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Research Paper

Study on the effective chemical components extracted from the tea stems and tea hairs and their antioxidant activity

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ABSTRACT

Tea is the most consumed beverage in the world. Since ancient times, green tea has been considered by the traditional Chinese medicine as a healthful beverage. However, there are many by-products formed during producing of the tea, such as tea stems and tea hairs, which were thrown away as waste. To reuse these by-products, we studied the chemical components of tea stems and tea hairs. In this work, we obtained different polar extractions from the tea stems and tea hairs and then their antioxidant activity was studied accordingly. The result showed that ethyl acetate extractions of tea hairs (B and D) and tea stems (G and I) exhibited the highest antioxidant effect among all extractions (A-J) and the antioxidant ability is almost the same with the scavenging rate between 80-85%, which provide the guidance for the below work.

Key words: Tea stems, tea hairs, effective chemical components, antioxidant activity.

INTRODUCTION

Tea (such as black, oolong and green tea) is widely consumed all over the world, and it lies in the first place among the three major beverages (tea, cocoa, coffee). In China, tea culture has a history of thousands of years and tea is one of the most popular natural beverages (Zhou et al., 2014). China is a major tea producer and exporter in the world (Chen, 1979). There are many beneficial chemical components in the tea: such as tea polyphenols, protein enzymes, amino acids, carbohydrates, oils, sterols, vitamins and pigments (Cabrera et al., 2006). Many studies proved that the tea extracts exhibited a wide spectrum of biological activities: such as anticancer [4-5] (Mimoto et al., 2000; Kim et al., 2004), anti-aging, antioxidant (Zapora et al., 2009; Sinha et al., 2010; Li et al., 2018), reducing blood glucose and lipid (Wolfram et al., 2006). The main components in the tea are polyphenols (accounting for 18-36% in the dry tea) and which exhibited potent antioxidant activity (Wan, 2008). However, during producing the tea, a large amount of tea hairs (Lin et al., 2014; Yi et al., 2016) (named Chahao in Chinese) and tea stems (Wu et al., 2010; Wang et al., 2019) (named Chageng in Chinese) were also produced and were thrown away as the waste, which causes a great waste of resources. To reuse these abandoned resources, we took the lead to study the chemical components of the tea hairs and tea stems and to discover new components beneficial to human health. In current work, we obtained different polar extractions from the tea hairs and tea stems and studied their *in vitro* antioxidant activity. From this work, we can obtain the effective extraction and provide scientific evidence for the further study.

METHODOLOGY

Materials and instruments

The tea hairs and tea stems were collected from the oolong (named Tie guanyin in Chinese) in August of 2020, planted at an'xi of Fujian province. Other chemicals used in this work are analytical reagents.

Detailed experimental processes for tea hairs and tea stems extractions

100 g tea hairs were added into a 1 L conical flask with 500 mL solution of $V_{ethanol}/V_{pure\ water}$: 7:3. The mixture was ultrasoundly extracted for 30 min then the mixture was filtered. The residue was added in the conical flask again and ultrasoundly extracted with 500 mL solution of $V_{ethanol}/V_{pure}$

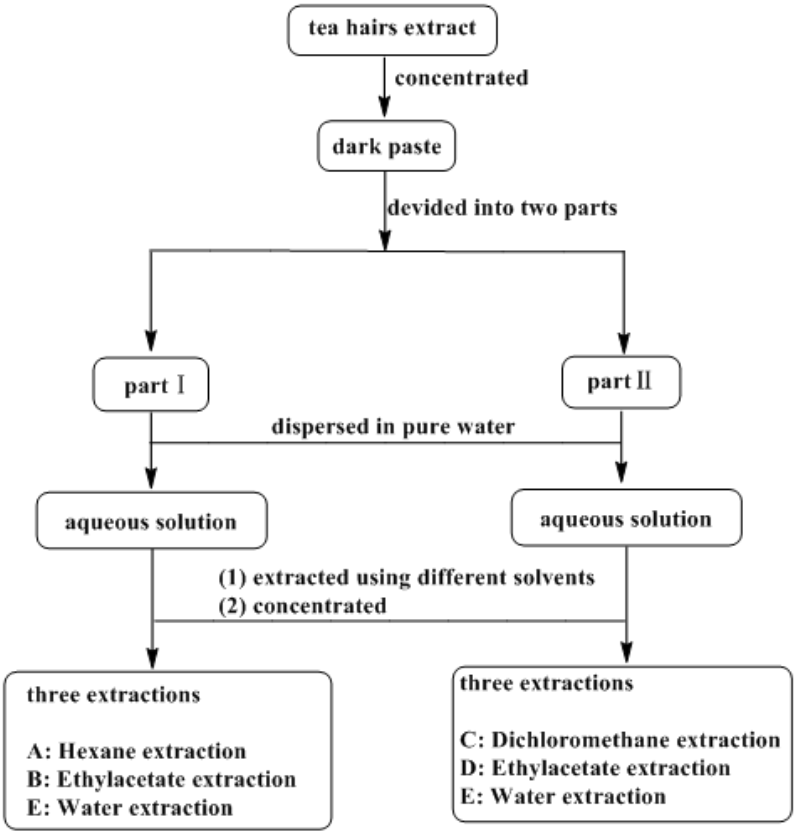

Figure 1: The processes of extraction of the tea hairs

$_{water}$: 7:3 for 30 min, then filter and the filtrations were combined and concentrated under reduced pressure to obtain 10 g dark paste, which was divided into two parts, both were dispersed into 100 mL pure water respectively. One part was extracted with 50 mL×3 *n*-hexane, ethyl acetate respectively, while the other was extracted with 50 mL×3 DCM, ethyl acetate respectively. The different organic layers were combined and concentrated under reduced pressure to obtain different extractions. The processes for tea stems extractions are the same as tea hairs listed above, the experimental processes and the extractions are shown in Figure 1 and Figure 2 respectively.

The procedure for antioxidant activity

The antioxidant ability of the 10 extractions was evaluated in the conventional system of DPPH (Amarowicz et al., 2004). The evaluation processes were described elsewhere with some modifications. In brief, ten extractions were dissolved in DMSO at a starting concentrations of 11.3 mg/mL(A), 17.7 mg/mL(B), 16.7 mg/mL(C), 11.7 mg/mL(D), 6 mg/mL(E), 13.3 mg/mL(F), 11.9 mg/mL(G), 16.2 mg/mL(H), 15.8 mg/mL(I) and 16.2 mg/mL(J) respectively. The detailed processes of antioxidant activity listed: (1) 5 mg DPPH was added into a 25 mL volumetric flask, and DMSO was added to 25 mL. The mixture was shaken fully to give the DPPH stocking solution, which was kept away from the light; (2) 200 μL of extraction A was added to 10 mL different concentrations of DPPH solutions respectively and studied the scavenging ability to optimize the best experimental conditions; (3)10 mL of the DPPH working solution was taken out and the absorbance A_0 was measured at 519 nm, which was repeated for three times; (4) Sample from 200 m μL to 500 μL of the ten extractions was added in 10 mL fresh DPPH working solutions and shaken to mix well, which was also measured the absorbance as A at 519 nm. The DPPH scavenging ability was calculated at the ratio $\{[(A_0\text{-}A) / A_0] \times 100\}$. Each experiment was repeated for 3 times.

RESULT AND DISCUSSION

The antioxidant ability of the extractions of the tea hairs and tea stems was evaluated in the conventional system of DPPH. Firstly, we selected the tea hairs extraction A as the model to optimize the conditions. The results showed in Table 1, which showed that the optimized DPPH concentration is 0.06 mg/mL, the amount of extraction A is 200 μL with the highest scavenging ability of 47.00%. Then, we evaluated the antioxidant effect of different tea hairs

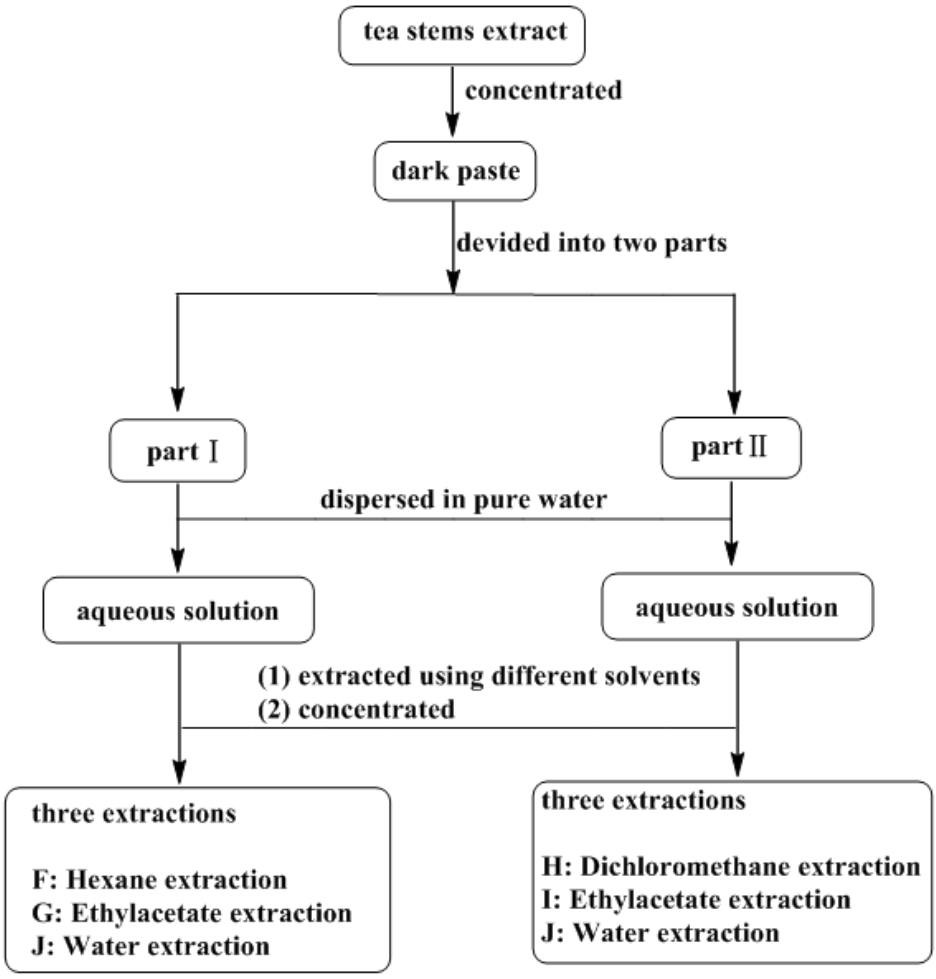

Figure 2: The processes of extraction of the tea stems.

Table 1: The scavenging ability of extraction A at different DPPH concentrations.

$V_{DPPH\ stocking\ solution}$ (mL)	V_{DMSO} (mL)	Total$V$ (mL)	Extraction A(μL)	Scavenging rate (%)
1.0	9.0	10.0	200	31.70
3.0	7.0	10.0	200	47.00
3.5	6.5	10.0	200	28.30
4.0	6.0	10.0	200	25.60

and tea stems extractions under the optimized conditions. From the results listed in Table 2, we can find that the ethyl acetate extractions of tea hairs and tea stems exhibited the highest antioxidant effect and the antioxidant ability is almost the same with the scavenging DPPH rate between 80-85%. Based on these results, we also studied the effect of concentrations of ethyl acetate extractions (B, D, G and I) on DPPH scavenging ability and the results listed in Figure 3. As for the extraction B, the scavenging ability reduced sharply with the increasing of concentrations from 200 to 500 μL; as for the extraction D, the scavenging ability reduced slowly with the increasing of concentrations from 200 to 400 μL, but increase slowly from 400 to 500 μL; as for the extractions G and I, the scavenging ability is a little volatile from 400 to 500 μL, but the fluctuation is not too much. Compared with the antioxidant effect of the ethyl acetate extractions from tea hairs (B and D) and tea stems (G and I), there was no significant difference for their antioxidant effect at 200 μL, which means that there is not much difference for the chemical components between the

Table 2: The scavenging ability of different amounts of extractionsin9.8mL DPPH stocking solutions.

Extractions	Starting concentrations of extractions(mg/mL)	Volume of extractions in experiment (μL)	DPPH working solution (mL)	concentrations of extractions in experiment (mg/mL)	Scavenging rate (%)
A	11.3	200	9.8	0.226	6.49
B	17.7	200	9.8	0.354	80.96
C	16.7	200	9.8	0.334	22.97
D	11.7	200	9.8	0.234	85.44
E	6.0	200	9.8	0.120	56.76
F	13.3	200	9.8	0.266	59.18
G	11.9	200	9.8	0.238	82.95
H	16.2	200	9.8	0.324	25.23
I	15.8	200	9.8	0.316	84.32
J	16.2	200	9.8	0.324	69.44

The extraction numbers (A-J) listed in Table 2 are the same as shown in Figures 1 and **2.**

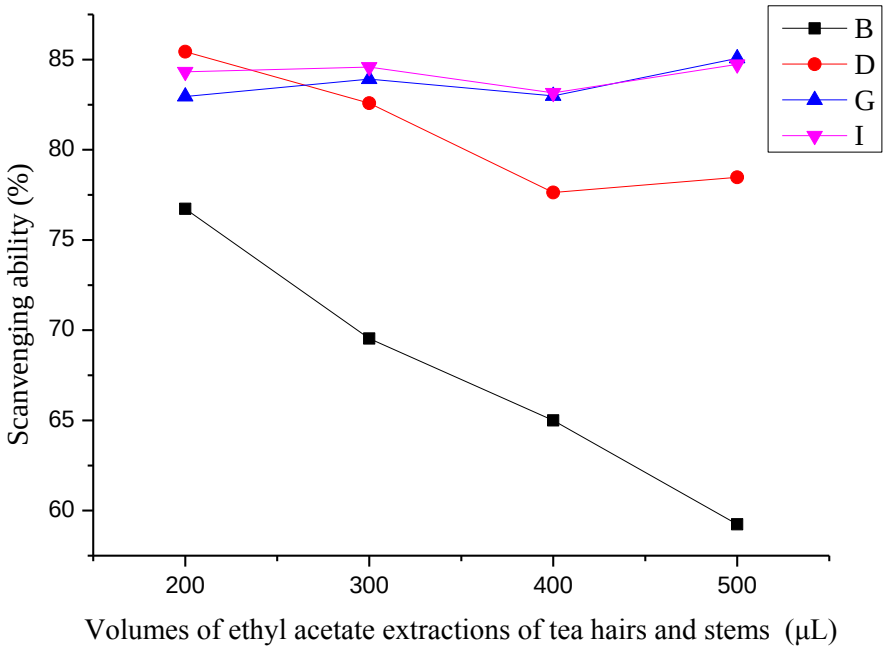

Figure 3: The curves of the concentrations of tea hairs and stems ethyl acetate extractions and DPPH scavenging ability.

ethyl acetate extractions of tea hairs and tea stems.

CONCLUSION

Tea is the most consumed beverage in the world. While producing the tea, tea hairs and tea stems were thrown away as the waste, which causes a great waste of resources. In this work, we took the lead to develop these abandoned resources and we obtained the effective extraction with the higher antioxidant effect, which can be used in the field of foods, drinks, cosmetics and drugs. The relevant work will be carried out so soon.

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