

Efficacy of Drying and Stir-frying to Purple Rice Paddy Herb (*Limnophila aromatica*) Tea

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Abstract

In Vietnam, *L. aromatica* is easily cultivated in flooded rice fields. This herb has two very distinct flavours of lemon oil and cumin. It is used in Vietnamese cuisine to add flavour in soup broths, sauces, and other foods. In order to create a new kind of functional herb tea, we have penetrated on various parameters such as drying and stir-frying the total phenolic and total flavonoid content in the dried stir-fried rice paddy herb tea. Our results revealed that drying raw purple rice paddy herb at 55°C to 8.5% moisture content and then stir-frying at 140°C in 6 minutes could produce the good organoleptic property while maintaining the best phenolic and flavonoid content in this functional beverage. These findings provided useful information for manufactures in processing of this herb to preserve potential sources of bioactive components for consumer and public health.

Keywords: Rice paddy herb, Tea, Beverage, Drying, Stir-frying, Phenolic, Flavonoid, Organoleptic.

Introduction

Rice paddy herb (*Limnophila aromatica*) is a tropical flowering plant in the plantain family, Plantaginaceae, and flourishes in a hot, watery environment, particularly rice fields. Single white, pink, purple or blue to lavender flowers, sometimes with conspicuous spots, occasionally occur on the emerged portion of the stem [1]. It is known to have a distinct flavour and aroma reminiscent of lemon/cumin [2, 3]. The essential oil from *L. aromatica* was found in a high percentage of sabinene, terpinen-4-ol and α -humulene [4].

The aerial component of these plants is widely used as spice and as a medicinal herb [5]. It has been reported to possess diuretic, muscle relaxant and antispasmodic activities [6]. Eugenol and γ -terpinene inside *Limnophila aromatica* exhibited antilipid peroxidation [7]. Extract of *L. aromatica* has a phenolic loading of 40.5 mg/g and flavonoid 31.11 mg/g [8]. Physicochemical properties of the defatted and dephenolated *Limnophila aromatica* starch such as solubility,

morphology, swelling power, crystallinity, gelatinization, retro gradation, decomposition temperature, pasting profile, and surface functional groups were evaluated. *L. aromatica* can be potential biomass to reduce the use of staple foods as starch producing biomass [9]. There were several research mentioned to drying of rice paddy herb (*Limnophila aromatica*). Effect of drying method to antioxidants capacity of *Limnophila aromatica* was investigated [10].

One study investigated the total, soluble and insoluble oxalate contents of two rice paddy herbs (*Limnophila aromatica* and *Limnophila geoffrayi*) as affected by hot-air and vacuum drying methods at different temperatures (50, 60, 70, and 80 °C) One study investigated the changes in color and the contents and compositions of bioactive compounds in rice paddy herbs as affected by air-drying with different temperature [11]. There was not any research mentioned to the effect stir-frying to the dried paddy herb.

Therefore, objective of this study focused on various parameters such as drying and stir-frying to the total phenolic and total flavonoid content in the dried stir-fried rice paddy herb tea.

Materials and Method

Material

Pink rice paddy herb was bought from local market, Hau Giang province, Vietnam. After collecting, they must be conveyed to laboratory within 8 hours for experiments. They were washed under tap water to remove foreign matters. The raw samples were washed and kept at room temperature to drain. Afterwards, the samples were dried under hot-air drying. After drying, samples were kept in cool temperature for 3 hours before coming to the stir-frying step. Dried samples were stir-fried under different conditions. Apart from rice paddy herb, other materials were used including Folin-Ciocalteu reagent, sodium carbonate, NaNO_2 , $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$, NaOH . Lab utensils and equipments such as, drying oven, stir-frying oven, spectrophotometer, vortex mixer, test tube, erlenmeyer flask, beaker, cylinder were also utilized.

Researching Procedure

Effect of Drying Condition to Total Phenolic, Total Flavonoid and Sensory Score of Dried Stir-fried Purple Rice Paddy Herb Tea

Raw purple rice paddy herb samples were subject to hot-air drying oven with different temperature (45, 50, 55, 60, 65°C). Drying time was set to achieve the dried samples containing 8.5% moisture content. After drying, these samples were put to cool at ambient temperature before analysis. For each drying method, 1000 g of fresh sample was used (in triplicate).

Effect of Stir-frying Condition to Total Phenolic, Total Flavonoid and Sensory Score of Dried Stir-fried Purple Rice Paddy Herb Tea

After drying, dried samples were kept in cool temperature for 3 hours before coming to the stir-frying step. Dried samples were stir-fried under different conditions (125°C in 12 minutes, 130°C in 10 minutes, 135°C in 8 minutes, 140°C in 6 minutes, 145°C in 4 minutes). For each stir-frying method, 150 g of dried sample was used (in triplicate).

Chemical, Sensory and Statistical Analysis

Total phenolic content (mg GAE/g extract) was determined using Folin-Ciocalteu assay [12]. Total flavonoid content (mg RE/g extract) was determined by the aluminium calorimetric method [13]. Sensory score was evaluated by a group of panelist using 9 point-Hedonic scale. The experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Stat graphics Centurion XVI.

Result & Discussion

Effect of Drying Condition to Total Phenolic, Total Flavonoid and Sensory Score of Dried stir-fried Purple Rice Paddy Herb Tea

In Vietnam, *L. aromatica* is easily cultivated in flooded rice fields and soggy land. Oil of *L. aromatica* rich in Z-ocimene (39.2%), terpinolene (17.2%) and camphor (12.9%) [14]. In another report, *Limnophila micrantha* (Benth.) Benth., gave oil whose main compounds are mentha-1,5,8-triene (38.5%) and β -myrcene (24.4%) [15]. In one report, total phenolic compound was recorded in raw *Limnophila aromatic* (19 mg GAE/g). The main phenolic acids (hydrocinnamic acids) in this herb were ferulic acid, sinapic acid and protocatechuic acid [16]. In our current report, raw purple rice paddy herb samples were subject to hot-air drying oven with different temperature (45, 50, 55, 60, 65°C). Our results revealed that 55°C was adequate for drying of this herb.

Table 1: Effect of drying temperature to total phenolic and total flavonoid in dried *L. aromatica*

Drying temperature (oC)	45	50	55	60	65
Total phenolic (mg GAE/g)	12.36±0.02 ^c	12.83±0.03 ^{bc}	13.48±0.03 ^a	13.21±0.02 ^{ab}	13.05±0.01 ^b
Total flavonoid (mg RE/g)	9.47±0.00 ^c	10.17±0.02 ^{bc}	11.04±0.01 ^a	10.69±0.00 ^{ab}	10.33±0.03 ^b
Sensory score	5.79±0.01 ^c	6.43±0.00 ^{bc}	7.71±0.02 ^a	7.15±0.00 ^{ab}	6.91±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 ($\alpha = 5\%$)

Rice paddy herb contains high amount of antioxidants which play an important role in getting rid of hydroxyl radicals considered to be the free radicals causing several serious diseases such as cancer, heart disease, and diabetes [17]. *L. aromatica* has been shown to have negligible toxicity and possesses diuretic, muscle relaxant, and antispasmodic activities. The antioxidant activity, total phenolic content, and total flavonoid content of the freeze-dried *L. aromatica* extracts were investigated. Its extract exhibited the highest phenolic content (40.5 mg gallic acidequivalent/g of defatted *L. aromatica*) and the highest flavonoid content (31.11 mg quercetin equivalent/g of defatted *L. aromatica*) [8]. In one study, the drying temperature at 40 °C was showed that the antioxidant activity decreased the most. The drying temperature of 50 °C is suitable for convection drying method and drying temperature of 60 °C suitable for vacuum drying, as it retains the most antioxidant properties. Regarding the drying method, freeze drying proved to be effective when retaining high antioxidant capacity.

Using the convection drying at 50 °C and the vacuum drying at 60 °C, the antioxidant activity of *Limnophila aromatica* was not different [10]. Phenolic compounds and antioxidant properties of thai rice paddy herb as affected by different drying temperature were examined. Phenolic compounds and their antioxidant activities of *L. aromatica* dried by hot-air (HA) oven and vacuum (VC) oven at different temperatures (50, 60, 70, and 80 °C) were evaluated. The most predominant phenolic was sinapic acid for all samples dried with temperature of 50-80 °C

extract, ranged from 30-50 mg/g in HA dried *L. aromatica*. the VC dried *L. aromatica* was 41-53 mg/g. VC drying at 70°C should be considered as suitable drying method for rice paddy herbs with respect to preserving its color, antioxidant properties, and phenolic compounds [11]. One study investigated the total, soluble and insoluble oxalate contents of two rice paddy herbs (*Limnophila aromatica*) as affected by hot-air and vacuum drying methods at different temperatures (50, 60, 70, and 80 °C). The lowest content of soluble oxalate was observed which a high temperature (70 and 80°C) of hot-air dried samples (11.39 and 11.75 mg/g DW in *L. aromatic*) while soluble oxalate content was highest in the high temperature (80°C) vacuum dried samples (18.23 mg/g DW in *L. aromatica*). Hot-air drying at 70°C provided the optimal results with respect to the content of soluble oxalates [18].

Effect of Stir-frying Condition to Total Phenolic, Total Flavonoid and Sensory Score of Dried Stir-fried Purple Rice Paddy Herb Tea

Among the other compounds identified in the oil are perillaldehyde and an unusual monoterpenoid ketone, cis-4-caranone [19]. My-Linh et al [20]. Reported that uncommon 8-oxygenated flavonoids found from *L. aromatica*. In our present study, dried samples were stir-fried under different conditions (125°C in 12 minutes, 130°C in 10 minutes, 135°C in 8 minutes, 140°C in 6 minutes, 145°C in 4 minutes). Our results noted that the optimal stir-frying condition for this herb was recorded at 140°C in 6 minutes.

Table 2: Effect of stir-frying condition to total phenolic, total flavonoid and sensory score of dried stir-fried purple rice paddy herb tea

Stir-frying condition	125 °C, 12 min	130 °C, 10 min	135 °C, 8 min	140 °C, 6 min	145 °C, 4 min
Total phenolic (mg GAE/g)	11.34±0.02 ^c	11.68±0.01 ^{bc}	12.05±0.02 ^{ab}	12.09±0.01 ^a	11.94±0.00 ^b
Total flavonoid (mg RE/g)	9.23±0.00 ^c	9.38±0.00 ^{bc}	9.74±0.03 ^b	10.09±0.03 ^a	9.87±0.00 ^{ab}
Sensory score	7.38±0.00 ^b	7.57±0.03 ^{ab}	7.93±0.00 ^{ab}	8.16±0.02 ^a	8.02±0.02 ^a

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant ($\alpha = 5\%$)

Stir-frying was widely used in herb-processing to prevent exaggerated pharmacological actions, alleviate side effects, modify energy properties (nature, flavor, and channel tropism), mask disagreeable odors, or prolong the shelf-life of crude herbs [21, 22]. Usually there are three degrees of stir-frying evaluated by the color in appearance and/or odor of a specific herb:

stir-frying till yellow, till charred, and till carbonized [23].

Conclusion

Limnophila aromatica, known as rice paddy herb, is easily cultivated in high moisture soil or watery area. It can be harvested and used as ornamental, food, and herb. *L. aromatica* has a flavor and aroma reminiscent of both

lemon and cumin. *L. aromatica* can be used in dietary applications with a potential to reduce oxidative stress. We have successfully defined some major factors affecting to the

quality of the dried stir-frying purple rice paddy herb. From this finding, we can preserve the most valuable phenolic and flavonoid content inside this herb.

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