ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in
Nguyen Phuoc Minh et al /J. Pharm. Sci. & Res. Vol. 11(4), 2019, 1406-1409

Microencapsulation of *Fallopia multiflora* for Spray Drying of Instant Herbal Tea

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Abstract.
Fallopia multiflora is an important medicinal plant in Oriental medicine. It is grown for various medicinal values ranging from bowel relaxation, antiaging, hair loss prevention, increasing sexual vigour, treatment of high cholesterol, high blood pressure, and inflammation. Microencapsulation of the herbs appears to be an excellent tool for masking flavour, colour and astringency of the extract. It could enough to hold the bioactive compounds herb extracts which has not only minimizing its undesirable effect but also maintained stability. The aim of this work was to study the feasibility of microencapsulation of of *Fallopia multiflora* extract by spray drying into herbal tea. Various characteristics of instant tea are well affected by microencapsulation conditions including inlet/ out let air temperature, feed flow rate, malodextrin as drying carrier agent. Results revealed that inlet/ outlet spray drying temperature (165ºC: 85ºC), speed flow rate (24 ml/ min), maltodextrin (7 % w/v) were appropriated for spray drying of *Fallopia multiflora* instant tea from its extract. The instant tea of maltoxetrin-*Fallopia multiflora* was considered to be the good technique to dry *Fallopia multiflora* extract on the result of phytochemical determination, physical and chemical properties and antioxidant activity. Value addition of *Fallopia multiflora* extract has been created by changing in the physical form of herb which leads to its greater acceptability, extended availability, enhanced market viability and increased cost to benefit ratio for the grower of the *Fallopia multiflora* produce.

Keywords: *Fallopia multiflora extract, microencapsulation, spray drying, instant tea, inlet air, outlet air, speed flow rate, carrier agent*

I. INTRODUCTION

Fallopia multiflora is one of the most valuable traditional medicinal herbs. This plant is grown in different regions of Vietnam *(*Pham Thanh Huyen, Nguyen Thi Ha Ly, 2017*)* (Thi Thoa Nguyen et al., 2018). *F. multiflora* is closely related to *Beta macrocarpa* and *Silene latifolia (*Chang-Kug Kim & Yong-Kab Kim, 2018*)*. *F. multiflora* is used in Vietnamese traditional medicine for treatment of depression, anemia, hair-loss and constipation (Szu-Hsiu Liu and Ling-Jen Ma). Phytochemical investigations have revealed the presence of stilbenes and anthraquinones as major components in *F. multiflora* (T. H. Wang et al., 2015).

Microencapsulation can be prepared by using certain food grade core materials like maltodextrin, WPC, B-cyclodextrin is useful for delivery of bioactive herbal compound (Chiou D, Langrish TAG, 2007). The matrix for encapsulation is constructed using food grade or GRAS materials that can fulfill these requirements may include polysaccharides of plant or microbial origin, food proteins, emulsifiers (McClements DJ et al., 2009). Various microencapsulation techniques solvent dispersion/evaporation, phase separation (coacervation), drying, co-crystallization, and interfacial polymerization have been widely used to protect food ingredients against deterioration, volatile losses or premature interaction with other ingredients (Shu B et al., 2006). Spray drying is the most widely used method of microencapsulation. This technology offers a high production rate, lower operating costs in comparison with others, stable and easily applicable powders. Spray drying microencapsulation of herbal extracts has been providing higher powder and polyphenolic yield by employing certain carrier materials, in comparison to drying plain herbal extract. Several materials have been encapsulated in the food industry, including, amino acids, vitamins, minerals, antioxidants, colorants, enzymes and sweeteners (Shahidi F, Naczk M, 2005). Maltodextrin has been widely used as carrier for spray drying. Maltodextrin, a hydrolyzed starch, is a popular material in encapsulation by this technique. It offers advantages such as low cost, neutral aroma, and taste, low viscosity; protection against oxidation. The protective mechanism is to form a membrane (wall system) to enclose droplets or particles of the encapsulated material. There were several studies using microencapsulation for herbal instant tea. A study was to optimize the extraction and microencapsulation of red grape pomace. This study illustrated that the optimal conditions for extraction and microencapsulation of the red grape extract have a high potential to produce functional ingredients (Thapakorn Boonchu and Niramon Utama-ang, 2015). A research aimed to investigate the encapsulation of Michelia champaca L. (Champaca; MCL) extract and apply in green tea powder to create instant Champaca tea. The MCL extract 10% w/v was the most suitable to produce the MCL encapsulated flavor powder and the suitable amount of the MCL encapsulated flavor powder to produce the instant Champaca tea was 0.3% w/w (Niramon Utama-Ang et al., 2017).

However, no any research mentioned to processing of *Fallopia multiflora* extract into herbal tea, especially the microencapsulation approach as spray drying. *Fallopia multiflora* extract is very sensitive and affected the different drying parameters. Spray drying is one of the most complex methods for microencapsulation. The aim of this work was to study the feasibility of spray drying of *Fallopia multiflora* extract. Various characteristics of instant herbal tea well affected by microencapsulation conditions including inlet/ out air temperature, feed flow rate, maltodextrin as drying carrier agent were examined.

II. MATERIAL AND METHOD

2.1 Material

Fallopia multiflora was collected from Vinh Phuc province, Vietnam. The herb was stored at 4-8 °C and transfer quickly to laboratory for experiment.

Figure 1. ***Fallopia multiflora***

2.2 Researching method

2.2.1 Effect of inlet and outlet air spray drying temperature to water activity, total phenolic, bulk density, yield, solubility, hygroscopicity, total plate count, sensory score in instant tea

Different inlet: outlet air drying temperature (145^{o}C: 75^{o}C, 155^{o}C: 80^{o}C, 165^{o}C: 85^{o}C, 175^{o}C: 90^{o}C) was examined. The optimal parameter was selected by comparing different values of the instant tea such as water activity (a_w), total phenolic (mg GAE/g), , bulk density (g/ml), yield (%), solubility (%), hygroscopicity (%), total plate count (cfu/g), sensory score.

2.2.2 Effect of speed flow rate to water activity, total phenolic, bulk density, yield, solubility, hygroscopicity, total plate count, sensory score in instant tea

Different speed flow rate (7, 14, 21, 28 ml/ min) was examined**.** The optimal parameter was selected by comparing different values of the instant tea such as water activity (a_w), total phenolic (m**g** GAE/g), bulk density (g/ml), yield (%), solubility (%), hygroscopicity (%), total plate count (cfu/g), sensory score.

2.2.3 Effect of ratio of maltodextrin as drying carrier agent to water activity, total phenolic, bulk density, yield, solubility, hygroscopicity, total plate count, sensory score in instant tea

Different ratio of maltodextrin as drying carrier agent (3, 5, 7, 9% w/v) were used to prepare the microencapsulation. The optimal parameter was selected by comparing different values of the instant tea such as water activity (a_w), total phenolic (mg GAE/g), bulk density (g/ml), yield (%), solubility **(%),** hygroscopicity (%), total plate count (cfu/g), sensory score.

2.3 Physico-chemical, microbial and sensory evaluation

Water actitity (a_w) was measured was measured by a water activity meter with the standard solution of 0.25 and 0.50 as the control samples. Total phenolic content was determined using the FolinCiocalteu method described by Rocha and Morais (2002). Bulk density was determined by gently pouring instant tea into a 10 cm^3 graduated cylinder, and was calculated as the ratio of the weight (g) of the sample contained in the cylinder to the volume occupied (Gallo et al., 2011). The total plate count (cfu/g) was enumerated during the storage period by Petrifilm - 3M. The sensory attributes such as visual appearance, color, taste, flavor and acceptability was carried out by selected panel of judges (9 members) rated on a five point hedonic scale. The yield of the spray drying process was calculated by taking into consideration the total solid content of the feed sample with carrier agent and weight of the final dry powder. Yield (%) was calculated using the equation: Yield (%) = Weight of the solids in dried powder x 100/ Solid content of the feed material (Sangeeta Saikia et al., 2014). The solubility (%) was determined according to the method described by Chau et al. (2007). Briefly, samples were mixed with distilled water (1:10 w/v), stirred for 1 h at room temperature and centrifuged at 1,500 rpm for 10 min. The supernatant was collected, dried and weighed. Solubility (%) = weight (g) of supernatant after drying x100/ weight (g) of sample. The hygroscopicity (%) property of the sample powders was determined according to Cai and Corke (2000) with some modifications. Briefly, 2 g of spraydried powder samples were placed in pre-weighed glass vials and placed in a desiccator containing saturated salt solution of sodium chloride (relative humidity of 75.09%) maintained at 30^{o}C and kept for 7 days. After the incubation period, sample vials were weighed and hygroscopicity was expressed as g moisture/100 g solids.

2.4 Statistical analysis

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Statgraphics Centurion XVI.

III. RESULT & DISCUSSION

3.1 Effect of inlet/ outlet spray drying temperature to moisture content, water activity, total phenolic, ascorbic acid, carotenoid, bulk density, yield, solubility, hygroscopicity, total plate count, sensory score in instant tea

The main advantages of this type of drying process are its high yield and a reduction of the product of exposure time to high temperatures. This, in turn, reduces the thermal damage caused to the product (Samantha Serra Costa et al., 2015). Processing factors affecting particle size, loose density and nutrient contents of the instant tea include inlet and outlet drying temperature (Phisut, N., 2012). According to Walton (2000), increasing air-drying temperature or decreasing feed flow rate generally resulted in a decrease in bulk density and there was a greater tendency for particles to be hollow. This could have resulted from a higher evaporation rate (Goula & Adamopoulos, 2008) or a lower residual moisture content (Chengini & Ghobadian, 2005), which may be the reason why bulk density decreased dramatically as the inlet air drying temperature increased.

From table 1, the optimal inlet/ outlet spray drying temperature should be 165^{o}C: 85^{o}C so we choose this value for further experiments.

Table 1. Effect of inlet/ outlet spray drying temperature (145^{o}C: 75^{o}C, 155^{o}C: 80^{o}C, 165^{o}C: 85^{o}C, 175^{o}C: 90 ^{o}C) to moisture content (%), water activity (a_w), total phenolic (mg GAE/g), ascorbic acid (mg/ 100g), carotenoid (mg/ 100g), bulk density (g/ml), yield (%), solubility (%), hygroscopicity (%), total plate count (cfu/g), sensory score in instant tea

Inlet/ outlet spray drying temperature (^{o}C)	145^{o}C: 75^{o}C	155^{o}C: 80^{o}C	165^{o}C: 85^{o}C	175^{o}C: 90^{o}C
Water activity (a_w)	0.31±0.02^a	0.30±0.00^a	**0.30±0.03^a**	0.29±0.03^a
Total phenolic (mg GAE/g)	566.19±0.01^c	594.12±0.01^b	**613.75±0.01^a**	579.58±0.01^{bc}
Bulk density (g/ml)	0.35±0.03^a	0.34±0.02^{ab}	**0.32±0.03^b**	0.34±0.02^{ab}
Yield (%)	64.84±0.01^b	66.12±0.01^{ab}	**66.39±0.02^a**	66.14±0.01^{ab}
Solubility (%)	64.21±0.00^b	66.77±0.03^{ab}	**68.24±0.01^a**	66.34±0.03^{ab}
Hygroscopicity (%)	11.25±0.00^a	10.89±0.01^{ab}	**10.41±0.02^b**	11.03±0.01^{ab}
Total plate count (cfu/g)	1.0x10^1±0.01^a	1.0x10^1±0.00^a	**1.0x10^1±0.00^a**	1.0x10^1±0.01^a
Sensory score	7.20±0.03^b	7.34±0.02^{ab}	**7.45±0.00^a**	7.38±0.02^{ab}

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 different speed flow rate (7, 14, 21, 28 ml/ min) to water activity (a_w), total phenolic (mg GAE/g), bulk density (g/ml), yield (%), solubility (%), hygroscopicity (%), total plate count (cfu/g), sensory score in instant tea

Speed flow rate (ml/ min)	7	14	21	28
Water activity (a_w)	0.30±0.03^a	0.30±0.01^a	**0.31±0.01^a**	0.31±0.01^a
Total phenolic (mg GAE/g)	613.75±0.01^b	624.11±0.02^{ab}	**629.40±0.02^a**	630.01±0.02^a
Bulk density (g/ml)	0.32±0.03^b	0.32±0.00^a	**0.33±0.01^a**	0.33±0.01^a
Yield (%)	66.39±0.02^a	68.25±0.00^b	**69.12±0.02^{ab}**	69.35±0.01^a
Solubility (%)	68.24±0.01^b	69.04±0.03^{ab}	**69.42±0.01^a**	65.21±0.02^c
Hygroscopicity (%)	10.41±0.02^b	10.45±0.01^{ab}	**10.47±0.03^{ab}**	10.50±0.01^a
Total plate count (cfu/g)	1.0x10^1±0.00^a	1.0x10^1±0.02^a	**1.0x10^1±0.02^a**	1.0x10^1±0.01^a
Sensory score	7.45±0.00^b	7.52±0.02^{ab}	**7.64±0.01^a**	7.34±0.02^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. Effect of different ratio of maltodextrin as drying carrier agent (3, 5, 7, 9% w/v) to water activity (a_w), total phenolic (mg GAE/g), bulk density (g/ml), yield (%), solubility (%), hygroscopicity (%), total plate count (cfu/g), sensory score in instant tea

Maltodextrin (% w/v)	3	5	7	9
Water activity (a_w)	0.31±0.01^a	0.31±0.03^a	**0.31±0.02^a**	0.31±0.02^a
Total phenolic (mg GAE/g)	629.40±0.02^b	632.18±0.01^{ab}	**639.37±0.03^a**	640.01±0.02^a
Bulk density (g/ml)	0.33±0.01^a	0.33±0.00^a	**0.34±0.02^a**	0.34±0.02^a
Yield (%)	69.12±0.02^b	72.01±0.01^{ab}	**73.14±0.01^a**	73.20±0.01^a
Solubility (%)	69.42±0.01^c	70.13±0.00^b	**72.20±0.02^a**	71.83±0.00^{ab}
Hygroscopicity (%)	10.47±0.03^a	10.40±0.02^{ab}	**10.32±0.02^b**	10.30±0.01^b
Total plate count (cfu/g)	1.0x10^1±0.02^a	1.0x10^1±0.00^a	**1.0x10^1±0.03^a**	1.0x10^1±0.01^a
Sensory score	7.64±0.01^c	7.70±0.03^b	**7.77±0.03^a**	7.72±0.00^{ab}

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%).

3.2 Effect of speed flow rate to water activity, total phenolic, bulk density, yield, solubility, hygroscopicity, total plate count, sensory score in instant tea

Feed flow rate have significant effect on the dryer yield and wall deposit of spray dryer individually and jointly (G.R. Chegini and B. Ghobadian, 2007). Different speed flow rate (7, 14, 21, 28 ml/ min) was examined. From table 2, the optimal speed flow rate was noticed at 12 ml/min so this value was selected for further experiments.

From table 2, the speed flow rate 21 ml/ min was appropriated for next experiments.

3.3 Effect of ratio of maltodextrin as drying carrier agent to water activity, total phenolic, bulk density, yield, solubility, hygroscopicity, total plate count, sensory score in instant tea

Maltodextrins are products of starch hydrolysis, consisting of D-glucose units linked mainly by α (1→4) glycosidic bonds. Maltodextrins are low cost and very useful for spray drying process on food materials (Rodriguez-Hernandez *et al*., 2005).

From table 3, ratio of maltodextrin (7% w/v) was appropriate for application. In another research, a study was to optimize the extraction and microencapsulation of red grape pomace. The temperature (45–85 °C), and the time (2–8 h) were designed for the extraction. The results indicated that the extraction temperature and time introduced the increasing the extraction yield, total phenolic content, anthocyanin and resveratrol, but the long extraction time reduced the tannin content. The results showed that the optimize condition was the extraction at 80 ± 1 °C for 2 h 53 min. This provided the highest content of polyphenolic compounds. The next experiment was microencapsulation of the extract which studied the amounts of maltodextrin (7–28 % w/v) and carboxymethylcellulose (CMC) (0–1.4 % w/v). The results showed that the optimized microencapsulation used 10.21 % w/v maltodextrin and 0.21 % w/v CMC to maximize all polyphenolic compounds, and also to minimize bitterness and astringency (Thapakorn Boonchu and Niramon Utama-ang, 2015). A research aimed to investigate the encapsulation of Michelia champaca L. (Champaca; MCL) extract and apply in green tea powder to create instant Champaca tea. The MCL encapsulated flavor powder was produced using spray drying. The carries of encapsulation were varied 20% w/v of maltodextrin with 0.5% w/v of trehalose. The experiment was conducted by variation of 5, 10, 15 and 20% MCL extract. The result showed that 10% MCL extract provided the highest encapsulation efficiency (93.39±0.57), the highest overall aroma rating score (6.5±0.5) with high yield recovery (34.52±0.61) (Niramon Utama-Ang et al., 2017).

IV. CONCLUSION

Fallopia multiflora is chemically rich with its varied content of active compounds. Its herbal nutraceuticals are commonly used by people who seek alternative health care. Microencapsulation of *Fallopia multiflora* extract is important in order to handle the market demand throughout the year. Spray drying is the continuous transformation of feed from a fluid state into dried particulate form by spraying the feed into a hot drying medium. Drying as a preservation method may be an alternative for a better utilization of *Fallopia multiflora* extract, creating new product and make available throughout the year. Spray drying can be used to convert *Fallopia multiflora* extract into instant tea with new possibilities of industrial applications. Value addition is desirable from both the horticulturer's as well as the consumer's point of view.

REFERENCES

1. Cai, Y.Z. and Corke, H. (2000). Production and properties of spray dried Amaranthus betacyanim pigments. *J. Food Sci.* 65: 1248–1252.
2. Chang-Kug Kim & Yong-Kab Kim (2018). The multipartite mitochondrial genome of *Fallopia multiflora* (Caryophyllales: Polygonaceae). *Mitochondrial DNA Part B* 3(1): 155-156.
3. Chau, C.F., Wang, T.Y. and Wen, L.Y. (2007). Different micronization methods significantly improve the functionality of carrot insoluble fibre. *Food Chem.* 100: 1402–1408.
4. Chegini, G. R., & Ghobadian, B. (2005). Effect of spray drying conditions on physical properties of orange juice powder. *Drying Technology* 23: 657–668.
5. G.R. Chegini and B. Ghobadian (2007). Spray dryer parameters for fruit juice drying. *World Journal of Agricultural Sciences* 3 (2): 230-236.
6. Chiou D, Langrish TAG (2007). Development & characterization of novel nutraceuticals with spray drying technology. *Journal of Food Engineering* 82: 84-91
7. Gallo, L., Llabot, J. M., Allemandi, D., Bucalá, V., & Piña, J. (2011). Influence of spray-drying operating conditions on *Rhamnus purshiana* (*Cáscara sagrada*) extract powder physical properties. *Powder Technology* 2018: 205–214.
8. Goula, A. M., & Adamopoulos, K. G. (2008). Effect of maltodextrin addition during spray drying of tomato pulp in dehumidified air: I. Drying kinetics and product recovery. *Drying Technology* 26(6): 714–725.
9. McClements DJ, Decker EA, Park Y, Weiss J (2009). Structural design principles for delivery of bioactive components in nutraceuticals and functional foods. *Critical. Review in Food Science and Nutrition* 49(6): 577-606.
10. Niramon Utama-Ang, Phikunthong Kopermsub, Prodepran Thakeow and Rajnibhas Samakradhamrongthai (2017). *International Journal of Food Engineering* 3(1): 48-55.
11. Pham Thanh Huyen, Nguyen Thi Ha Ly (2017). Survey on distribution and quality evaluation of *Fallopia Multiflora* (Thunb.) Haraldson towards conservation and expansion of planting in Vietnam. ***VNU Journal of Science: Medical and Pharmaceutical Sciences*** 33(1): 24-31.
12. Phisut, N. (2012). Spray-drying technique of fruit juice powder: Some factors influencing the properties of products. *Int. Food Res. J.* 19: 1297–1306.
13. Rocha, A. M. C. N., & Morais, A. M. B. B. (2002). Polyphenoloxidase activity and total phenolic content as related to browning of minimally processed 'Jonagored' apple. *Journal of the Science of Food and Agriculture* 82: 120-126.
14. Rodriguez-Hernandez, G.R., Gonzalez-Garcia, R., GrajalesLagunes, A. and Ruiz-Cabrera, M.A. (2005). Spraydrying of cactus pear juice (*Opuntia streptacantha*): Effect on the physicochemical properties of powder and reconstituted product. *Drying Technology* 23: 955–973.
15. Samantha Serra Costa, Bruna Aparecida Souza Machado, Adriana Regina Martin, Fabio Bagnara, Sandro Andre Ragadalli and Aline Rabello Costa Alves (2015). Drying by spray drying in the food industry: Spray drying, process parameters and main carriers used. *African Journal of Food Science* 9(9): 462-470.
16. Sangeeta Saikia, Nikhil Kumar Mahnot and Charu Lata Mahanta (2014). Effect of spray drying of four fruit juices on physicochemical, phytochemical and antioxidant properties. *Journal of Food Processing and Preservation* 1: 1-9.
17. Shahidi F, Naczk M (2005). Phenolic in food and nutraceuticals. *Book Reviews in Trends in Food Science & Technology* 16: 171-176.
18. Shu B, Yu W, Zhao Y, Liu X (2006). Study on microencapsulation of lycopene by spray drying. *Journal of Food Engineering* 76: 664-669.
19. Szu-Hsiu Liu and Ling-Jen Ma (2015). Effects of Chinese herbal extracts on tyrosinase activity and melanogenesis. *Natural Products Chemistry & Research* 3(4): 183.
20. Thapakorn Boonchu and Niramon Utama-ang (2015). Optimization of extraction and microencapsulation of bioactive compounds from red grape (*Vitis vinifera* L.) pomace. *J Food Sci Technol.* 52(2): 783–792.
21. Thi Thoa Nguyen, Thanh Binh Pham, Nguyen Phuong Thao, Nguyen Hai Dang, Van Hung Nguyen, Van Cuong Pham, Chau Van Minh, Quang Hai Tran, and Nguyen Tien Dat (2018). Phenolic constituents from *Fallopia multiflora* (Thunberg) Haraldson. Journal of Chemistry Volume 2018, Article ID 4851439, 5 pages.
22. Walton, D. E. (2000). The morphology of instant tea particles. A qualitative view. *Drying Technology* 18(9): 1943–1986.
23. T. H. Wang, J. Zhang, X. H. Qiu, J. Q. Bai, Y. H. Gao, and W. Xu (2015). Application of ultra-high-performance liquid chromatography coupled with LTQ-Orbitrap mass spectrometry for the qualitative and quantitative analysis of *Polygonum multiflorum* Thumb. and its processed products. *Molecules* 21(1): 40-47.