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Different Parameters of Herbal Tea Production from Straw Berry (*Muntingia calabura*) Leaf

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Abstract.

Muntingia calabura is an underexploited fruit in South of Vietnam. *Muntingia calabura* L is a fast growing medicinal plant, attracts fruit eating birds such as flower peckers. It is a sweet fruit and mainly used as fresh fruit consumption. *Muntingia calabura* fruit is rich in antioxidant polyphenol and possess significant antioxidant activity, is an important and interesting finding. Straw berry leaves (*Muntingia calabura*) contain antioxidants that generally form by phenolic or pholifenols, the sinamat acid derivatives, flavonoids, tocopherols, coumarin and polifungsional acids. Flavonoids that have an antioxidant activity consist of flavonol, flavanon, flavones, isoflavones, catechins and kalkon. There is limited study mentioning to processing of this phytochemical leaf. Therefore we explored a herbal tea production from this leaf by focusing on the effect of different parameters such as the effect of blanching temperature and time; heat pump drying temperature and storage condition to vitamin C (mg/100g), flavonoid (mg/g) and sensory score of the dried *Muntingia calabura* leaf tea. Results showed that *Muntingia calabura* leaves should be blanched in hot water 95^{o}C at 5 seconds in the present of $CaCl_2$ 0.5% and then beeing dried by heat pump dryer at 40^{o}C until 8% moisture. The final herbal tea could be preserved under vacuum in PET/AL/PE bag at 4^{o}C to maintain flavonoid content for 12 months.

Keywords: *Muntingia calabura, blanching, drying, heat pump, herbal tea, vacuum*

1. INTRODUCTION

Drying is the most common method of medicinal plant preservation and, due to high investment and energy costs, drying is also a large expense in medicinal plant production. Drug quality and consequently earnings are significantly influenced by the drying regime. Heat sensitive properties (aromatic, medicinal, culinary, colour) provide specialty crops with their high market value. Care must be taken when drying specialty crops not to cause extreme losses of heat sensitive properties. Therefore, they must be dried at low temperatures for longer periods of time resulting in large power requirements for dryer operation. Heat pumps can simultaneously raise the temperature from that of the waste heat stream and multiply the energy supplied to the heat pump. Pereira et al. (2004) justified the addition of a heat pump system to a convention re-circulating convection dryer. They found that heat pumps are able to deliver more energy than they consume. It was stated that the additional compressor energy required is counterbalanced by the energy savings if traditional (fossil fuel or electrical resistance) dryers were used instead. Chua et al. (2002) discusses advantages and limitations of heat pump dryers as compared with conventional convection dryers. Increased efficiency, accurate control of drying conditions, wide range of drying conditions, better product quality, increased throughput, and reduced operational cost all provide a distinct advantage to heat pump dryers. Freshly dried herbs are very storage-sensitive products. Microbiological deterioration caused by fungal agents can also occur within a short time. Loss of active ingredients is a major problem encountered in stored herbs. These involve various reactions. Certain components of the essential oils can also undergo transformation as a result of resinification. The dried product is also a favourite habitat for certain insects.

Straw berry (*Muntingia calabura)* belonging to Elaeocarpaceae family. This plant is a fast-growing tree of slender proportions, reaching a height of approximately 7.5–12 m with nearly horizontal spreading branches. It is often seen growing as roadside trees (Ragragio EM et al., 2014), also used as an air pollution tolerance indicator. It is an annual plant, flowers throughout the year. *M. calabura* are evergreen approximately 5–12.5 cm long, alternate lanceolate or oblong, long pointed at the apex, oblique at the base with dark green color and minutely hairy on the upper surface, gray- or brown-hairy on the underside and irregularly toothed. The leaves are rich in flavanoidal compounds like flavones, flavanones, flavans, and biflavans as the major constituents, possessing antidiabetic and cytotoxic activities (Perez GRM et al., 1998; Nshimo CM et al., 1993). Straw cherry (*Muntingia calabura*) leaf extract contains flavanoid compounds, terpenoids, tannins and high antioxidant activity (Diana Triswaningsih et al., 2017). Its leaves are distinctively lanceolate in shape, with margins irregularly serrate and fruits are berries which turn red on maturation and are sweet in taste (Bayer C et al., 1998). The fruits are abundant, in round shape; approximately 1–1.25 cm wide, with red or yellow, thin, smooth, tender skin and light-brown, soft, juicy pulp, with very sweet, musky, fig-like flavor, and filled with exceedingly tiny, yellowish seeds (N. D. Mahmood et al., 2014). Phytochemical studies revealed that it presented phenolics, flavonoids, terpenoids, reducing sugars, saponins, tannins, and carbohydrates, anthocyanins,

ascorbic acid and vitamin E. (Preethi Kathirvel, 2017; Vijayanand S and Ann Steffy Thomas, 2018). Their fruits are processed in to jams, leaves are used for making tea. Fruit from *Muntingia* is also harvested for export overseas (Marimuthu Krishnaveni and Ravi Dhanalakshmi, 2014). Reports are there for its anti-tumor, antinociceptive, anti-inflammatory, anti-pyretic, antibacterial, antiproliferative and antioxidant, antihypertensive, antiulcer and antistaphyloccocal activities (Kaneda NJM et al., 1991; Su BNE et al., 2003; Zakaria ZA et al., 2007; Shih CD et al., 2006; Preethi, Kathirvel et al., 2012; Consolacion Y. Ragasa et al., 2015). The incorporation of fruits into routine diet could prevent the risk of cardiovascular diseases, ageing, inflammations and cancers due to antioxidant compounds present in the fruits (Preethi Kathirvel, 2017).

Muntingia calabura is an underutilized fruit crop and still now there is very limited research available. In order to improve the added value of this leaf, objective of this study focused on the effect of blanching temperature and time; heat pump drying temperature and storage condition to vitamin C (mg/100g), flavonoid (mg/g) and sensory score of the dried *Muntingia calabura* leaf tea.

2. MATERIAL & METHOD

2.1 Material

We collected *Muntingia calabura* leaf in Ben Tre province, Vietnam. They must be harvested from gardens without pesticide and fertilizer residue to ensure food safety. After harvesting, they must be conveyed to laboratory within 8 hours for experiments. They were washed under tap water to remove foreign matters. Besides *Muntingia calabura* leaf we also used another material during the research such as $CaCl_2$. Lab utensils and equipments included digital weight balance, cooker, heat pump dryer.

Figure 1. *Muntingia calabura* leaf

2.2 Research method

2.2.1 Effect of blanching temperature and time to vitamin C (mg/100g), flavonoid (mg/g) and color (sensory score) in the dried Muntingia calabura leaf tea

Raw *Muntingia calabura* leaves were blanched in water solution with 0.5% $CaCl_2$ at different temperature and time (100^{o}C, 3 second; 95^{o}C, 5 seconds; 90^{o}C, 7 seconds; 85^{o}C, 9 seconds). Then they were dried by heat pump at 60^{o}C until 8% moisture. All samples were analyzed vitamin C (mg/100g), flavonoid (mg/g), color (sensory score) to validate the appropriate blanching condition.

2.2.2 Effect of drying temperature to vitamin C (mg/100g), flavonoid (mg/g) and color (sensory score) in the dried Muntingia calabura leaf tea

Raw *Muntingia calabura* leaves were blanched in water solution with 0.5% $CaCl_2$ at 95^{o}C in 5 seconds. Then these samples would be dried under heat pump dryer at different temperature (35^{o}C, 40^{o}C, 45^{o}C, 50^{o}C, 55^{o}C, 60^{o}C) until 8% moisture. All samples were analyzed vitamin C (mg/100g), flavonoid (mg/g), color (sensory score) to validate the appropriate drying temperature.

2.2.3 Effect of storage condition to flavonoid (mg/g) in the dried leaf tea

After completion of drying treatment, the dried *Muntingia calabura* leaves were subjected to storage. They were kept in PET/AL/PE (zipper top), PET/AL/PE (vaccum) bag at different 4^{o}C, 28^{o}C. The flavonoid content (mg/g) will be analyzed in 3 months interval for 12 months.

2.3 Physico-chemical and sensory analysis

The vitamin C (mg/100g) content of the *Muntingia calabura* leaves was determined by redox titration using iodate solution. Flavonoid (mg/g) was determined with reference to the method of Shanmugapriya S. et al., (2017). Color (sensory score) of *Muntingia calabura* leaves was assessed by a group of panelist. They were required to evaluate the odour, colour, taste, sweetness and overall acceptance using the 9-point hedonic scale (1 = dislike extremely, 9 = like extremely).

2.4 Statistical analysis

The experiments were performed in triplicate. Statistical analysis was conducted by the Statgraphics Centurion XVI.

3. RESULT & DISCUSSION

3.1 Effect of blanching temperature to vitamin C (mg/100g), flavonoid (mg/g) and color (sensory score) in the dried *Muntingia calabura* leaf tea

Thermal blanching is an essential operation for many fruits and vegetables processing. It not only contributes to the inactivation of polyphenol oxidase (PPO), peroxidase (POD), but also affects other quality attributes of products. The purposes of blanching include inactivating enzymes, enhancing drying rate and product quality, removing pesticide residues and toxic constituents, expelling air in plant tissues, decreasing microbial load. Raw *Muntingia calabura* leaves were blanched in water solution with 0.5% $CaCl_2$ at different temperature and time (100^{o}C, 3 second; 95^{o}C, 5 seconds; 90^{o}C, 7 seconds; 85^{o}C 9 seconds). All samples were analyzed vitamin C (mg/100g), flavonoid (mg/g), color (sensory score) to validate the appropriate blanching condition. Results were mentioned in table 1. From table 1, the *Muntingia calabura* leaves should be blanched at 95^{o}C in 5 seconds to maintain the most vitamin C (mg/100g), flavonoid (mg/g) and sensory score in the dried *Muntingia calabura* leaf tea.

Blanching involves heating vegetables and fruits rapidly to a predetermined temperature and maintaining it for a specified amount of time, typically 1 to less than 10 min. Then blanched product is either rapidly cooled or passed immediately to a next process. The time required for blanching a product depends on the time required for inactivation of peroxidase and polyphenoloxidase enzymes.

Blanching better preserved and also promoted more nutrients and antioxidant properties in green leafy vegetables than steaming (Nartnampong, A. et al., 2016).

3.2 Effect of drying temperature by heat pump to vitamin C (mg/100g), flavonoid (mg/g) and color (sensory score) in the dried *Muntingia calabura* leaf tea

Conventionally, low drying temperatures between 30 and 50°C are recommended to protect sensitive active ingredients, but the decelerated drying process causes a low capacity of drying installations. Raw *Muntingia calabura* leaves were blanched in water solution with 0.5% $CaCl_2$ at 95^{o}C in 5 seconds. Then these samples would be dried under heat pump dryer at different temperature (35^{o}C, 40^{o}C, 45^{o}C, 50^{o}C, 55^{o}C, 60^{o}C). All samples were analyzed vitamin C (mg/100g), flavonoid (mg/g), color (sensory score) to validate the appropriate drying temperature. Results were mentioned in table 2. From table 2, the *Muntingia calabura* leaves should be dried at 40^{o}C to maintain the most vitamin C (mg/100g), flavonoid (mg/g) and sensory score in the dried *Muntingia calabura* leaf tea.

Table 1. Effect of blanching temperature to vitamin C (mg/100g), flavonoid (mg/g) and color (sensory score) in the dried *Muntingia calabura* leaf tea

Blanching	Vitamin C (mg/100g)	Flavonoid (mg/g)	Sensory score
100^{o}C, 3 seconds	24.35±0.01^b	1.13±0.02^{bc}	6.38±0.01^b
95^{o}C, 5 seconds	25.78±0.00^a	1.45±0.01^a	7.40±0.00^a
90^{o}C, 7 seconds	21.20±0.00^c	1.02±0.00^b	6.24±0.01^c
85^{o}C, 9 seconds	19.38±0.01^d	0.83±0.01^c	5.06±0.03^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%).

Table 2. Effect of drying temperature by heat pump to vitamin C (mg/100g), flavonoid (mg/g) and color (sensory score) in the dried *Muntingia calabura* leaf tea

Drying temperature	Vitamin C (mg/100g)	Flavonoid (mg/ml)	Sensory score
35^{o}C	26.00±0.02^a	1.61±0.01^a	7.88±0.02^a
40^{o}C	25.99±0.01^a	1.60±0.02^a	7.85±0.01^a
45^{o}C	25.93±0.02^{ab}	1.54±0.01^{ab}	7.70±0.00^{ab}
50^{o}C	25.85±0.00^b	1.50±0.01^b	7.64±0.03^b
55^{o}C	25.81±0.01^{bc}	1.47±0.02^{bc}	7.53±0.01^{bc}
60^{o}C	25.78±0.00^c	1.45±0.01^c	7.40±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%).

Table 3. Flavonoid content (mg/g) in dried *Muntingia calabura* leaves by the effect of packaging material and storage temperature

Storage time (month)	Dried *Muntingia calabura* leaves by the storage temperature (^{o}C) kept in PET/AL/PE (zipper top)		Dried *Muntingia calabura* leaves by the storage temperature (^{o}C) kept in PET/AL/PE (vaccum)	
	4 ^{o}C	28 ^{o}C	4 ^{o}C	28 ^{o}C
0	1.60±0.02^a	1.60±0.02^a	1.60±0.02^a	1.60±0.02^a
3	1.53±0.00^{ab}	1.52±0.03^b	1.55±0.01^a	1.54±0.02^a
6	1.36±0.01^b	1.32±0.01^c	1.38±0.03^{ab}	1.35±0.03^{ab}
9	1.30±0.02^c	1.26±0.02^{cd}	1.33±0.01^b	1.29±0.00^b
12	1.20±0.00^c	1.18±0.02^d	1.25±0.02^b	1.20±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%).

3.3 Effect of storage condition to flavonoid (mg/g) in the dried *Muntingia calabura* leaf tea

Freshly dried herbs are very storage-sensitive products. Several factors are important in deciding the quality of dried and stored herbs. Because the dried herbs contain a large quantity of hydrophilic constituents like sugars, flavonoids, mucilage, choline and salts they are very hygroscopic products. Their moisture content can therefore, adopt the surrounding microclimatic conditions very quickly, absorbing moisture from the air in the stack or room very fast. This means that the water content of the dry product very soon exceeds the limit of the physiological water activity of $\varphi = > 0.60$, which is responsible for microbiological deterioration. This causes a wide of range of reactions. Purely biochemical transformations occur more frequently, leading to discoloration, especially of parts of the plant that were previously damaged by pressure, heat or a deficiency of oxygen. Microbiological deterioration caused by fungal agents can also occur within a short time (Suresh Kumar, 2013).

After completion of drying treatment, the dried *Muntingia calabura* leaves were subjected to storage. They were kept in PET/AL/PE (zipper top), PET/AL/PE (vaccum) bag at different 4^{o}C, 28^{o}C. The flavonoid (mg/g) will be analyzed in 3 months interval for 12 months. Dried *Muntingia calabura* leaves should be stored under vacuum in PET/AL/PE bag at 4^{o}C to maintain flavonoid content for 12 months.

The packaging should provide necessary protection against the dried products getting more moist again.It should offer protection against infestation by insects.It must minimize evaporation of the essential oils. Finally, it should keep out of light since light can encourage the oxidation of lipohilic constituents (Suresh Kumar, 2013).

4. CONCLUSION

Drying is the most common and fundamental method for post-harvest preservation of medicinal plants because it allows for the quick conservation of the medicinal qualities of the plant material in an uncomplicated manner. *Muntingia calabura* leaf contains different phytochemicals that include terpenoids, reducing sugars, flavonoids, saponins, tannins, phenols and carbohydrates. Its leaf has a potent antioxidant activity. The plant leaves are rich in healthy bioactive compounds and nutrients; and has potential to be used as medicine, feed and or food additive with multiple purposes. High nutritional content found in the dried leaves are important nutritional indicators of the usefulness of the plant. Drying the leaves assists to concentrate the nutrients, facilitate conservation and consumption, as such, it can be used during the time when source is scarce or can be transported to areas where it is not cultivated.

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