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Technical Parameters in Browning Prevention During Processing of Water Caltrop Kernel

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Abstract: Water caltrop (*Trapa* spp.) is a floating, annual, aquatic plant that grows in slow moving water. It would most likely be found in farm dams of Vietnam. It has been cultivated for food and traditional medicine for thousands of years. It is a minor food and vegetable crop in rural area. The fresh water caltrop fruit has a short postharvest shelf life because it is very susceptible to become brown or even black discoloration when stored at ambient temperatures. Browning is a major problem in the food industry and is considered to be one of the main causes of quality loss during post harvest handling and processing of water caltrop. Therefore, we examined several technical parameters to remove to water caltrop shell and get its kernel without browning formation during preservation. Our results showed that blanching at 95°C in 20 sec, soaking with ascorbic acid 0.8% in 20 min and modified atmosphere packaging (HDPE bag with 80% N_2: 20% CO_2) would effectively maintain color and texture of water caltrop kernel during preservation.

Key words: Water caltrop, kernel, blanching, soaking, modified atmosphere packaging, preservation

INTRODUCTION

Water caltrop is native to the warm temperate parts of Vietnam. Water caltrop was found to be effective for the removal of different parameters of municipal wastewater and can be used effectively to reduce the pollution load of municipal wastewater drained from the treatment plants (Kumar and Chopra, 2018). The fruit is a woody or bony nut, about 3 cm wide with four (1 cm long) stout spines or horns. Each fruit contains a single seed. The seeds are cooked and eaten. The fresh nuts have a high moisture content and are in demand for quenching thirst. Dried water caltrops were ground into flour and used to make various foodstuff (Hummel and Kiviat, 2004). The outer pericarp is hard, making it difficult to peel off to obtain the white edible fruit inside (Tulyathan *et al*., 2005). Wang *et al*. (2009) investigated the effect of micronization on the functional properties of the water caltrop (*Trapa taiwanensis* Nakai) pericarp. These findings suggested that different micronization treatments could improve functional properties of the fibre components of water caltrop pericarp which provide a good source of dietary fibre in food applications. Peels and kernels of water caltrop are rich in starch, dietary fiber, essential amino acids and certain types of phenolics and minerals and showed a range of bioactivities such as anti-cancer and antioxidant capacities (Mann *et al*., 2012; Yu and Shen, 2015). Water caltrop has been utilized in diverse food and non-food sectors. There is great potential of water caltrop for various applications due to the unique chemical composition and abundance of supply (Zhu, 2016; Zhu and Zhan, 2010).

On the purspose of commercial utilization of this fruit, we performed an assessment for various technical parameters affecting to the removal of its shell to get kernel without discoloration druing preservation. We focused on the effect of blanching, ascorbic acid soaking, vaccumn and modified atmosphere packaging to color and texture of water caltrop kernel.

MATERIALS AND METHODS

We collected water caltrop in Mekong River delta, Vietnam. They must be cultivated following VietGAP without pesticide and fertilizer residue to ensure food safety. After harvesting, they must be conveyed to laboratory within 4 h for experiments. We used knife to remove its shell out of kernel. Besides collecting water caltrop kernel, we also used other materials such as ascorbic acid, PA bag, HDPE bag. Lab utensils and equipments included knife, blanching oven, weight balance, thermometer, vaccuming machine, modified atmosphere packaging machine (Fig. 1).

Effect of blanching temperature and time to color and structure of water caltrop kernel: Water caltrop fruits were treated by blanching in different temperature (80, 85, 90, 95, 100°C) and time (5, 10, 15, 20, 25 sec). Weight of

Fig. 1: Water caltrop

each sample was 200 g. The treated samples would be removed their shell out of kernel by knife. We evaluated the color and texture of water caltrop kernel to determine the appropriate treatment.

Effect of ascorbic acid concentration and time of soaking to color and structure of water caltrop kernel: Water caltrop fruits were treated by blanching in 95°C in 20 sec. Weight of each sample was 200 g. Weight of each sample was 200 g. The treated samples would be removed their shell out of kernel by knife. Then these kernels would be soaked in ascorbic acid (0.2, 0.4, 0.6, 0.8, 1.0%) by different time (5-25 min). We evaluated the color and texture of water caltrop kernel to determine the appropriate treatment.

Effect of vaccumn and modified atmosphere packaging to color and structure of water caltrop kernel: Water caltrop fruits were treated by blanching in 95°C in 20 sec. Weight of each sample was 200 g. Weight of each sample was 200 g. The treated samples would be removed their shell out of kernel by knife. Then these kernels would be soaked in ascorbic acid 0.8% in 20 min. A comparision about the effectiveness of vaccumn (in PA bag) with modified atmosphere packaging (in HDPE bag with 80% N_2: 20% CO_2) was applied. We evaluated the color and texture of water caltrop kernel to determine the appropriate treatment.

Physical and sensory analysis: We conducted various testing procedures during this research such as color evaluation (score, 1-5) and texture (penetrometer).

Statistical analysis: Data were statistically summarized by Statgraphics.

RESULTS AND DISCUSSION

Effect of blanching temperature and time to color and structure of water caltrop kernel: The browning of water caltrop pericarp frequently occurs from either exposure to high temperatures during postharvest storage or heat treatment. The effects of increased temperatures on the activities of Polyphenol Oxidase (PPO) and Peroxidase (POD) play a key role in the enzymatic browning of processed fruits. The effects of heating temperature and time on color and texture of water caltrop kernel are summarised in Table 1-3. Our results showed that the optimal blanching should be performed at 95°C in 20 sec. Enzymatic browning, common at the cut surface of light-coloured fruits and vegetables was the major contributor in the browning of water caltrop kernel during heat treatment.

Table 1: Effect of blanching temperature and time to color (L value) of water caltrop kernel

	Blanching time (sec)				
Blanching temperature (°C)	5	10	15	20	25
80	75.03^{d}	75.89^{d}	76.25^{e}	77.29^{d}	77.31^{d}
85	76.17^{c}	76.23^{c}	76.97^{d}	78.30^{c}	78.33^{c}
90	77.05^{b}	77.18^{b}	77.34^{c}	79.46^{b}	79.50^{b}
95	78.85^{a}	78.88^{a}	79.05^{b}	80.21^{a}	80.37^{a}
100	78.93^{a}	79.02^{a}	79.45^{a}	80.23^{a}	80.41^{a}

Table 2: Effect of blanching temperature and time to texture (kg/cm^2) of water caltrop kernel

	Blanching time (sec)				
Blanching temperature (°C)	5	10	15	20	25
80	20.31^{a}	20.25^{a}	20.22^{a}	20.18^{a}	19.76^{a}
85	20.30^{a}	20.24^{a}	20.20^{a}	20.15^{a}	19.75^{a}
90	20.29^{a}	20.24^{a}	20.17^{a}	20.13^{a}	19.73^{a}
95	20.27^{a}	20.22^{a}	20.17^{a}	20.12^{a}	19.70^{a}
100	19.12^{b}	18.78^{b}	18.21^{b}	18.01^{b}	17.52^{b}

Table 3: Effect of ascorbic acid concentration (%) and soaking time (min) to color (L value) of water caltrop kernel

	Ascorbic acid soaking time (min)				
Ascorbic acid concentration (%)	5	10	15	20	25
0.2	75.05^{d}	75.88^{d}	76.29^{e}	77.30^{d}	77.30^{d}
0.4	76.15^{c}	76.21^{c}	76.95^{d}	78.28^{c}	78.31^{c}
0.6	77.06^{b}	77.17^{b}	77.32^{c}	79.44^{b}	79.48^{b}
0.8	78.87^{a}	78.87^{a}	79.07^{b}	80.20^{a}	80.36^{a}
1.0	78.95^{a}	79.07^{a}	79.47^{a}	80.21^{a}	80.39^{a}

$^{a-d}$The values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Ciou *et al*. (2011) demonstrated the mechanism of browning involving enzymatic browning was investigated in the pericarp of water caltrop. Polyphenol Oxidase (PPO) and Peroxidase (POD) activities were determined in pericarp at various times and temperatures. Water caltrop consisted of 44.22% moisture content, 37.23% crude fibre and 2.63% crude protein. PPO and POD activities dropped from 62 and 38 units/g sample, respectively as water temperature was increased from 30-80°C. Optimum pH and temperature for PPO activity was at pH 5.0, 25-45°C and POD activity peaked at 60°C. High PPO and POD activities at 40-50°C resulted in degradation of phenolic compounds

Table 4: Effect of ascorbic acid concentration (%) and soaking time (min) to texture (kg/cm^2) of water caltrop kernel

Ascorbic acid concentration (%)	Ascorbic acid soaking time (min)				
	5	10	15	20	25
0.2	20.29[a]	20.23[a]	20.21[a]	20.17[a]	19.74[a]
0.4	20.29[a]	20.23[a]	20.21[a]	20.17[a]	19.74[a]
0.6	20.28[a]	20.21[a]	20.20[a]	20.15[a]	19.71[a]
0.8	20.26[a]	20.20[a]	20.18[a]	20.14[a]	19.69[a]
1.0	19.10[b]	18.75[b]	18.14[b]	18.13[b]	17.50[b]

Table 5: Effect of vaccumn and modified atmosphere packaging to color and structure (score) of water caltrop kernel

Packing method	Color score (1-5)	Texture score (1-5)
Vaccuming (PA bag)	4.11[b]	4.25[b]
Modified atmosphere (HDPE bag, 80% N_2: 20% CO_2)	4.74[a]	4.82[a]

[a-d]The values were expressed as the mean of three repetitions; The same characters (denoted above), the difference between them was not significant (α = 5%)

which led to increased aggregation of browning pigments and discolouration (lower L-values) of the pericarp.

Effect of ascorbic acid concentration and time of soaking to color and structure of water caltrop kernel: Ciou *et al*. (2011) indicated that the optimum pH values for both polyphenol oxidase and peroxidase of water caltrop pericarps were close to pH 5.0. pH strongly affects to enzymatic browning activity. Effect of ascorbic acid concentration and time of soaking to color and structure of water caltrop kernel were illustrated in Table 3 and 5. Our results showed that the color and firmness of water caltrop kernel could be effectively maintained while being soaked with ascorbic acid 0.8% in 20 min.

Effect of vaccumn and modified atmosphere packaging to color and structure of water caltrop kernel: Air composition and method of packaging highly affected to color and texture of water caltrop kernel, especially the browning reaction. We compared two different packaging methods: vaccuming (PA bag) and modified atmosphere (HDPE bag, 80% N_2: 20% CO_2). We realized that modified atmosphere packaging was superior to vaccuming.

CONCLUSION

The fresh, tender, starchy water caltrops are consumed raw as they are sweet, delicious and thirst-quenching. Browning in water caltrop is the result of pigment degradation or aggregation caused by polyphenol oxidase enzyme. We successfully investigated the effects of blanching time and temperature, ascorbic acid soaking time and temperature, modified atmosphere packaging on prevention of the browning formation created by the Polyphenol Oxidase (PPO) activity. These results were important because they could help water caltrop processors to arrange proper storage with appropriated processing methods to avoid the undesirable colour acceleration.

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