Identification of flowers of Musa nana Lour., flowers of Musa basjoo Sieb. et Zucc and flowers of Musa balbisiana Colla by HPLC fingerprinting

Lingling Zhang¹, Yuqing Liang¹, Peng Zhang¹, Liubo Yang¹, Xiaofen Li¹, Xiangpei Wang¹, Hongmei Wu¹ *
¹Department of Pharmacognosy, Guiyang University of Chinese Medicine, 50, Nanning District, Guiyang City, Guizhou Province, Guiyang 550002, PR China
*Corresponding author’s e-mail: whm0425@126.com

Abstract. Objective: HPLC fingerprint identification method of flowers of Musa nana Lour., flowers of Musa basjoo Sieb. et Zucc and flowers of Musa balbisiana Colla were established, and the chromatogram similarities difference of three kinds of flowers were compared, in order to provide reference for variety identification, resource development and utilization of flowers of Musaceae medicinal materials. Methods: The separation was performed on a Diamonsil C18 column (4.6mm×250mm, 5μm) at 30°C. A binary gradient elution system was composed of acetonitrile and water containing 0.05% phosphoric acid and the flow rate was 0.8mL/min. The detection wavelength was 280nm. The HPLC fingerprint of 17 batches of flowers of Musaceae medicinal materials were determined and the similarities were evaluated. Results: The experimental results showed that the samples from flowers of same varieties showed high similarities, and had more common peaks. Flowers of Musa nana Lour., are compared with flowers of Musa basjoo Sieb. et Zuccr and flowers of Musa balbisiana Colla, whose similarities were less than 0.430 with few common peaks. However, the comparison between flowers of Musa basjoo Sieb. et Zuccr and flowers of Musa balbisiana Colla showed high similarities with more common peaks. The similarities of 17 batches of flowers of Musaceae medicinal materials were between 0.187 and 0.984 with few common peaks, indicating the significant difference of three kinds of flowers. Conclusion: The proposed method is simple, highly reproducible and suitable for the identification of flowers of Musaceae medicinal materials.

1. Introduction
Flowers of Musa nana Lour., flowers of Musa basjoo Sieb. et Zucc and flowers of Musa balbisiana Colla are the dried flower buds or flowers of Musa nana Lour., Musa basjoo sieb. et Zucc and Musa balbisiana Colla, respectively. Flowers of Musa nana Lour. are the wastes of banana after they are ripe and picked. It is eaten as a daily vegetable in Southeast Asia and Southwest China. It is rich in potassium and a variety of unsaturated fatty acids which can prevent hypertension and cardiovascular diseases[1-4]. Recently, studies have indicated that flowers of Musa nana Lour. extracts exhibited hypoglycemic, antioxidation and free radical scavenging activity [5-9]. The flowers of Musa basjoo Sieb. et Zucc are valuable herbs to eliminate sputum soft hard mass, calm the liver and promote blood circulation to remove stasis and possess various pharmacological actions, such as inhibitory activities against α-glucosidase, bacteriostasis in vitro and antioxidant activity[10-11]. Petroleum ether, ethyl acetate parts of flowers of Musa basjoo Sieb. et Zucc had inhibitory effect on the hepatoma BEL-7402
cells[12].

Owing to these benefits, many people use flowers of *Musa nana* Lour., flowers of *Musa basjoo* Sieb. et Zucc immersed in water to treat or prevent diabetes and cardiovascular disease. However, flowers of *Musa nana* Lour., flowers of *Musa basjoo* Sieb. et Zucc and flowers of *Musa balbisiana* Colla are easy confused edible in China. In addition, the circulation and use of the three kinds of flowers are confused also. At present, only simple properties and characteristics were used to identify three kinds of flowers. However, it is difficult to distinguish them because they are plants of the same family and genus, and are closely related to each other, and their medicinal materials are similar in character and microscopic characteristics. In addition, it is not reported whether the three kinds of flowers have the same effect and can replace each other. In order to control the quality of flowers of *Musaceae* medicinal materials comprehensively. HPLC fingerprint of flowers of *Musa nana* Lour., flowers of *Musa basjoo* Sieb. et Zucc and flowers of *Musa balbisiana* Colla were established in this study, and the results to comprehensively reflect the types and quantities of chemical components contained in the three flowers. It provides reference for the identification, accurate use and development and utilization of flowers of *Musaceae* medicinal materials.

2. Experimental

2.1 Sample Collection and Preparation

Flowers of *Musa nana* Lour., flowers of *Musa basjoo* Sieb. et Zucc and flowers of *Musa balbisiana* Colla has been identified as dried flower buds or flowers of *Musa nana* Lour., *Musa basjoo* Sieb. et Zucc, *Musa balbisiana* Colla by Professor Xiangpei Wang of Guiyang University of Chinese Medicine, respectively. The specific sources are shown in table 1. Plants were air-dried, crushed into fine powder, accurately weighed 1g, placed into round bottom flask, respectively. Reflux extraction samples twice times with 50mL Methanol, each time is 1.5h, combined with filtrate and water bath wipe dry. The residue is dissolved with methanol and its volume is 10mL. The residue is filtered by microporous membrane (0.22 micron) and the filtrate is obtained.

2.2 Chemicals and Reagents

HPLC-grade methanol and acetonitrile were obtained from Tianjin Kemiou Chemical Reagent Co., Ltd; the rest are analytical pure and the water is purchased from Hangzhou Wahaha Group Co., Ltd.

2.3 Instrumentation and Apparatus

HPLC(Waters e-2695) with PDA detector; HS-10260T ultrasonic cleaner (Tianjin Heng'ao Science and Technology Development Co., Ltd.); HH-6 Digital Display Constant Temperature Water Bath pot (Changzhou Aohua Instruments Co., Ltd.); AL204-IC/10000 analytical balance (Metler Instruments Co., Ltd.); Chinese Herbal Chromatographic Similarity Evaluation System(2004 A edition).

2.4 Chromatographic Conditions

The column was Diamonsil C18 (4.6mm×250mm, 5μm). A binary gradient elution system consisting of acetonitrile(B) and water containing 0.05% phosphoric acid(A) was used with the following gradient programs: 0-15min, 2%-10%B; 15-35min, 10%-20%B; 35-50min, 20%-30%B; 50-65min, 30%-55%B; 65-80min, 55%-72%B; 80-85min, 72%-80%B; 85-110min, 80%-100%B; 110-120min, 100%-2%B, detection wavelength was set at 280nm, and the flow rate was 0.8mL/min. The injection volume was 20μL and the column temperature was maintained at 30℃.

2.5 HPLC method validation

2.5.1 Precision test. Samples of the same sample solution (Yunnan Jinghong 2) were injected six times in accordance with the chromatographic conditions under "2.4". The RSD of relative retention time
and relative peak area of each common peak were 0.01%-0.11% and 0.47%-2.26%, respectively; indicating that the instrument had good precision.

2.5.2 Stability test. The same sample solution (Yunnan Jinghong 2) was determined at 0, 2, 4, 8, 24 and 48h, respectively. The RSD of the relative retention time and relative peak area of the common peaks were 0.01%-0.114% and 0.10%-2.87%, respectively; it shows that the sample solution was stable within 48h.

2.5.3 Repeatability test. Six samples of Jinghong No. 2 in Yunnan Province were taken and the sample solution was prepared under "2.1" and determined under "2.4" chromatographic conditions. The RSD of relative retention time and relative peak area of each common peak ranged from 0.01% to 0.28% and from 0.23% to 2.02%, respectively; which showed that the method had good repeatability.

3. Data analysis

3.1 Establishment of HPLC fingerprint
A total of 17 batches of flowers of Musa nana Lour., flowers of Musa basjoo Sieb. et Zucc and flowers of Musa balbisiana Colla were taken and accurately weighed. The sample solution was prepared under "2.1" and analyzed under "2.4" chromatographic conditions. Samples were used to detect and analyze by HPLC-PDA chromatogram. The peak value, peak number and peak position of HPLC-PDA chromatogram were compared and analyzed the fingerprint of flowers of Musaceae medicinal materials. The relative retention time and area of the common peak of flowers of Musaceae medicinal materials were calculated. The results are shown in figure 1.

3.2 Establishment of Common Fingerprint Peaks
The 11 peaks with retention time of about 26.479 min were used as reference peaks S, and 22 common peaks were established. The relative retention time and relative peak area of each peak were calculated, as shown in table2-table3.

3.3 Similarity Evaluation of Fingerprint
The chromatographic data of 17 batches of flowers of Musa nana Lour., flowers of Musa basjoo Sieb. et Zucc and flowers of Musa balbisiana Colla were imported into the "Chinese medicine chromatographic fingerprint similarity evaluation system 2004A edition" for matching. The time window was 0.20. The consistency of chromatographic peak similarity was examined by median method. The results are shown in table 1.

| No. | species                        | producing area            | Similarity |
|-----|--------------------------------|---------------------------|------------|
| S1  | flowers of Musa basjoo Sieb. et Zucc | Jinghong City, Yunnan Province | 0.966      |
| S2  | flowers of Musa basjoo Sieb. et Zucc | Jinghong City, Yunnan Province | 0.984      |
| S3  | flowers of Musa basjoo Sieb. et Zucc | Jinghong City, Yunnan Province | 0.975      |
| S4  | flowers of Musa basjoo Sieb. et Zucc | Jinghong City, Yunnan Province | 0.952      |
| S5  | flowers of Musa basjoo Sieb. et Zucc | Jinghong City, Yunnan Province | 0.973      |
| S6  | flowers of Musa basjoo Sieb. et Zucc | Jinghong City, Yunnan Province | 0.975      |
| S7  | flowers of Musa basjoo Sieb. et Zucc | Jinghong City, Yunnan Province | 0.937      |
| S8  | flowers of Musa balbisiana Colla | Panyu City, Guangdong Province | 0.864      |
| S9  | flowers of Musa balbisiana Colla | Panyu City, Guangdong Province | 0.813      |
| S10 | flowers of Musa balbisiana Colla | Zhaoqing City, Guangdong Province | 0.866      |
S11 flowers of *Musa balbisiana* Colla  
Zhaoqing City, Guangdong Province 0.746

S12 flowers of *Musa balbisiana* Colla  
Yulin City, Guangxi Province 0.749

S13 flowers of *Musa balbisiana* Colla  
Yulin City, Guangxi Province 0.883

S14 flowers of *Musa nana* Lour.  
Zhangzhou City, Fujian Province 0.187

S15 flowers of *Musa nana* Lour.  
Zhangzhou City, Fujian Province 0.202

S16 flowers of *Musa nana* Lour.  
Zhangzhou City, Fujian Province 0.370

S17 flowers of *Musa nana* Lour.  
Zhangzhou City, Fujian Province 0.416

Figure 1. HPLC chromatogram of 17 batches of flowers of *Musa nana* Lour., flowers of *Musa basjoo* Sieb. et Zucc and flowers of *Musa balbisiana* Colla (S1-S7: flowers of *Musa basjoo* Sieb. et Zucc; S8-S13: flowers of *Musa balbisiana* Colla; S14-S17: flowers of *Musa nana* Lour).

Table 2. Relative retention time of HPLC fingerprints of flowers of *Musa nana* Lour., flowers of *Musa basjoo* Sieb. et Zucc and flowers of *Musa balbisiana* Colla.

| Common peak | S1  | S2  | S3  | S4  | S5  | S6  | S7  | S8  | S9  | S10 | S11 | S12 | S13 | S14 | S15 | S16 | S17 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1           | 0.146 | 0.146 | 0.146 | 0.146 | 0.146 | 0.144 | 0.147 | 0.147 | 0.147 | 0.147 | 0.147 | 0.147 | 0.147 | 0.147 | 0.147 | 0.147 |
| 2           | 0.155 | 0.155 | 0.155 | 0.155 | 0.155 | 0.153 | 0.156 | 0.156 | 0.156 | 0.156 | 0.156 | 0.156 | 0.156 | 0.156 | 0.156 | 0.156 |
| 3           | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 | 0.164 |
| 4           | 0.235 | 0.235 | 0.235 | 0.235 | 0.236 | 0.241 | 0.237 | 0.237 | 0.237 | 0.237 | 0.237 | 0.237 | 0.237 | 0.237 | 0.237 | 0.237 |
| 5           | 0.341 | 0.341 | 0.341 | 0.341 | 0.342 | 0.347 | 0.344 | 0.345 | 0.346 | 0.344 | 0.345 | 0.345 | 0.345 | 0.345 | 0.345 | 0.345 |
| 6           | 0.374 | 0.374 | 0.374 | 0.374 | 0.374 | 0.374 | 0.378 | ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
| 7           | 0.689 | 0.689 | 0.689 | 0.688 | 0.688 | 0.689 | 0.689 | 0.691 | 0.692 | 0.689 | 0.688 | 0.689 | 0.691 | 0.692 | 0.692 | 0.689 | 0.689 | 0.689 | 0.689 | 0.689 | 0.689 |
| 8           | 0.723 | 0.723 | 0.723 | 0.722 | 0.722 | 0.723 | 0.724 | 0.743 | 0.743 | 0.743 | 0.743 | 0.743 | 0.743 | 0.743 | 0.743 | 0.743 | 0.743 | 0.743 | 0.743 | 0.743 | 0.743 |
| 9           | 0.742 | 0.741 | 0.741 | 0.739 | 0.739 | 0.740 | 0.744 | ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─
| 10          | 0.800 | 0.798 | 0.797 | 0.798 | 0.798 | 0.801 | 0.801 | 0.800 | 0.802 | 0.800 | 0.799 | 0.800 | 0.800 | 0.800 | 0.800 | 0.800 | 0.800 | 0.800 | 0.800 | 0.800 | 0.800 |
| 11(S)       | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 12          | 1.084 | 1.080 | 1.079 | 1.076 | 1.078 | 1.078 | 1.080 | 1.078 | 1.079 | 1.080 | 1.077 | 1.078 | 1.078 | 1.078 | 1.078 | 1.078 | 1.077 |
| 13          | 1.216 | 1.214 | 1.213 | 1.211 | 1.211 | 1.213 | 1.214 | 1.213 | 1.213 | 1.212 | 1.212 | 1.212 | 1.212 | 1.212 | 1.212 | 1.212 | 1.212 |
| 14          | 1.565 | 1.562 | 1.562 | 1.559 | 1.559 | 1.561 | 1.561 | 1.560 | 1.561 | 1.560 | 1.558 | 1.560 | 1.559 | 1.560 | 1.560 | 1.559 | 1.560 |
| 15          | 2.439 | 2.437 | 2.436 | 2.435 | 2.435 | 2.434 | 2.434 | 2.434 | 2.434 | 2.431 | 2.433 | 2.434 | 2.434 | 2.434 | 2.434 | 2.434 | 2.434 |
| 16          | 2.586 | 2.583 | 2.582 | 2.580 | 2.580 | 2.581 | 2.580 | 2.578 | 2.578 | 2.583 | 2.576 | 2.576 | 2.576 | 2.576 | 2.576 | 2.576 | 2.576 |
| 17          | 3.232 | 3.229 | 3.227 | 3.224 | 3.224 | 3.224 | 3.224 | 3.224 | 3.222 | 3.223 | 3.228 | 3.217 | 3.219 | 3.219 | 3.219 | 3.220 | 3.218 | 3.219 |
Table 3. Relative peak area of HPLC fingerprints of flowers of Musa nana Lour., flowers of Musa basjoo Sieb. et Zucc and flowers of Musa balbisiana Colla.

| Column peak | S1     | S2     | S3     | S4     | S5     | S6     | S7     | S8     | S9     | S10    | S11    | S12    | S13    | S14    | S15    | S16    | S17    |
|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1           | 0.295  | 0.295  | 0.295  | 0.295  | 0.295  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 2           | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 3           | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 4           | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 5           | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 6           | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 7           | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 8           | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 9           | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 10          | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 11(S)       | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 12          | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 13          | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 14          | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 15          | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 16          | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |
| 17          | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  | 0.312  |

4. Results and Discussion

The effects of different factors, such as 50% methanol, ethanol, 50% ethanol, different extraction time, reflux and ultrasound on the extraction of medicinal materials were examined. The results exhibited that the sample extracted by methanol reflux for 1.5h had more chromatographic peaks and complete information, and the method was stable with good repeatability. In the process of optimizing chromatographic conditions, various mobile phase systems were investigated, the results demonstrated that the mobile phase was acetonitrile and water containing 0.05% phosphoric acid, the separation degree of each peak was good and the baseline was stable, which was suitable for the analysis of the fingerprint of HPLC. In the investigation of wavelength, column temperature and flow velocity, it was found that at the wavelength of 280nm and the velocity of 0.8mL/min, information was rich in chromatogram, characteristic peak was significantly and the separation degree of each peak was good.
The experimental results showed that the similarities of 4 batches of flowers of *Musa nana* Lour. ranged from 0.877 to 0.987 with 19 common peaks. The similarities of 7 batches of flowers of *Musa basjoo* Sieb. et Zucc were between 0.937 and 0.984 with 22 common peaks, and the similarities of 6 batches of flowers of *Musa balbisiana* Colla ranged from 0.910 to 0.980 with 21 common peaks. Comparison of three varieties showed that the similarities between flowers of *Musa nana* Lour. and flowers of *Musa basjoo* Sieb. et Zucc were less than 0.420 with 15 common peaks, the similarities between flowers of *Musa nana* Lour. and flowers of *Musa balbisiana* Colla were less than 0.430 with 16 common peaks. And the similarities between flowers of *Musa balbisiana* Colla and flowers of *Musa basjoo* Sieb. et Zucc were less than 0.900 with 19 common peaks. The similarities of 17 batches of flowers of *Musaceae* medicinal materials were between 0.187 and 0.984. The results showed that high similarities of flowers of same variety, but the similarities of different varieties flowers were low, and the chemical composition were different. The proposed method is simple, highly reproducible and suitable for the identification of flowers of *Musaceae* medicinal materials. In addition, whether the three kinds of flowers of *Musaceae* medicinal materials can be used as the same medicinal material or not, it should be further studied on the difference of pharmacodynamic effects in combination with their functional treatment, so as to provide reference for the rational development and utilization and clinical application of flowers of *Musaceae* medicinal materials.

**Acknowledgments**

This work was supported by the Key Laboratory Project of Miao Medicine in Guizhou Province (Qianmiao K character [2017] 027]), and The Guizhou First-Class Course Construction Project [2017], the authors thank the government of China for their financial support.

**References**

[1] Ngamsaeng A, Wanapat M, Khampa S. (2006) Evaluation of local tropical plants by in vitro rumen fermentation and their effects on fermentation end-products. Pak. J. Nutr, 5:414-418.

[2] Sheng Z W, Ma W H, Jin Z Q et al. (2010) Investigation of dietary fiber, protein, vitamin E and other nutritional compounds of banana flower of two cultivars grown in China. African J. Biotechnol, 25:3888-3895.

[3] Sheng Z W, Ma W H, Jin Z Q et al.(2010) Analysis and evaluation of nutritional components in different locations of banana inflorescence. Food Science, 9:263-267.

[4] Sheng C L, Lai Z S.(2012) Development and utilization of banana bud edible and medical values. Journal of Agricultural Science and Technology, 3:80-84.

[5] Dhanabal SP, Sureshkumar M, Ramanathan M, et al. (2005) Hypoglycemic effect of ethanolic extract of *Musa sapientum* alloxan induced diabetes mellitus in rats and its relation with antioxidant potential. Journal of Herbal Pharmacotherapy, 2:7-19.

[6] Pari L, Maheswari JU. (1999) Hypoglycemic effect of *Musa sapientum* L. in alloxan-induced diabetic rat. Journal of Ethnopharmacol, 1:321-325.

[7] Pari L, Maheswari JU.(2000) Antihyperglycemic activity of *Musa sapientum* flowers: effect on lipid peroxidation in alloxan diabetic rats. Phytotherapy Research, 2:136-138.

[8] Xu G L, Yang Y L, Fang L K, et al.(2016) Study on different extraction processing of flavonoids from banana flower and DPPH radical ability. Farm Products Processing, 6:22-27.

[9] Zhan W S, Hui W, Li L Z, et al.(2014) Study on inhibitory components of alpha-glucosidase activity in banana flower extract. Journal of Chinese Institute of Food Science and Technology, 9:68-74.

[10] Divyar S, Venkata LS, Vadivel V, et al. (2016) In vitro studies on the biological activities of flowers of banana(*Musa Paradisiaca* L.). Der Pharmacia Lettre, 10:238 -246.

[11] Qing Z, Xing C, Wen Y K, et al.(2010) Study on α-glucosidase inhibitory activity of extracts from *Musa basjoo* Sieb. et Zucc. Science and Technology of Food Industry, 2:125-126.

[12] Zi Q F, Zhi Y Z, Zhe X et al.(2017) Analysis of the chemical compositions of the flower of *Musa*
*bassjoo* Sieb. et Zucc and their bioactivity in vitro. Journal of Guangdong Pharmaceutical University, 4:1-6.