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RESEARCH ARTICLE

# Production of Dried Roasted Watermelon *(Citrullus Lanatus)* Seed

**Nguyen Phuoc Minh[1*], Nguyen Phu Thuong Nhan[2], Huynh Chi Bang[3], Lam Quang Khuon[4], Nguyen Thi Bich[5], Quach Hong Thuy[6]**

1. *Faculty of Chemical Engineering and Food Technology, Nguyen Tat Thanh University, Ho Chi Minh, Vietnam.*
2. *NTT Hi-Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam.*
3. *Can Tho University, Can Tho City, Vietnam.*
4. *Vinh Long Education Technology, Vinh Long Province, Vietnam.*
5. *Ho Chi Minh University of Technology, Ho Chi Minh City, Vietnam.*
6. *An Giang University, An Giang Province, Vietnam.*

***Corresponding Author: Nguyen Phuoc Minh**

## Abstract

Watermelon seeds are a source of protein, B vitamins, and minerals. The watermelon seeds are often discarded while the fruit is eaten. Watermelon seeds are considered as a good source of food for human nutrition and health. Drying and roasting are the most important processes giving necessary 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 tocopherol, total phenolic and antioxidant activity in the dried roasted watermelon (*Citrullus lanatus)* seed. Results demonstrated that drying temperature (45 $^{o}$C), roasting (165 $^{o}$C in 3 min), vaccum packing in polyethylene (PA) bag and keeping in 4 $^{o}$C were recommended to maintain the tocopherol, total phenolic and antioxidant activity in the final products for 16 weeks. The effect of drying, roasting temperature and time were clearly demonstrated to produced dried roasted watermelon seed.

**Keywords:** *Watermelon seed, Drying, Roasting, Antioxidant, tocopherol, Phenolics, vaccum.*

## Introduction

Watermelon (Citrullus lanatus) a fruit crop, is a herbaceous creeping plant belonging to the family cucurbitaceae [1]. It is mainly propagated by seeds and thrives best in warm areas [2]. Fruits are rich in lycopene and with a total antioxidant capacity similar to tomato [3]. The fruits are also rich source of ß-carotene, vitamins (B, C and E), minerals (K, Mg, Ca and Fe), amino acid (citrulline) and phenolics.

Watermelon seeds are known to be highly nutritional; they are rich sources of protein, vitamins B, minerals and fat among others as well as phytochemicals such as tannins, saponins, flavonoids, cyanogenic glycosides, oxalates and alkaloids [4]. Watermelon seed extract may be of supportive treatment to combat diabetes complications [5]. Seeds of C. lanatus contained bioactive compounds with potent antibacterial activity such as S. aureus, E. coli, and P. aeruginosa [6]. There were several researches mentioned to processing of watermelon seed. An experiment to investigate the effect that different drying methods would have on the quality and quantity of oil from water melon (Citrilus lanatus) seeds was conducted [7].

Effects of processing either by roasting or drying of the seeds was assayed by analyzing proximate, mineral and vitamin A contents for possible boasting of animal feeds [8]. Water melon (Citrullus lanatus) seeds were subjected to three different processing methods (sun drying, roasting and

boiling/oven-drying). The processed seeds were milled into flour. Chemical composition, functional properties and storage characteristics of sun dried, roasted and boiled/oven-dried flours were investigated [9]. 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 watermelon (Citrullus lanatus) seed.

## Materials & Method

### Material

Watermelon (Citrullus lanatus) seeds were collected in Ben Tre 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, watermelon seeds were soaked in 35% (w/w) salt solution for 10 min. Then, the excess water of sieved seeds was removed using cloth.

Beside watermelon (Citrullus lanatus) we also used other materials during the research such as PA bag, NaCl, HCL, Na2CO3, Folin-Ciocalteau. Lab utensils and equipments included weight balance, infrared dryer, and spectrophotometer and vaccum machine.

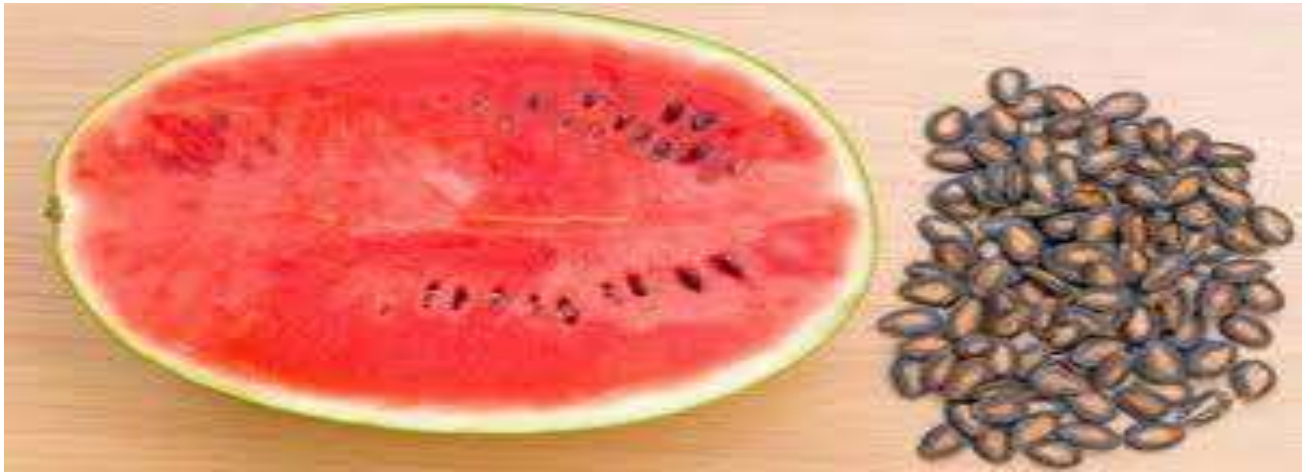

**Figure 1: Watermelon (*Citrullus lanatus*)**

### Researching Procedure

### Chemical Compositions in Fresh Watermelon (Citrullus lanatus) 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 watermelon (Citrullus lanatus) were analyzed. Protein (by Kjeldahll), lipid (by Soxhlet) and moisture (drying to constant weight) were applied.

Tocopherol analysis would be performed by HPLC. Watermelon seed powders, 2.0 g, were quantified for total phenolics. Phenols were determined using Folin-Ciocalteu protocol as described by Torres et al. (1987) [10]. The analyses were done in triplicates using gallic acid as a standard.

The amount of total phenolics was calculated in mg gallic acid equivalents/g dry seed material. The antioxidant activity on watermelon seed extracts was based on their scavenging capacity of 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radicals according to a modified assay by Odhav et al. (2007).11 To determine the time course of antioxidant activity, phenolic extracts were mixed with 200 μM DPPH and allowed to stand for 10 min before absorbance was read at 517 nm. An absorbance versus time graph was plotted to determine the time course of inhibition.

### Effect of Infrared Drying Temperature to Tocopherol, Total Phenolic and Antioxidant activity in Dried Watermelon (Citrullus lanatus) Seed

 

In order to verify the effect of infrared drying temperature to tocopherol, total phenolic and antioxidant activity in dried watermelon (Citrullus lanatus) seed, the tocopherol, total phenolic and antioxidant activity will be analyzed before drying (fresh watermelon (Citrullus lanatus) and after drying in different infrared drying temperature (35 oC, 40 oC, 45 oC and 50 oC). All sample analysis would be performed by HPLC.

**Effect of Roasting Conditions on Tocopherol, Total Phenolic and Antioxidant Activity in the Dried Watermelon (Citrullus lanatus) Seed**

After completion of drying treatment, the dried seeds were subjected to roasting at different conditions (160 °C for 4 min, 165 °C for 3 min, and 170 °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 Watermelon (Citrullus lanatus) Seed**

The dried roasted watermelon (Citrullus lanatus) seeds were kept in PA bag in different 4°C, 28°C. The tocopherol, total phenolic and antioxidant activity will be analyzed in 4 weeks interval for 16 weeks. All sample analysis would be performed by HPLC.

## Statistical Analysis

The Methods were run in triplicate with three different lots of samples. Statistical significance tests were performed using SPSS at $p < 0.05$ by means of one-way analysis of variance (ANOVA) followed by LSD post hoc multiple comparisons.

## Results & Discussion

Chemical compositions in fresh watermelon (Citrullus lanatus)

The chemical compositions in fresh watermelon (Citrullus lanatus) seed were analyzed.

**Table 1: The chemical compositions in fresh watermelon (*Citrullus lanatus*) seed**

| Parameter | Protein (g/100g) | Lipid (g/100g) | Tocopherol (mg/100g) | Moisture (%) | Total phenolics (mg/100g) | Antioxidant activity DPPH (IC50) (mg/ml) |
|---|---|---|---|---|---|---|
| Value | 18.59±0.02 | 27.55±0.01 | 279.64±0.03 | 22.40±0.00 | 2279.35±0.01 | 45.68±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 a research, watermelon seeds had moisture content in the range of 7.40 - 8.50%; fat, 26.50 - 27.83%; protein, 16.33 - 17.75%; fibre, 39.09 - 43.28%; ash, 2.00 - 3.00%; carbohydrate, 9.55 - 15.32% and energy value of 354.05 - 369.11 kcal/100g. DPPH% inhibition varied between 59.88-94.46% inhibition with trolox equivalent of 82.59-130.29 µM/g. Its seeds had the total phenol content (5416 mgGAE/100g) [2].

In another report, the total phenols varied from 16.77 to 21.41 mg/g, total flavoniods 55.60 to 100.93 mg/100g and tannin content 35.07 to 60.83 mg/100g on dry weight basis. Total carotenoids and lycopene ranged from 4.90 to 8.06 mg/100g and 3.74 to 6.80 mg/100g, respectively on fresh weight basis. The average antioxidant activity was found to be varied from 40.13 to 84.05 µmol TE/100g fresh weight [12].

**Effect of Infrared Drying Temperature to Tocopherol, Total Phenolic And Antioxidant Activity In Dried Watermelon (*Citrullus Lanatus*) 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 watermelon (*Citrullus lanatus*) seed; the tocopherol, total phenolic and antioxidant activity will be analyzed before drying (fresh watermelon (*Citrullus lanatus*)) and after drying in different infrared drying temperature (35 °C, 40 °C, 45 °C and 50 °C). From table 2, the watermelon (*Citrullus lanatus*) should be dried at below 45°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 watermelon (*Citrullus lanatus*) seed by the effect of infrared drying temperature (°C)**

| Parameter | Fresh Watermelon (*Citrullus lanatus*) before drying | Dried watermelon (*Citrullus lanatus*) seed by the effect of infrared at drying temperature (°C) | | | |
|---|---|---|---|---|---|
| | | 35 | 40 | 45 | 50 |
| Tocopherol content (mg/100g) | 279.64±0.03$^{a}$ | 241.75±0.01$^{b}$ | 236.40.±0.02$^{bc}$ | 229.25±0.01$^{bc}$ | 224.12±0.03$^{c}$ |
| Total phenolic (mg/100g) | 2279.35±0.01$^{a}$ | 2245.11±0.03$^{b}$ | 2226.39±0.02$^{bc}$ | 2218.40±0.02$^{bc}$ | 2206.28±0.01$^{c}$ |
| Antioxidant activity (IC50, mg/ml). | 45.68±0.02$^{a}$ | 42.79±0.01$^{ab}$ | 41.55±0.02$^{ab}$ | 40.38±0.01$^{ab}$ | 39.94±0.00$^{c}$ |

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%)

An experiment to investigate the effect that different drying methods would have on the quality and quantity of oil from water melon (*Citrilus lanatus*) seeds was conducted. Drying by sun as expected was gradual as compared to the oven drying method which was faster and more rapid.

Free Fatty Acid (FFA) and Acid values were higher in oven-dried sample relative to the sun-dried sample; whereas other chemical properties were not affected. Free Fatty Acid value for the oven-dried sample was 6.4% and 2.4% for the sun-dried sample.

This is an important variable in considering the quality of oil because the lower the FFA, the better the quality of the oil [7]. Effects of processing either by roasting or drying of the seeds was assayed by analyzing proximate, mineral and vitamin A contents for possible boasting of animal feeds. The proximate analysis and vitamin A determination were performed using standard methods.

The results of the proximate composition of processed and unprocessed watermelon seeds had moisture content of 6.29% and 5.06%, ash content 2.59% and 2.98%, crude fat 47% and 32.9%, crude protein 68.04% and 49.7%, crude fibre 1.13% and 2.10% and carbohydrate 24.99% and 6.06% respectively.

The elemental composition of both processed and unprocessed seeds showed that magnesium and sulphur contents were higher in unprocessed than processed seeds, while potassium, calcium, phosphorus, iron, copper, zinc and manganese contents of both processed and unprocessed seed were statistically similar.

The crude fats, proteins and carbohydrates contents of the processed seeds were significantly higher ($p<0.001$) compared with the unprocessed seeds. The vitamin A content of both processed and unprocessed seeds were found to be 0.033 µg/g and 0.056 µg/g respectively [8].

## Effect of Roasting Conditions on Tocopherol, Total Phenolic and Antioxidant Activity in the Roasted Dried Watermelon (*Citrullus lanatus*) 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 [13, 16].

Due to the strong bitter taste, watermelon 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 (160 oC for 4 min, 165 oC for 3 min, and 170 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. Watermelon (*Citrullus lanatus*) seed should be roasted at 165 oC for 3 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 watermelon (*Citrullus lanatus*) seed**

| Roasting conditions | 160 °C for 4 min | 165 °C for 3 min | 170 °C for 2 min |
|---|---|---|---|
| Tocopherol content (mg/100g) | 229.25±0.01$^{b}$ | 235.29±0.01$^{a}$ | 231.85±0.01$^{ab}$ |
| Total phenolic (mg/100g) | 2218.40±0.02$^{b}$ | 2236.13±0.03$^{a}$ | 2229.26±0.01$^{ab}$ |
| Antioxidant activity (IC50, mg/ml). | 40.38±0.01$^{c}$ | 44.35±0.00$^{a}$ | 42.26±0.03$^{b}$ |

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%).

Watermelon seeds contain antinutrients which are minor components and can be reduced by boiling and roasting of the seeds. The boiling–oven drying and roasting significantly reduced the levels of the antinutrients. Decrease in the oxalate levels was in the range of 92–96% for boiled-oven dried samples and 49–64% for roasted samples.

Decrease in the phytate levels ranged 58-76% and 73–82% for boiled–oven dried and roasted samples, respectively. However, decrease in the tannin levels ranged 15-35% for boiled–oven dried samples and 23-38% for roasted samples [17].

## Effect of Packaging Material and Storage Temperature to Tocopherol, Total Phenolic and Antioxidant Activity in Dried Roasted Watermelon (*Citrullus lanatus*) Seed

After completion of drying treatment, the dried seeds were subjected to roasting at 155°C for 4 min and storage. The dried watermelon (*Citrullus lanatus*) seeds were kept in PA (vaccum) bag at different 4°C, 28°C.

The tocopherol, total phenolic and antioxidant activity will be analyzed in 4 weeks interval for 16 weeks. From Table 4, the roasted dried watermelon (*Citrullus lanatus*) 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 16 weeks of storage.

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

| Storage time (weeks) | Dried watermelon (*Citrullus lanatus*) seed kept in PA (vaccum) at 4°C | Dried watermelon (*Citrullus lanatus*) seed kept in PA (vaccum) at 28°C | Storage time (weeks) | Dried watermelon (*Citrullus lanatus*) seed kept in PA (vaccum) at 4°C | | Dried watermelon (*Citrullus lanatus*) 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 | 235.29±0.01$^{a}$ | 2236.13±0.03$^{a}$ | 44.35±0.00$^{a}$ | 235.29±0.01$^{a}$ | 2236.13±0.03$^{a}$ | 44.35±0.00$^{a}$ |
| 4 | 228.43 ±0.02$^{ab}$ | 2331.14 ±0.01$^{ab}$ | 44.05 ±0.01$^{ab}$ | 226.17 ±0.02$^{ab}$ | 2329.48 ±0.01$^{ab}$ | 43.98 ±0.02$^{ab}$ |
| 8 | 224.69 ±0.02$^{b}$ | 2324.75 ±0.01$^{b}$ | 43.80 ±0.02$^{b}$ | 221.48 ±0.03$^{b}$ | 2320.30 ±0.01$^{b}$ | 43.65 ±0.02$^{b}$ |
| 12 | 219.77 ±0.02$^{bc}$ | 2312.63 ±0.01$^{bc}$ | 43.61 ±0.02$^{bc}$ | 213.14 ±0.03$^{bc}$ | 2306.05 ±0.02$^{bc}$ | 43.38 ±0.03$^{bc}$ |
| 16 | 211.37 ±0.02$^{c}$ | 2304.86 ±0.02$^{c}$ | 43.12 ±0.01$^{c}$ | 209.29 ±0.02$^{c}$ | 2297.49 ±0.03$^{c}$ | 42.97 ±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%)

Water melon (*Citrullus lanatus*) seeds were subjected to three different processing methods (sun drying, roasting and boiling/oven-drying). The processed seeds were milled into flour. Chemical composition, functional properties and storage characteristics of sun dried, roasted and boiled/oven-dried flours were investigated.

The processed flours were stored for five weeks at room temperature (28 ± 1°C) and moisture content, free fatty acid and peroxide values determined weekly. The result shows

 

that roasting significantly reduced ($P < 0.05$) all the functional properties of the flour, there was a significant difference ($P < 0.05$) between sun dried samples in terms of water

and fat absorption, viscosity and least gelatin concentration except for foam capacity. Roasting and boiling/oven-drying decreased the foam capacity; however boiling for 10 minutes then oven dry at 50°C for 12 hours proved to be more effective than sun drying and roasting in improving the functional properties of the water melon seed. Free fatty acid and peroxide values of the flour samples increased slightly during storage but were within the reported acceptable limits [9].

## Conclusion

Watermelon (*Citrullus lanatus*) seeds are often discarded while the fruit is eaten. Watermelon seeds are considered as a source of nutrients in the diet and may have health and economic benefits due to its fibre, minerals, phenolics content and antioxidant activity. Watermelon seeds also contain antinutrients which are minor components and can be reduced by drying and roasting of the seeds.

## References


1. Emmanuel Alpheus Mogotlane, Phatlane William, Mokwala Phetole Mangena (2018) Comparative analysis of the chemical compositions of indigenous watermelon (Citrullus lanatus) seeds from two districts in Limpopo Province, South Africa. African Journal of Biotechnology, 17(32): 1001-1006.
2. Betty Tabiri, Jacob K Agbenorhevi, Faustina D Wireko-Manu, Elsa I Ompouma (2016) Watermelon seeds as food: nutrient composition, phytochemicals and antioxidant activity. International Journal of Nutrition and Food Sciences, 5(2): 139-144.
3. Perkins-Veazie P, Collins J K, Pair S D and Roberts W (2001) Lycopene content differs among red-fleshed watermelon cultivars. Journal of the Science of Food and Agriculture, 81: 983-987.
4. Braide W, Odiong I J, Oranusi S (2012) Phytochemical and antibacterial properties of the seed of watermelon (Citrullus lanatus). Prime Journal of Microbiology Research, 2(3): 99-104.
5. Omigie Io, Agoreyo Fo (2014) Effects of watermelon (Citrullus lanatus) seed on blood glucose and electrolyte parameters in diabetic wistar rats. J. Appl. Sci. Environ. Manage, 18(2): 231-233.
6. Bello HS, Ismail HY, Goje MH, Mangga HK (2016) Antimicrobial activity of Citrullus lanatus (watermelon) seeds on some selected bacteria. Journal of Biotechnology Research 2(6): 39-43.
7. Taiwo AA, MO Agbotoba, JA Oyedepo, OA Shobo, I Oluwadare, MO Olawunmi (2008) Effects of drying methods on properties of water melon (Citrullus lanatus) seed oil. African Journal of Food Agriculture Nutrition and Development, 8(4): 492-501.
8. MA Milala, A Luther, B Burah (2018) Nutritional comparison of processed and unprocessed citrillus lanatus (watermelon) seeds for possible use in feed formulation. American Journal of Food and Nutrition, 6(2): 33-36.
9. DB Kiin-Kabari, OM Akusu (2014) Effect of processing on the proximate composition, functional properties and storage stability of water melon (Citrullus lanatus) seed flour. International Journal of Biotechnology and Food Science, 2(7): 143-148.
10. Torres AM, Mau-lastovicka T, Rezaainyan R (1987) Total phenolics and high-performance liquid chromatography of phenolics in avocado. Journal of Agriculture Food Chemistry, 35: 921-925.
11. Odhav B, Beckrum S, Akula A, Baijnath H (2007) Preliminary assessment of nutritional value of traditional leafy vegetables in KwaZulu-Natal South Africa. Journal of Food Composition and Analysis, 20:430-435.
12. BR Choudhary, SM Haldhar, SK Maheshwari, R Bhargava, SK Sharma Phytochemicals and antioxidants in watermelon (Citrullus lanatus) genotypes under hot arid region. Indian Journal of Agricultural Sciences, 85 (3): 414-417.


 

13. AD Demir, JM Frías Celayeta, K Cronin, K Abodayeh (2002) Modelling of the kinetics of colour change in hazelnuts during air roasting. Journal of Food Engineering, 55(4): 283-292.
14. AD Demir, K Cronin (2005) Modelling the kinetics of textural changes in hazelnuts during roasting. Simulation Modelling Practice and Theory, 13(2): 97-107.
15. W Schlörmann, M Birringer, V Böhm (2015) Influence of roasting conditions on health-related compounds in different nuts. Food Chemistry, 180: 77-85.
16. P Sharma, HS Gujral (2011) Effect of sand roasting and microwave cooking on antioxidant activity of barley. Food Research International, 44(1): 235-240.
17. Philip W Addo, Jacob K Agbenorhevi, David Adu-Poku (2018) Antinutrient contents of watermelon seeds. MOJ Food process Technol., 6(2): 237-239.

 