Fresh Processing Technology in *Polygonatum odoratum* Production Area and Its Comparison with Traditional Processing

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Abstract [**Objectives**] To compare the effects of traditional processing and fresh processing on the quality of *Polygonatum odoratum* decoction piece. [**Methods**] The effects of fresh processing and traditional processing on the quality of *P. odoratum* decoction piece were compared and analyzed with appearance characteristics, total ash content, extract content, total polysaccharides content, and total flavonoids content as the evaluation indexes. [**Results**] Fresh processing method in different production areas has different effects on *P. odoratum* decoction piece. *P. odoratum* was dried in oven of 50 ℃. When moisture content was 41.44% - 59.67%, it was cut. After complete drying at 50 ℃, the moisture content of dried *P. odoratum* was 8.94% - 9.60%, and ethanol-soluble extract content was 77.29% - 78.20%, and water-soluble extract was 77.7% - 78.14%. At this time, the appearance characteristics of section of *P. odoratum* decoction piece were better than that of traditional processing, which was yellowish white. The total polysaccharide content was higher than that of traditional processing, and the content of total flavonoids was statistically significant different from that of traditional processing. [**Conclusions**] The quality of *P. odoratum* decoction piece by fresh processing is better than that of the traditional processing, and it is feasible to use fresh processing.

Key words Processing technique, *Plygonatum odoratum*, Fresh processing, Total polysaccharide, Total flavonoids

1 Introduction

Polygonati Odorati Rhizoma is the dry rhizome of Liliaceae plant *Plygonatum odoratum*. It can be used as both medicine and food[1-2], with the health benefits of nourishing yin, moistening dryness, generating fluids, and quenching thirst. It is used for lung and stomach yin injury, dry heat and cough, dry throat and thirst, internal heat and thirst quenching[3]. Medically, it can be used to treat diseases such as fever causing yin damage, dry cough and restlessness, fatigue and fever, loss of grain and hunger, and frequent urination[4]. Modern research has found that *P. odoratum* contains various effective ingredients such as polysaccharides, saponins, flavonoids, volatile oils, amino acids, *etc.* It has excellent pharmacological effects in fields such as hypoglycemia, antitumor, antioxidant, and immune regulation[5].

The fresh processing of Chinese medicinal materials is currently highly respected, which can improve the efficiency of medicinal material processing, avoid the loss of some effective ingredients in medicinal materials, and reduce enterprise costs[6-7]. It has been applied in processing of various decoction pieces. At present, there are only 69 varieties available for fresh processing in the 2020 edition of the *Chinese Pharmacopoeia*, which is relatively small and cannot meet the actual production needs of traditional Chinese medicine decoction pieces. Fresh *P. odoratum* is often harvested in autumn, and it usually goes through the steps of kneading sugar juice during the processing[8-9]. When cutting into decoction pieces, it is necessary to moisten *P. odoratum* until the internal and external humidity is consistent, then it is cut into thick pieces, and secondary drying is performed, which can easily lead to the loss of some active ingredients and mold growth of the medicinal material[10]. At present, there is relatively little research on the fresh processing technology for *P. odoratum* production area, and it mainly focuses on the integration of processing in production area and processing aspect. This study conducted a study on the key technical specifications of the fresh processing of *P. odoratum*. Using appearance characteristics, extract content, total ash content, total polysaccharide content, and total flavonoid content as evaluation criteria, the impacts of traditional processing and fresh processing on the quality of *P. odoratum* decoction pieces were compared, and the feasibility of *P. odoratum* fresh processing was explored. The research aimed to provide reference for enterprises' fresh processing technology, and promote the industrialization, modernization, and intensive development of *P. odoratum* fresh processing.

2 Materials and methods

2.1 Materials *P. odoratum* is provided by Guilin Juhui Ecological Agroforestry Development Co., Ltd. and identified by Tang Hui, a researcher of Guangxi Institute of Botany, Chinese Academy of Sciences. After processing, *P. odoratum* is dried at 50 ℃ to a constant weight, crushed through a 60-mesh sieve, and stored for later use.

2.2 Reagents and instruments Concentrated sulfuric acid and anhydrous glucose (AR, Sichuan Xilong Co., Ltd.); phenol (AR, Ron Reagent); anhydrous ethanol (AR, Tianjin Zhiyuan Chemical Reagent Co., Ltd.); rutin (China Institute of Pharmaceutical and Biological Products Identification); FA2204B preci-

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sion electronic balance (Shanghai Yueping Scientific Instrument Manufacturing Co., Ltd.); 200A multifunctional crusher (Shanghai Senai Machinery Co., Ltd.); DHG-9075A type of DHG series heating and drying oven (Shanghai Yiheng Scientific Instrument Co., Ltd.); UV-1800 ultraviolet spectrophotometer (Jinan Ouweiteng Biotechnology Co., Ltd.).

2.3 Processing methods

2.3.1 Fresh processing. After removing soil and impurities from the excavated fresh *P. odoratum*, they are promptly divided into 13 groups for processing. The moisture content was measured at different intervals, and they were cut into 2 – 4 mm thick slices while fresh, and dried at 50 ℃. Each group was repeated for three times, and numbers were S1 to S13. Group S1: cut fresh, and dried for 0 d. Groups S2-S5: natural drying for 2 – 5 d. Groups S6-S9: drying in shade for 3 – 6 d. Groups S10-S13: after washing and softening with water, it was cut into 2 – 4 mm thick slices and dried at 50 ℃ for 1/6, 1/3, 1/2, 2/3 d.

2.3.2 Traditional processing. After removing soil and impurities from the excavated fresh *P. odoratum*, they were divided into three groups in a timely manner. Group S14: natural drying for 4 d. Group S15: drying in shade for 7 d. Group S16: drying at 50 ℃ for 1 d. Each group was repeated for three times.

2.4 Determination of moisture, leachate, and ash contents

It referred to the 2020 edition of the *Chinese Pharmacopoeia* (Volume IV) (General Rule 0832, Method 2 for Moisture Determination).

2.5 Determination of total polysaccharide content[11]

2.5.1 Drawing of standard curve. 60 mg of anhydrous glucose reference substance was taken, and water was added to a 100 mL of volumetric flask to fix the volume, which was taken as the reserve solution. 1.0, 1.5, 2.0, 2.5, and 3.0 mL of glucose reserve solutions were accurately measured and placed in a 50 mL of volumetric flask. Water was used to the fix the volume, and it was shaken well. 2 mL of the above solutions were accurately measured and placed in a stoppered test tube. 1.0 mL of 4% phenol solution was added and mixed well. Then, 7.0 mL of concentrated sulfuric acid was quickly added and shaken well. It was set in a 40 ℃ water bath for 30 min, then removed and placed in an ice water bath for 5 min. At the same time, distilled water was used as the blank control group, and the blank group was used as the reference. The absorbance value at the wavelength of 490 nm was measured by UV-visible spectrophotometry. A standard curve was drawn with glucose solution concentration as the horizontal axis and absorbance as the vertical axis, and a linear regression equation was obtained: $A = 0.235\ 7x + 0.005\ 4$, $R^2 = 0.995\ 2$.

2.5.2 Determination of sample content. About 1 g of rough *P. odoratum* powder was taken and weighed accurately. Then it was placed in a round bottom flask, and 100 mL of water was added for heating reflux for 1 h. It was filtered with degreased cotton, and the above operation was repeated once. The filtrate was combined and concentrated to an appropriate amount. Then, it was transferred to a 100 mL of volumetric flask. Water was added to fix the volume, and it was shaken well. 2 mL of sample solution was accurately measured, and 10 mL of ethanol was added. After stirring and centrifuging, the supernatant was discarded. The precipitate was taken and dissolved in water, and it was placed in a 50 mL of volumetric flask and diluted to the mark. After shaken well, the sample solution of *P. odoratum* polysaccharide was obtained. 2 mL of *P. odoratum* polysaccharide sample solution was accurately measured. According to the method of Section **2.5.1**, starting from "adding 1 mL of 4% phenol solution", the absorbance according was measured. The weight of glucose in *P. odoratum* sample was obtained from the glucose standard curve, and the polysaccharide content in *P. odoratum* sample was calculated. Each group was repeated for 3 times.

2.6 Determination of total flavonoid content[12-13]

2.6.1 Drawing of standard curve. 10 mg of rutin was taken and added in a 50 mL of volumetric flask. It was prepared into 0.2 mg/mL of rutin standard solution with 45% ethanol. 0, 2.0, 4.0, 6.0, 8.0, and 10.0 mL of rutin standard solutions were taken sequentially into a 50 mL of volumetric flask, and 0.4 mL of 5% sodium nitrite was added to shake well. After standing for 6 min, 0.4 mL of 10% aluminum nitrate was added to shake well. After standing for 6 min, 2 mL of 4% sodium hydroxide was added. After shaken well, it was calibrated with 45% ethanol. After standing for 15 min, the absorbance at 512 nm was measured. Using a blank group as a reference, rutin concentration as the horizontal axis and absorbance as the vertical axis, a standard curve was drawn, and a linear regression equation was obtained: $A = 0.226\ 6x - 0.006\ 2$, $R^2 = 0.999\ 3$.

2.6.2 Determination of sample content. 1 g of rough *P. odoratum* powder was taken, and 45% ethanol was added. Material to liquid ratio (g/mL) was 1∶10, and ultrasound time was 35 min. After filtering, it was transferred to a 50 mL of volumetric flask, and 2 mL of filtrate was transfered into a 10 mL of volumetric flask. According to the method of Section **2.5.1**, the absorbance at 512 nm was measured.

3 Results and analysis

3.1 Influence of different processing methods on appearance and moisture content The moisture content of dried *P. odoratum* with different processing methods ranged from 8.04% to 12.87%. The *Chinese Pharmacopoeia* (2020 edition) stipulates that the appearance of *P. odoratum* decoction pieces is "yellow white to light yellow brown in color, semi transparent, sometimes with visible segments. The section may have a keratin like or granular appearance." They were processed in below manners: cut freshly; after naturally drying for 2 – 5 d, they were cut when moisture content was between 46.63% and 68.86%; after dried at 50 ℃ for 1/6 – 1/3 d, they were cut when moisture content was between 45.23% and 59.67%. After drying, their appearance differed from traditional processing. The appearance of the cut product after fresh processing was more in line with the description in *Chinese Pharmacopoeia*. With the increase of time, water loss was the

fastest in drying treatment before cutting, followed by the shade drying treatment, and finally the natural drying treatment (Fig. 1).

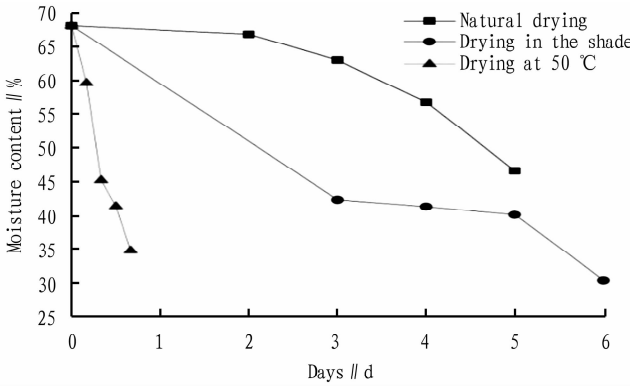

Fig. 1 Relationship between time before *Polygonatum odoratum* fresh processing and cutting and moisture content

3.2 Extract content The extract content of *P. odoratum* decoction pieces by different processing manners was higher than 50%, which met the pharmacopoeia standard (Fig. 2A). When dried at 50 ℃ for 1/6 d to a moisture content of 59.67%, the content of ethanol-soluble extract was 78.20% ±0.57%, which was the highest. From the results, it can be seen that the content of ethanol-soluble extract with a moisture content of 34.79% – 59.67% after drying at 50 ℃ for 1/6 – 2/3 d was slightly higher than that of traditional processing, and the difference was statistically significant ($P<0.05$).

3.3 Content of total polysaccharide The total polysaccharide results of each batch of processed *P. odoratum* were shown in Fig. 2B. Polysaccharide from *P. odoratum* is one of the effective components, and the content of polysaccharide is an important technical support for evaluating the quality of *P. odoratum*[14-16]. From the results, it can be seen that except for the group (dried at 50 ℃ for 1/3 d), the total polysaccharide content of the decoction pieces obtained from the fresh processing group was higher than that of the traditional processing group. Among them, the total polysaccharide contents of the fresh cut group, drying treatment at 50 ℃ for 1/6 d to 45.23% of moisture content, and drying treatment at 50 ℃ for 1/2 d to 41.44% – 59.67% of water content had statistically significant differences compared to the traditional treatment ($P<0.05$). This may be due to the loss of total polysaccharide content caused by the traditional processing group during the infiltration process.

3.4 Content of total flavonoid Fig. 2C showed the results of total flavonoid in *P. odoratum* processed in each batch. The total flavonoid of *P. odoratum* had strong antioxidant capacity, and the effects of anti-aging and enhancing body immunity[17]. The traditional processing group of drying in the shade had the highest content of total flavonoid. The total flavonoid content of the slices obtained from the fresh processing group decreased compared to the traditional processing group. Total flavonoid content by freshly cut and dried at 50 ℃ for 1/6 – 1/2 d to a moisture content of 41.44% – 59.67% had statistically significant difference when compared to the traditional processing group ($P<0.05$). The possible reason for this was that total flavonoid was released to a certain extent during the process of kneading sugar.

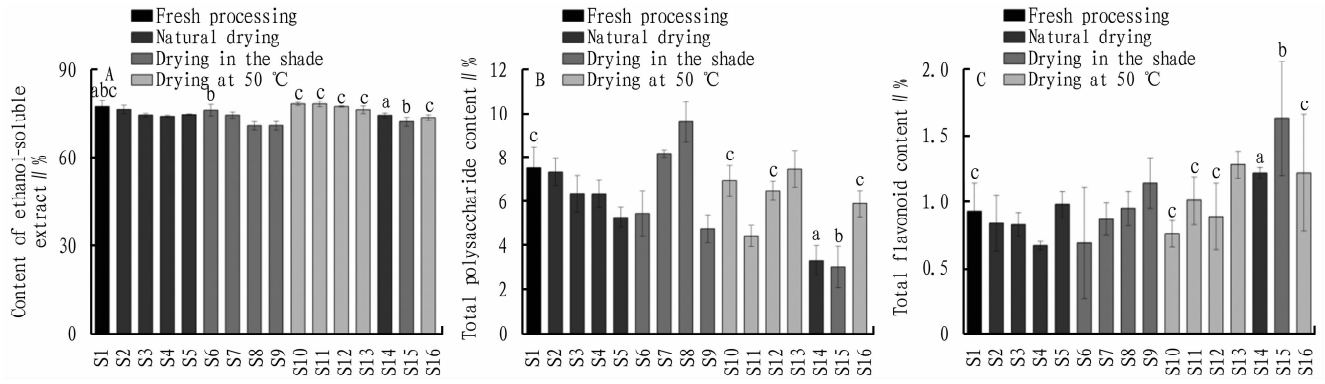

Fig. 2 Contents of ethanol-soluble extract (A), total polysaccharides (B), and total flavonoids (C) of *Polygonatum odoratum* processed in different manners (%, $\bar{x}\pm s$, $n=3$)

4 Discussion

This paper investigated the effects of fresh processing and traditional processing on the quality of *P. odoratum* decoction pieces. By comparing the appearance characteristics of *P. odoratum* and measuring the moisture content, total ash content, extract content, total polysaccharide content, and total flavonoid content of *P. odoratum* decoction pieces under different processing methods, it was found that the total polysaccharide content of the decoction pieces obtained from the fresh processing group was higher than that of traditional processing. After drying and processing at 50 ℃ for 1/6 – 1/2 d with a moisture content of 41.44% – 59.67%, the difference in total flavonoid content was statistically significant when compared with traditional processing group. Therefore, fresh processing of *P. odoratum* had certain feasibility.

In summary, the decoction pieces obtained by natural drying and processing for 2 – 5 d with a moisture content of 46.63% – 68.86%, and drying and processing at 50 ℃ for 1/6 – 1/3 d with a moisture content of 45.23% – 59.67% were more in line with the description in the *Chinese Pharmacopoeia* compared to the corresponding traditional processed decoction pieces. In terms of the process of preparing decoction pieces, processing at the place of

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origin reduces the drying time, sugar kneading process, and soaking time at the place of origin. In terms of chemical composition, the total polysaccharide content of the fresh processing group was higher than that of the traditional processing group, but the total flavonoid content was lower in the fresh processing group. After dried and processed at 50 ℃ for 1/6 - 1/2 d with a water content of 41.44% - 59.67%, the total flavonoid content had significant difference with the traditional processing group. Based on the analysis of the above results, it can be concluded that the fresh processing of *P. odoratum* was feasible, with a simple and reliable process. The research could provide a certain theoretical basis for the fresh production of *P. odoratum* decoction pieces.

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