Study on Quality Influence of Hot Air Drying and Heat pump drying of Xiaocaoba Gastrodia elata

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Abstract. This paper takes fresh gastrodia elata of Xiaocaoba as the research object. After the samples are steamed, two processing methods which are hot air drying and heat pump drying are used respectively. The drying temperature is set at 50 degrees for both methods. The results show that different weight gastrodia elata is suitable for different drying methods. The gastrodia elata of 70-105 grams is suitable dried by the hot air drying, while the gastrodia elata of 105-140 grams is better dried by the hot pump drying. The two drying methods had no effect on polysaccharides of samples.

1. Introduction
Gastronomic elate is a saprophytic herb, and its rhizome can cure dizziness, headache, migraine, infantile convulsion and so on[1]. It has been used in medicine for more than 1000 years in China. Due to its special natural geography, climate and non-reproducability of soil, Zhaotong in Yunnan province has cultivated the high quality gastronomic elate[2].

In recent years, with the increasing demand for gastrodia elata in the market, the large-scale artificial wild imitation planting area of small caoba has been increasing year by year. By 2017, the planting area of Gastrodia elata in Zhaotong has reached 5367 hectares in 2017, with a total output value of 3.97 billion yuan[3]. However, fresh gastrodia elata is difficult to be stored for a long time, and it is easy to empty the stem or rot. Therefore direct thermal radiation drying of coal burning is a widely used method locally[4]. But there are many problems using hot air drying of coal furnace locally: uneven heating, too low temperature, appearance affected, low quality, large amount of labor, large space occupied and sulfur residue exceeding the standard.

Therefore, two processing methods including hot air drying and heat pump drying are used to research on the quality of gastrodia elata. The comparative analysis of the two methods is of practical significance for the study of the drying technology of gastrodia elata.
2. Materials and methods

2.1. Raw materials
On January 12, 2019, the research team collected *Gastrodia elata* in a farmer's field in Xiaocaoba, Yiliang County, Yunnan Province. When collecting samples, we first dug the topsoil with tools, and then collected the *Gastrodia elata* by hand when approaching the *Gastrodia elata* (see Figure 1). The sample was divided into two parts, one for hot air drying and the other for heat pump drying.

![Samples collection](image1)

Figure 1. Samples collection

2.2. Main equipment
Laboratory equipment in Yunnan agricultural university: electric thermostatic air blower dryer (model 101) as shown in Figure 2, Condensing heat pump dryer is seen in Figure 3, Auy220 electronic balance, induction cooker, steamer, knife, etc.

Detection equipment and reagents: LC-20A liquid chromatograph, SPD-20A ultraviolet-visible detector, JA2003 electronic balance, Auy220 electronic balance, High-speed multifunctional grinder (JHF-150), grind, p-hydroxybenzyl alcohol, heavy distilled water, gastrodin standard, ethyl acetate, ethanol, acetonitrile, gastrodin which number is 0807-200104, chromatographic grade methanol, ultra-pure water, etc.

![Electric thermostatic hot air blower dryer](image2)

![Condensing heat pump dryer](image3)

Figure 2. Electric thermostatic hot air blower dryer

Figure 3. Condensing heat pump dryer

2.3. Hot air drying
Hot air drying takes hot air as drying medium, exchanges moisture and heat with dried products by convection circulation. When water on the surface of the material diffuse, the surface become drying. Due to the material surface evaporation, moisture difference in internal and external is produced, and the internal moisture begin to move to the surface and liquid outward expansion, so as to achieve drying purpose.
2.4. *Hot pump drying*

Pump drying principle is based on the principle of carnot cycle. It use a small amount of electric energy, by the compressor, and transform working medium through expansion valve to gas inside the evaporator, and absorbs a lot of heat from the air, then gaseous medium is compressed into high temperature and high pressure gas by compressor. Finally, the gas goes into the condenser for releasing heat, so keep heating in cycles like this.

2.5. *The evaluation index*

The evaluation indexes in this paper include appearance of *Gastrodia elata*,

1) Appearance of *Gastrodia elata* The appearance indicators of *gastrodia elata* include texture curl degree and color. The texture is divided into hard and loose. After drying, the curl degree is recorded to analyze the reasons for the difference in curl degree and analyze the influence of the change on the experimental results. The colors are yellow, dark yellow and milky white, etc.

2) *Gastrodine* As one of the main effective ingredients of *gastrodia elata*, gastrodine is known for its sedative and tranquilizing effects. Currently, the content determination of *gastrodia elata* in Chinese pharmacopoeia (2015 edition) requires the high performance liquid phase chromatography method to determine and take it as the main index for quality control and evaluation of *gastrodia elata* [5].

3) *Polysaccharide* *Polysaccharide* compounds of *gastrodia elata* are important components of the effective components of *gastrodia elata*. In this paper, anthrone-sulfuric acid method was used for the determination of polysaccharide [6]. According to the data results, the polysaccharide content of *gastrodia elata* was calculated as follows:

$$w = \frac{C \times D \times f}{m}$$

*C* is the concentration of glucose in polysaccharide solution (mg/ml), *D* is the dilution ratio of polysaccharide, *m* is the raw polysaccharide quality of *gastrodia elata* (g), *f* is the conversion factor, and *w* is the polysaccharide content of *gastrodia elata* (%).

2.6. *The technological process*

The laboratory drying process includes:

1) Classification: the sample *gastrodia elata* is classified into three levels. The *gastrodia elata* of 140-175 grams is level I. The corresponding samples are labeled beginning with A; the *gastrodia elata* of 105-140g is level 2, and the corresponding sample are labeled beginning with B; the *gastrodia elata* of 70-105g is level 3, and the corresponding sample shall be labeled beginning with C.

2) Steaming: it is adopted to steam the *gastrodia elata* in the boiled process,. The estimated time of steaming *gastrodia elata* is set as follows: 15-20 minutes for first-level *gastrodia elata*, 10-15 minutes for second-level *gastrodia elata* and 8-10 minutes for third-level *gastrodia elata*.

3) Judging the success of boiled: two methods, needle insertion and light transmission, are both used for it.

   Needle insertion: the needle is directly insert into the *gastrodia elata* and judge by the color of the liquid. If it is transparent, the steaming is successful. D3 sample needs to continue steaming because the liquid is milk white (seeing Figure 4).

   Light transmission: the steamed *gastrodia elata* is put in the place with light and judge whether the light is completely transparent or not. If the light is completely transparent, the steaming is successful. The above sample needs to be further steamed for its light impermeability, while the below sample is successfully steamed (seeing Figure 5).
(4) Drying process: drying in 50 degree of hot air drying and heat pump drying, the data of weight record by every 4 hours.

3. Results and discussion

3.1. The Appearance
By recording the data, the weight of sample A6 dried by hot air changed very slowly and gradually stabilized after 65 hours, while the weight of sample A1 dried by the heat pump become stably after 90 hours. A6 is the dried sample of hot air drying, and A1 is the dried sample of heat pump drying (seeing Figure 6). As can be seen from the Figure 6, gastrodia elata has a wrinkled appearance. These samples are long elliptic, solid, without hollow, with transverse ring grain, and the top with residual stem base. But the color of the samples of hot air drying is obviously darker than that of the samples of heat pump drying.

3.2. Gastrodin
According to the Chinese Pharmacopoeia (2015 edition) for the determination of gastrodia elata, phase high Performance liquid chromatography (RP-HPLC) was used to determine the content of gastrodin. An appropriate amount of gastrodin control substance was added to acetonitrile solution with a concentration of 3%, and then different concentrations were injected into the HPLC to obtain the standard curve square Area=17777.57082*Amt +8.0580846, R=0.99999. The conclusion is shown in the Table 1. Air number means sample number by hot air drying and pump number means heat pump drying and sample number in local drying method.

| Air number | Gastrodin content(ug) | Pump number | Gastrodin content(ug) |
|------------|-----------------------|-------------|-----------------------|
| A5         | 0.27                  | A1          | 0.48                  |
| A6         | 0.27                  | A2          | 0.49                  |
| B5         | 0.33                  | B1          | 0.64                  |
| B6         | 0.31                  | B2          | 0.54                  |
| C5         | 0.38                  | C1          | 0.24                  |
| C6         | 0.36                  | C2          | 0.25                  |
The data (see Table 1) show that the gastrodin content of samples are all higher than 0.20% (according to the Chinese pharmacopoeia, gastrodin content in gastrodia elata should not be less than 0.20%). The experimental results showed that among the same grade gastrodia elata, the gastrodin content in samples of dried by hot pump drying is significantly higher than that of the samples of dried by hot air drying in level 1 and level 2. While the gastrodin content in samples of dried by hot pump drying is significantly lower than that of the samples of dried by hot air drying in level 3. According to the data of hot air drying, the sample with the highest content of gastrodia elata is level 3, not level 1. Therefore, the gastrodia elata of 70-105 grams is better dried by the hot air drying of 50 degrees. According to the data of hot pump drying, the sample with the highest content of gastrodia elata is level 2, not level 1. Therefore, the gastrodia elata of 105-140 grams is suitable dried by the hot pump drying of 50 degrees.

3.3. Polysaccharide
The polysaccharide is detected by anthranone - sulfuric acid method. The standard polysaccharide curve is first determined: \( Y = 30.65X + 0.6617 \). Then the polysaccharides were extracted for determination and the results is shown in Table 2.

| Air number | Pump number | Absorbance | Polysaccharide content (%) | Absorbance | Polysaccharide content (%) |
|------------|-------------|------------|----------------------------|------------|----------------------------|
| A5         | A1          | 2.420      | 16.39                      | 2.436      | 16.54                      |
| A6         | A2          | 2.418      | 16.37                      | 2.436      | 16.54                      |
| B5         | B1          | 2.436      | 16.54                      | 2.420      | 16.39                      |
| B6         | B2          | 2.431      | 16.49                      | 2.465      | 16.81                      |
| C5         | C1          | 2.401      | 16.21                      | 2.428      | 16.46                      |
| C6         | C2          | 2.415      | 16.34                      | 2.423      | 16.41                      |

As can be seen from the table, under constant temperature drying at 50°C, there is no obvious correlation between the polysaccharide content of the samples dried by hot air drying and heat pump drying, and the polysaccharide content had no relation with gastrodia elata levels.

4. Conclusions
In this paper, constant temperature hot pump drying in 50 degree is compared to hot air drying in the same temperature. The main conclusions are as follows:

1) The appearance of the samples differs little, but the color of the samples of hot air drying is obviously darker than that of the samples of heat pump drying.

2) The drying methods have great influence on the quality of gastrodia elata. Different weight gastrodia elata is suitable for different drying methods. The gastrodia elata of 70-105 grams is suitable dried by the hot air drying of 50 degrees, while the gastrodia elata of 105-140 grams is better dried by the hot pump drying of 50 degrees.

3) No evidence shows there is obvious correlation between the polysaccharide content of the samples dried by hot air drying and heat pump drying, and also the relation with gastrodia elata levels.

Acknowledgements
This work was supported by the Opening Fund of Key Lab of Process Analysis and Control of Sichuan Universities of China (2017001)

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