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Study of the best decocting time of sun dried ginseng by using the hyperspectral imaging technology

Qing He*,†, Lan Liang†, Zhenqiang Chen*,§, Qichang Pang* and Jing Zhao‡
*Key Laboratory of Optoelectronic Information and Sensing Technologies of Guangdong Higher Educational Institutes, Jinan University
Guangzhou 510630, P. R. China
†Department of Biomedical Engineering
Guangdong Medical College Dongguan 523808, P. R. China
‡College of Science, South China Agricultural University
Guangzhou 510640, P. R. China
§tzqchen@jnu.edu.cn

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In this research, a new method based on the hyperspectral imaging for searching the best decocting time of sun dried ginseng is reported. The spectral images at different decocting time of test sample have been taken by the staring hyperspectral fluorescence imaging system and the solubility of active ingredients have been discussed by analyzing the changes on the spectral curves. The spectral range of the system is 400–720 nm and the spectral resolution is 5 nm. In the decocting process, the active ingredients of nonsoaked ginseng was dissolved in the tissue fluid at first, and reached equilibrium condition at last after the precipitation–dissolution reciprocating process of boiling. At last, the experimental results show that the best decoction time of sun dried ginseng is about 60 min after boiling.

Keywords: Sun dried ginseng; active ingredients; decocting time; hyperspectral imaging; characteristic spectrum; characteristic peaks.

1. Introduction

Sun dried ginseng is the dry root of Panax ginseng C. A. Meyer, which contains ginsenoside, volatile oil, carbohydrate, multiple amino acids and vitamin i.e., Sun dried ginseng spring can reinforce vital energy, invigorate spleen, benefit lung, generate saliva, slake thirst, soothe nerves and promote mentality, and has curative effect for the treatment of hypertension, diabetes, anemia, etc. All the features mentioned above make it famous.[1] Choosing

§Corresponding author.

the most appropriate way to consume the sun dried ginseng is important for exerting its efficacy. Decoction, steaming and making tea are common ways of taking sun dried ginseng. For traditional Chinese medicine decoction, the time needed for different drugs is generally different. There had been accounts about traditional Chinese medicine decoction methods in our country since the ancient times, and the methods were summarized and improved unceasingly. They provide a lot of proposals for people.[2,3] In recent years, some research about the scientific methods applied in the quantitative detection of the dissolution change of the active ingredients of herbs during the decoction process have been reported, which made decoction rise from the guidance of traditional experience up to theoretical level.[4–8] Meanwhile, it provided the reference for standardization of the decoction process of traditional Chinese medicine.

The dissolution of the active ingredients of sun dried ginseng during the decoction process was analyzed using hyperspectral imaging technology in this paper. Hyperspectral imaging is a new remote sensing technology which combines image detecting and spectral analysis, so it can provide spatial distribution information and chemical information simultaneously.[9] The advantages of convenience, speed and its nondestructive nature make it widely used in biomedical, food quality evaluation and other areas.[10,11] In this experiment, the images of sample under different wavelengths were obtained by imaging system. The image data was processed and the characteristic fluorescence spectrum was established. The change of the fluorescence intensity of curves can reflect the rule that the active ingredients of sun dried ginseng changed with decoction time. In addition, it can reflect the change in concentration of the active ingredients in fluid indirectly. At last, based on the above, an optimum decocting method for sun dried ginseng was obtained.

2. Research Methodology

2.1. *Instrument and materials*

Fluorescence spectral image system used in the research was designed by key laboratory of optoelectronic information and sensing technologies of Guangdong Higher Educational Institutes,[12] System structure as shown in Fig. 1, which mainly include: UV light sources with the center wavelength of

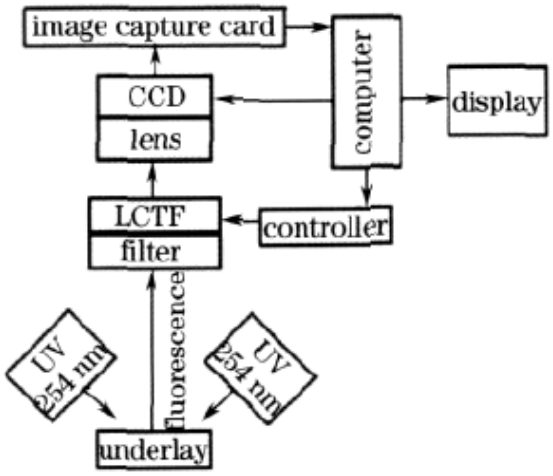

Fig. 1. Spectral imaging system diagram.

254 nm, the VariSpec Fluid Crystal Tunable Filter (LCTF), lens, CCD, image acquisition card and computer. Another instrument is the Automatic Decoction Machine with working voltage 220 V and power 450 W.

Samples were the root of ginseng bought from Beijing Tongrentang, and we chose a slice of sun dried ginseng as testing sample.

2.2. *Collection of fluorescence spectral image*

The parameters were described as follows for the test: working with single channel and continuous spectrum scanning mode; scanning wavelength range of LCTF was set to 400–720 nm and the scanning step was set to 5 nm; the exposure time of CCD receiver is 1000 ms. Testing sample was placed on the substrate and emitted fluorescence under the excitation of UV light sources. The fluorescence was divided into several narrow spectral bands in the time dimension after getting through LCTF. Then the spectral bands were imaged to CCD target surface one by one. Finally, the images were stored in the computer by image acquisition card. Image acquisition and spectral scanning synchronized, so it can obtain a set of hyperspectral image blocks consisting of 65 images for each test.

The images were pretreated to eliminate noise and background, which made the information reflected by image data more actual and credible. After filtering by using band-pass filter, the average gray value of all pixels of testing sample was calculated under each scanning wavelength then the

fluorescence spectrum curve was drawn. The whole process was based on MATLAB mathematical software platform.

2.3. *Methodology study*

2.3.1. *Precision test*

Took spectral images from a slice of sun dried ginseng under the parameters of setting that was mentioned above, and repeated this experiment for 5 times. Comparing the 5 fluorescence spectrum curves gained, the similarity of peak shape was more than 0.99 and relative instability of fluorescence intensity was less than or equal to 1.53%, which showed that the spectral imaging system had good precision.

2.3.2. *Stability test*

Test the same sample which was used in precision test every 24 h and 5 times continuously under the parameters of setting. The similarity of peak shape of fluorescence spectrum curves was more than 0.99 and the positions of characteristic peak were unchanged. Relative instability of fluorescence intensity was less than or equal to 1.53%. The imaging system had a good stability.

2.3.3. *Repeatability test*

Test five different pieces of sun drying ginseng then get the fluorescence spectrum curves of five samples. The similarity of peak shape was more than 0.99 and the positions of characteristic peak were unchanged. Relative instability of fluorescence intensity was less than or equal to 3.08%. The studied result of experiment showed that the spectral imaging method had a favorable repetition.

3. Results and Discussion

3.1. *Investigation during decoction process*

During decoction process, the spectral images of sample were acquired at different times, as shown in Table 1. A total of nine image blocks were obtained and their fluorescence spectrum curves were shown in Fig. 2. Comparing Nos. 1 and 2, it formed a thin water film on the surface of testing sample after soaking for 15 s, which resulted in the decrease in fluorescence intensity. Therefore, the surface water of testing sample was drawn with blotting paper before image collection. When decocted fluid started boiling, the fluorescence intensity of the characteristic spectrum curve of the sample was lowest, because during the decoction process, the active ingredients on the surface of sun dried ginseng would be dissolved into the solution firstly, while the inner active ingredients do not precipitate to the surface. Besides, there were subtle changes on the shape, although the characteristic spectrum curves before and after decoction were both double-peak structures. The peak intensity of the former at 530 nm was slightly higher than that of that at 555 nm; the latter was the opposite. The results indicated that not only the active ingredients of sun dried ginseng dissolved out in the decoction process, but also a chemical change had taken place between them.

Table 1. The sampling time at different stages.

Number	Sampling time	Number	Sampling time
1	drying test sample	6	boiling 45 min
2	soaking 15 s test sample	7	boiling 60 min
3	boiling 0 min	8	boiling 75 min
4	boiling 15 min	9	boiling 90 min
5	boiling 30 min		

Search results showed that when the decocted fluid boiled for 15 min, the fluorescence intensity of the sample was higher than that of boiled 0 min,

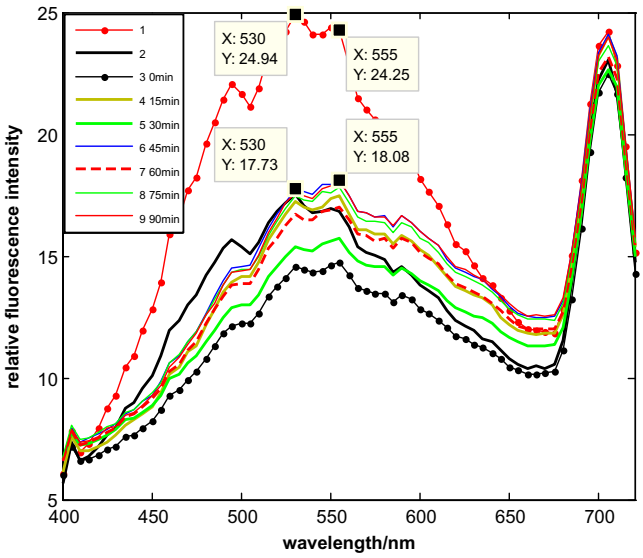

Fig. 2. Comparing of fluorescence spectrum curves at different decocting time.

which indicated that the active ingredients of sun dried ginseng precipitated to the surface. The fluorescence intensity decreased at 30 min as the active ingredients on the surface of medicinal materials gradually spread into the external fluid. At 45 min, the fluorescence intensity of the sample achieved the maximum value during the decoction process because the inner active ingredients continued to precipitate to the surface after the active ingredients on the surface diffusion. Then the active ingredients spread to the decocted fluid, the fluorescence intensity decreased again at 60 min. The situation of active ingredients of test sample alternated between precipitation and dissolution within the boiling time of 0–60 min. By comparing the peak intensity interval of different curves, the precipitation and diffusion rate of test sample was faster between 0 min and 30 min than that between 30 min and 60 min.

The decocted fluid continued boiling after 60 min, and the fluorescence intensity measured maximum at 75 min. But it had not changed when the sample was tested at 90 min. The results indicated that the active ingredients on the surface of medicinal materials were no longer spread to the decocted fluid. Because the concentration of a solution of medicinal herbs both inside and outside achieved equal, osmotic pressure was in a state of balance.

3.2. *Drying contrast after decoction*

After the decoction process, the sample was put into constant temperature and humidity equipment to dry at a low temperature. By comparing it with the dry sample before decoction, we further explored the dissolution of active ingredients. The fluorescence intensity of the spectral curve of the sample after decoction was much lower than that of the dry sample before decoction (see Fig. 3), which demonstrated that the active ingredients of medicinal herbs dissolved in the fluid during decoction process. This was the meaning of decoction and decoction of herbal medicine can be used to cure diseases. Dried sample was ground into powder, and the fluorescence intensity increased because the volume density of the powder was relative higher. Therefore, there was an edible method for sun dried ginseng called flour taking. As the active ingredients had partly dissolved in decoction, the fluorescence intensity was still lower than that before decoction.

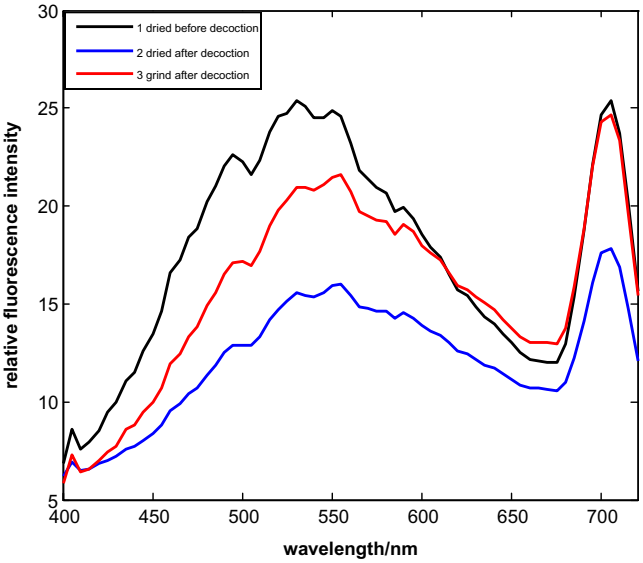

Fig. 3. The characteristic spectra of the sample before and after decoction. The black curve is the spectrum of the original sample, the blue curve is the spectrum of the sample after decocting and drying, and the red curve is the spectrum of the sample powder after decocting, drying and grinding.

4. Conclusion

According to the above analysis, the dissolution regularity of active ingredients of sun dried ginseng was obtained during the decoction process. Sun dried ginseng was not soaked before decoction and the active ingredient was not precipitated to the surface when decocted fluid started boiling. Within 60 min, a mass of active ingredient precipitated and dissolved, and the precipitation and dissolution alternately happened, which was different from the dissolution regularity during decoction of traditional Chinese medicine cortex phellodendri.[13] After boiling for 75 min, the osmotic pressure of medicinal herbs both inside and outside was in balance and active ingredients did not dissolve any longer. If we continued to boil out that would waste resources. Hence the optimal decoction time is about 60 min after boiling for sun dried ginseng without soaking. Comparison of dry sample before and after decoction indicated that portion of active ingredients did dissolve in the decocted fluid, so the decocted fluid had a certain curative effect. Moreover, the experimental result after grinding the sample demonstrated that all the active ingredients of sun dried ginseng cannot separate out by decocting at the same time.

In addition, the hyperspectral imaging test method used in the paper had characteristics of convenient and non-destructive on measurement of

Chinese medicinal materials.[14,15] It can be used in studying the dissolution regularity of active ingredients of other medicinal herbs in decoction process, and building a more scientific decoction method, which can make Chinese native medicine decoction provide better service for people's health.

References

1. M. X. Gao, *Science of Chinese Pharmacology*, China Press of Traditional Chinese Medicine, Beijing (2007).
2. Q. Y. Chen, "The method application and discussion of traditional Chinese medicine decoction," *China Foreign Med. Treatment* **20**, 146–147 (2010).
3. P. Liu *et al.*, "Analysis of factors affecting the quality of traditional Chinese medicine decoction," *J. Hubei College Traditional Chin. Med.* **12**(5), 44–46 (2010).
4. D. X. Zhang *et al.*, "Analysis of the content of paeonol and paeoniflorin in cortex moutan soup at different decoction time," *Traditional Chin. Med.* **22**(6), 18–20 (2009).
5. W. H. Zhang *et al.*, "Effect of different decocting time on Fuzi alkaloid and FP study," *J. Shaanxi College Traditional Chin. Med.* **33**(4), 100–101 (2010).
6. Y. Wang *et al.*, "The condensation reaction research of Aristolochic acidlin the decoction process," *Chin. Traditional Herbal Drugs* **8**, 1288–1292 (2010).
7. F. F. Wang *et al.*, "Effect of *Aconiti Radix Preparata* combined with *Glycyrrhizae Radix* in different ratios on monoester alkaloids," *Chin. Traditional Herbal Drugs* **43**(6), 1101–1104 (2012).
8. H. Q. Liu, "Detection of the content of patchouli oil in Herb cablin patchouli at different time by the GC method," *Clin. J. Chin. Med.* **5**(1), 26–29 (2013).
9. R. Zhang *et al.*, "Detection of illegally added drugs in dietary supplements by near-infrared spectral imaging," *J. Innov. Opt. Health Sci.* **7**(6), 1450032-1–1450032-7 (2014).
10. D. Wnag *et al.*, "The application of near-infrared spectral micro-image in the imaging analysis of biology samples," *J. Innov. Opt. Health Sci.* **7**(4), 1350062-1–1350062-1-10 (2014).
11. X. Xiao *et al.*, "Application of near-infrared spectroscopy for the rapid analysis of Lonicerae Japonicae Flos solution extracted by water," *J. Innov. Opt. Health Sci.* **7**(4), 1350063-1–1350063-9 (2014).
12. J. Zhao *et al.*, "Design of continuous spectrum imaging apparatus based on LCTFs," *Acta Photonica Sin.* **37**(4), 758–761 (2008).
13. L. Liang *et al.*, "Study of cortex phellodendri chinensis decoction experiment based on the spectral imaging technology," *Spectroscopy Spectral Anal.* **32**(5), 1359–1361 (2012).
14. X. Q. Meng *et al.*, "Transmission of spectral imaging research on folium uncariae from Guangdong," *J. Chin. Med. Mater.* **33**(5), 696–698 (2010).
15. J. Zhao *et al.*, "Rapid identification of cortex dictamni pieces and its counterfeit alangium Chinense by spectral imaging method," *China J. Chin. Mater. Med.* **35**(13), 1696–1698 (2010).