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Freeze-Drying (Lyophilization) of Yellow Camellia (*Camellia chrysantha*) Flower Bud

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Yellow camellia (*Camellia chrysantha*) plant is naturally distributed in Vietnam. Its flower has great ability to improve human health due to its phytochemical substances such as selens, catechin, quercetin and polyphenols. Therefore, its flower is commonly infused in dry form as tea. Freeze-drying is based on low temperatures to avoid the degradation of thermolabile constituents, preserve physicochemical and organoleptic properties. In this study, the impact of freeze-drying conditions on the quality of floral tea from Camellia bud was examined. Five different temperatures (-40, -45, -50, -55, -60 ◦C) and five working shelf pressures (0.022, 0.028, 0.034, 0.040, 0.046 mbar) were clarified. Results showed that 0.04 mbar at -55 ºC were suitable for dehydration of the *Camellia* flower buds into functional tea. The most total phenolic content (807.4±1.3 mg GAE/100 g), flavonoid content (397.5±0.4 mg QE/100 g), DPPH free radical scavenging (206.1±0.5 µg/mL), ABTS radical scavenging activity (45.7±0.01mM TE/g) would be maintained in the dried flower bud.

Keywords: ***Camellia chrysantha, flower bud, freeze-drying, tea, phenolic, flavonoid, DPPH, ABTS***

INTRODUCTION

Yellow camellia (*Camellia chrysantha*) is planted as an ornamental and herbal tree. Its flower has an excellent potential to minimize cancer, hypertension, diarrhea, obesity, cholesterol, and atherosclerosis (Tran et al. 2019; Nguyen et al. 2019c). The extracts from yellow camellia flower have antioxidant properties, superoxide anions, and hydroxyl free radicals scavenging assays (Qin et al. 2008). Polysaccharides, polyphenols, saponins, and flavonoids are active components existing in this flower contributing to its therapeutic properties (Wei et al. 2015; Hisashi et al. 2016; Pereira et al. 2017; Nguyen et al. 2019a). Its constituents may be potential chemopreventive agents for esophageal squamous cell carcinoma (Lu et al. 2016). Essential oil of tea flower included different volatile elements and remarkable DPPH scavenging activity (Yunqi et al. 2021). Tea flower could be utilized as raw materials in health-care food and food flavour (Zhenchun et al. 2014).

Freeze-drying is one of the most effective dehydration methods. It is based on the moisture separation by sublimation of frozen sample hence to preserve bioactive components as original appearance, colour and flavour of raw material (Zheng et al. 2015; Silva-Espinoza et al. 2020). Major obstacle of freeze-drying application is the long-time process and energy cost. Objective of our study is to examine the influence of freeze-drying conditions such as temperature and pressure to phenolic contents and antioxidant properties in the dried Camellia flower bud.

MATERIALS AND METHODS

2.1 Material

Camellia flower buds were collected from Dong Nai province. They should be processed as soon as possible. They were dried by freeze dryer

(Telstar, Spain). Chemical reagents were all analytical grade.

2.2 Researching method

Camellia flower buds were kept in polyethylene bag and frozen at -20 °C for 12 hours. The samples were separated from the bag and put in freezedryer at different temperature (-40, -45, -50, -55, -60 °C) for 24 hours at various pressure (0.022, 0.028, 0.034, 0.040, 0.046 mbar). The final moisture content of dried bud was 9.5±0.5%.Completing drying, samples were stored in plastic bag for analysis. All samples were taken to examine total phenolic content (mg GAE/100 g), total flavonoid content (mg QE/ 100 g), DPPH free radical scavenging (µg/mL), ABTSradical scavenging activity (mM TE/g). The total phenolic content (mg GAE/ 100 g) was quantified by the Folin-Cicalteau method(Abdullakasim et al. 2007).Aluminum chloride colorimetric method was used to measure total flavonoid content (mg QE/100) (Mandal et al. 2013).DPPH free radical scavenging activity (µg/mL) wasdeterminedfollowing method described by Andriana et al. (2019). ABTSradical scavenging activity (mM TE/g) was evaluated following method described by Sowndhararajan and Kang (2013).

2.3 Statistical analysis

The experiments were run in triplicate with different groups of samples. The data were presented as mean standard deviation. Statistical analysis was performed by the Stat graphics Centurion version XVI.

RESULTSAND DISCUSSION

In Vietnam, the yellow Camellia is regularlyinfused to prepare drink tea by its healthycharacteristics (Hong et al. 2020). Extractof yellow Camellia revealed anti-anxiety, antidepressant, and anti-bacterial characteristics (Xu et al. 2018; Nguyen et al. 2019b).The functional value of yellow *Camellia* is superior to green tea. Moreover, consuming golden camellia tea may not be suffered from caffeineinduced side effects. Hence its teacould be used as a natural alternative to current caffeine-free tea (Pham et al. 2020).

Table 1 presented the total phenolic, flavonoid content, DPPH free radical scavenging, ABTS radical scavenging activity of *Camellia* flower buds affected by drying temperature. Drying temperature significantly influenced the total phenolic, flavonoid content, DPPH, ABTS of *Camellia* flowers.

Table 1: Effect of drying temperature (ºC) to phenolic composition and antioxidant capacity of *Camellia* flower bud

Drying temperature (ºC)	Raw	-40	-45	-50	-55	-60
Total phenolic content (mg GAE/100 g)	827.6±1.1[a]	741.3±0.7[d]	762.6±1.2[cd]	784.9±0.8[c]	807.9±1.3[bc]	813.5±0.9[b]
Total flavonoid content (mg QE/100 g)	497.2±1.2[a]	301.5±0.9[d]	341.7±1.3[c]	362.7±0.7[bc]	399.4±1.1[b]	401.4±1.2[b]
DPPH free radical scavenging(µg/mL)	286.7±0.6[d]	109.6±0.5[d]	161.5±0.9[c]	187.3±0.6[bc]	202.9±0.5[b]	204.5±0.8[b]
ABTS radical scavenging activity(mM TE/g)	49.3±0.02[a]	30.7±0.04[c]	33.9±0.01[bc]	40.2±0.02[b]	45.4±0.03[ab]	48.7±0.01[a]

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 2: Effect of vacuum pressure (mbar) to phenolic composition and antioxidant capacity of *Camellia* flower bud

Drying pressure (mbar)	0	0.022	0.028	0.034	0.040	0.046
Total phenolic content (mg GAE/100 g)	481.5±0.7[d]	574.5±1.1[c]	650.7±1.4[b]	713.4±1.0[ab]	807.4±1.3[a]	819.2±1.4[a]
Total flavonoid content(mg QE/100 g)	219.3±1.1[c]	245.7±0.8[bc]	287.6±0.8[b]	321.5±0.7[ab]	397.5±0.4[a]	403.7±1.1[a]
DPPH free radical scavenging(µg/mL)	167.4±0.5[c]	180.0±0.7[bc]	187.1±0.7[b]	194.5±0.4[ab]	206.1±0.5[a]	207.9±0.6[a]
ABTS radical scavenging activity(mM TE/g)	19.6±0.03[c]	27.1±0.01[bc]	31.5±0.02[b]	38.6±0.03[ab]	45.7±0.01[a]	46.5±0.02[a]

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant (α = 5%).

Drying at -55 ºC preserved the highest content of total phenolic (807.9±1.3mg GAE/100 g), flavonoid content (399.4±1.1 mg QE/100 g), DPPH (202.9±0.5µg/ml), ABTS (45.4±0.03mM TE/g) in dried flower buds compared to the total phenolic (827.6±1.1mg GAE/100 g), flavonoid content (497.2±1.2mg QE/100 g), DPPH (286.7±0.6µg/ml), ABTS (49.3±0.02mM TE/g) in raw flower buds. The low thermal exposure of thermolabile constituents to a minimal presence of oxygen in a high porous matrix is less favourable to oxidative reactions (Silva-Espinoza et al. 2020).

Phenolic compositions and antioxidant properties were greatly influenced by drying pressure (Naomi et al. 2018). Table 2 showed the effectiveness of vacuum pressure to the total phenolic, flavonoid content, DPPH free radical scavenging, ABTS radical scavenging activity of *Camellia* flower buds. It's obviously realized that there was significant difference of the phenolic composition and antioxidant capacity of *Camellia* flower buds by vacuum pressure. However there was no significant difference at vacuum pressure 0.040 mbar and 0.046 mbar. Therefore we could choose 0.04 mbar at -55 ºC for drying the *Crinum latifolium* flower bulbs. From this freeze-drying dehydration, the most total phenolic content (807.4±1.3 mg GAE/100 g), flavonoid content (397.5±0.4 mg QE/100 g), DPPH free radical scavenging (206.1±0.5 µg/mL), ABTS radical scavenging activity (45.7±0.01mM TE/g) would be maintained in the dried flower bud. Tea flowers include functional components similar to those of tea leaves, such as catechins, flavonols, caffeine, and amino acids (Yiyong et al.2018).In raw material, antioxidants are existed in glycosidic linkage with covalent bond. Freeze-drying induces breakdown of cellular components and release of them (Wei et al. 2013).

CONCLUSION

Freeze-drying has the most positive influence on phytochemical substances and outlook of *Camellia* flower bud in this research. the total phenolic, flavonoid content, DPPH free radical scavenging, ABTS radical scavenging activity of *Camellia*flower buds were affected by the shelf temperature and the pressure during freeze-drying. Consumer make high-ranking drink tea from camellia due to its extremely beneficial benefits. Freeze-drying of yellow camellia flower into dried tea will improve its agricultural value contributing to poverty reduction for ethnic people in rural and mountainous areas.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Nguyen Phuoc Minh arranged the experiments and also wrote the manuscript.

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