics, color and volumetric shrinkage of Castanea sativa Mill. fruits. Food Research International 55: 426–435.

Demir AD and K. Cronin (2005) Modelling the kinetics of textural changes in hazelnuts during roasting. Simulation Modelling Practice and Theory 13(2): 97–107.

Demir AD, J. M. Fraas Celayeta, K. Cronin, and K. Abodayeh (2002) Modelling of the kinetics of colour change in hazelnuts during air roasting. Journal of Food Engineering 55 (4): 283–292.

Guiné, R. P. F.; Fernandes, R. M. C. (2006). Analysis of the drying kinetics of chestnuts. Journal of Food Engineering 76: 460–467.

Kosnovska J (2013). The origin, archaeobotany and ethnobotany of sweet chestnut (Castanea sativa Miller) in the Czech Republic. Natural Sciences in Archaeology 4: 163–176.

Koyuncu, T.; Serdar, U.; Tosun, I. (2004). Drying characteristics and energy requirement for dehydration of chestnuts (Castanea sativa Mill.). Journal of Food Engineering 62: 165–168.

Kunsch U., Scharer H., Conedera M., Sassella A., Jermini M., Jelmini G. (1999). Quality assessment of chestnut fruits. Acta Hort. 494: 119–127.

Kunsch U, Hans Scharer, Bruno Patrian, Ernst Hohn, Marco Conedera, Alberto Sassella, Mauro Jermini and Giorgio Jelmini (2001). Effects of roasting on chemical composition and quality of different chestnut (Castanea sativa Mill) varieties. Journal of the Science of Food and Agriculture 81: 1106-1112.

Moreira, R., Chenlo, F., Torres, M.D., Rama, B. and Arufe, S. (2015). Air drying of chopped chestnuts at several conditions: effect on colour and chemical characteristics

of chestnut flour. International Food Research Journal 22: 407-413.
Moreira, R.; Chenlo, F.; Chaguri, L.; Fernandes, C. (2008). Water absorption, texture, and color kinetics of air-dried chestnuts during rehydration. Journal of Food Engineering 86: 584–594.
Moreira, R.; Chenlo, F.; Chaguri, L.; Mayor, L. (2011). Analysis of chestnut cellular tissue during osmotic dehydration, air drying, and rehydration processes. Drying Technology 2: 10–18.
Moreira, R.; Chenlo, F.; Chaguri, L.; Vázquez, G. (2005). Mathematical modelling of the drying kinetics of chestnut (Castanea sativa Mill.) influence of the natural shells. Food and Bioproducts Processing 83: 306–314.
Moreira, R.; Chenlo, F.; Torres, M. D.; Rama, B. (2013). Influence of the chestnuts drying temperature on the rheological properties of their doughs. Food and Bioproducts Processing 91: 7–13.
Schlörmann W, M. Birringer, V. Böhm (2015) Influence of roasting conditions on health-related compounds in different nuts. Food Chemistry 180: 77–85.
Sharma P and H. S. Gujral. (2011) Effect of sand roasting and microwave cooking on antioxidant activity of barley. Food Research International 2011; 44(1): 235–240.
Vasconcelos M.C.B.M., Bennett R.N., Rosa E.A.S., Ferreira-Cardoso J.V. (2007). Primary and secondary metabolite composition of kernels from three cultivars of Portuguese chestnut (Castanea sativa) at different stages of industrial transformation. J Agric Food Chem. 55: 3508–3516.
Wani IA, Humaira Hamid, Afshan Mumtaz Hamdani, Adil Gani, and Bilal Ahmad Ashwar (2017). Physico-chemical, rheological and antioxidant properties of sweet chestnut (Castanea sativa Mill.) as affected by pan and microwave roasting. J Adv Res 8: 399–405.
Zhang, M.; Chen, H.; Zhang, Y. (2011). Physicochemical, thermal, and pasting properties of Chinese chestnut (Castanea mollissima) starches as affected by different drying methods. Starch 63: 260– 267.