

# EFFECTS OF PUERARIA LOBATA COMBINED WITH HIGH-INTENSITY INTERMITTENT TRAINING ON SKELETAL MUSCLE QUALITY AND GENE EXPRESSION



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EFEITOS DA PUERARIA LOBATA COMBINADOS COM TREINO INTERMITENTE DE ALTA INTENSIDADE NA QUALIDADE MÚSCULOESQUELÉTICA E EXPRESSÃO GENÉTICA

EFFECTO DE PUERARIA LOBATA Y ENTRENAMIENTO INTERMITENTE DE ALTA INTENSIDAD SOBRE LA CALIDAD DEL MÚSCULO ESQUELÉTICO Y LA EXPRESIÓN GÉNICA

Yun Zhao<sup>1</sup>   
(Public Health Education)  
Mingang Guo<sup>1</sup>   
(Public Psychology)

1. College of Sports Science and Engineering, East China University of Science and Technology, Xuhui 200237, Shanghai, China.

2. Department of Physical Education, Wuhan University of Technology, Wuhan 430070, Hubei, China.

## Correspondence:

Xuhui 200237, Shanghai, China.  
cs2098bkle4571@126.com

## ABSTRACT

Extraction of effective components from Pueraria lobata has important value for skeletal muscle quality and gene expression. The improvement effect of traditional high-intensity intermittent training on skeletal muscle has not been obvious, and it is difficult to guarantee the properties of some volatiles. Based on this, this paper analyzes the effect of high-intensity intermittent training on skeletal muscle quality and gene expression in Pueraria lobata. Based on a brief summary of extraction of Pueraria lobata, status of research on the pharmaceutical components of Pueraria lobata was summarized. Different specimens of Pueraria lobata were selected as research objects, and the process of high-intensity intermittent training was designed. High-intensity intermittent training, solvent extraction and water solvent extraction were combined together to design the fixed-bed continuous extraction scheme. According to the influence of Pueraria lobata on skeletal muscle quality, the influence of intermittent training on skeletal muscle quality was analyzed. The extraction results showed that Pueraria lobata combined with high-intensity intermittent training can effectively improve the content of skeletal muscle and ensure the effective expression of skeletal muscle gene.

**Keywords:** Pueraria; High-Intensity Interval Training; Muscle, Skeletal; Gene Expression.

## RESUMO

*A extração de componentes eficazes da Pueraria lobata tem importante valor para a qualidade músculoesquelética e para a expressão genética. O efeito da melhoria do tradicional treinamento intervalado de alta intensidade na estrutura músculoesquelética não tem sido óbvio, e é difícil garantir as propriedades de alguns voláteis. Com base nisso, este estudo analisa o efeito do treinamento intervalado de alta intensidade na qualidade músculoesquelética e na expressão genética na Pueraria lobata. Com base num breve resumo da extração da Pueraria lobata, resumiu-se o andamento das pesquisas sobre os componentes farmacêuticos da Pueraria lobata. Diferentes amostras de Pueraria lobata foram selecionadas como objeto de pesquisa, e formulou-se o processo do treinamento intervalado de alta intensidade. O treinamento intervalado de alta intensidade, a extração de solventes e a extração de solventes à base de água foram combinadas para conceber o sistema de extração contínua de leito fixo. De acordo com a influência da Pueraria lobata na qualidade músculoesquelética, analisou-se a influência do treino intervalado na qualidade músculoesquelética. Os resultados da extração mostraram que a Pueraria lobata, combinada com treino intervalado de alta intensidade, pode melhorar, de maneira eficaz, o teor músculoesquelético e garantir a expressão eficaz da expressão genética do músculoesquelético.*

**Descritores:** Pueraria lobata; Treinamento Intervalado de Alta Intensidade; Músculo Esquelético; Expressão Gênica.

## RESUMEN

*La extracción de componentes eficaces de la Pueraria lobata tiene un importante valor para la calidad músculoesquelética y para la expresión genética. El efecto de la mejora del tradicional entrenamiento intercalado de alta intensidad en la estructura músculoesquelética no ha sido obvio, y es difícil garantizar las propiedades de algunos volátiles. Basándose en eso, este estudio analiza el efecto del entrenamiento intercalado de alta intensidad en la calidad músculoesquelética y en la expresión genética en la Pueraria lobata. Basándose en un breve resumen de la extracción de la Pueraria lobata, se resumió el andamento de las investigaciones sobre los componentes farmacéuticos de la Pueraria lobata. Diferentes muestras de Pueraria lobata fueron seleccionadas como objeto de investigación, y se formuló el proceso del entrenamiento intercalado de alta intensidad. El entrenamiento intercalado de alta intensidad, la extracción de solventes y la extracción de solventes a base de agua fueron combinadas para concebir el sistema de extracción continua de lecho fijo. De acuerdo con la influencia de la Pueraria lobata en la calidad músculoesquelética, se analizó la influencia del entrenamiento intercalado en la calidad músculoesquelética. Los resultados de la*



*extracción mostraron que la Pueraria lobata, combinada con entrenamiento intercalado de alta intensidad, puede mejorar, de manera eficaz, el tenor músculoesquelético y garantizar la expresión eficaz de la expresión génica del músculoesquelético.*

**Descriptor:** *Pueraria lobata; Entrenamiento Intercalado de Alta Intensidad; Músculo Esquelético; Expresión Génica.*

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## INTRODUCTION

Traditional Chinese medicine as a traditional Chinese medicine has a long history, but affected by the side effects of traditional Chinese medicine, Chinese patent medicine is also criticized by many people, a large number of clinical studies found some common diseases, difficult disease indicators, Chinese medicine has a great advantage, so the world began to study Chinese Medicine. At present, although the domestic proprietary Chinese medicine is widely used, it has been difficult to have a good development in foreign countries. There are many problems in the registration and sales of traditional Chinese medicine or single Chinese medicine, or the use of drugs. The biggest problem lies in the uncertainty of the main components. Therefore, it is necessary to analyze the extraction and determination of the effective components of *Pueraria lobata*. Many scholars have analyzed the effective components of *Pueraria lobata*, and began to try to use various new technologies. In recent years, the extraction technology of *Pueraria lobata* in China has made great progress, and the output value of traditional Chinese medicine has also increased several times. The extraction and analysis of effective components of *Pueraria lobata* is a necessary stage to improve the quality of skeletal muscle, which is directly related to the quality of drugs. In the traditional analysis process of *Pueraria lobata*, hot water extraction is the most traditional method, which is the earliest and most common method. In China's drug standards, there are more than 800 kinds of Chinese patent medicines analyzed by hot water extraction method, accounting for nearly half.<sup>1</sup> This method has a certain application value, but it is too dependent on the experience level, the process parameters can not be quantitative analysis, and it is difficult to ensure the efficacy of the extract. With the progress of science and technology, the effect of *Pueraria lobata* on skeletal muscle quality and gene expression began to be determined by other methods.<sup>2</sup> The use of advanced technology can provide more data support for the extraction and determination of *Pueraria lobata*. Compared with the traditional extraction method of *Pueraria lobata*, the new technology has more advantages.

At present, the extraction of the main components of *Pueraria lobata* will still use traditional technology and experience, but a variety of new technologies are also constantly applied. For example, overweight position technology, molecular distillation technology, component analysis and number are the main indirect testing technologies for extracting genes. In this study, the medicinal value of the effective components of *Pueraria lobata* is planned to be realized by drug property analysis technology. On the basis of summarizing the research progress of drug property analysis methods, the effects of *Pueraria lobata* on skeletal muscle quality and gene expression were studied with specific *Pueraria* materials as an example.<sup>3</sup>

## STATE OF THE ART

Supercritical fluid analysis technology has great advantages in the extraction and determination of components. In addition, the solubility of some fatty acids can be obtained by supercritical fluid extraction. In supercritical state, the material contacts with the fluid, and part of the effective components are selectively extracted. In the corresponding pressure range, the components obtained are not unique, and other parameters need to be adjusted for component separation to obtain

pure substances.<sup>4</sup> Compared with other traditional medicine analysis technologies, the component analysis technology has strong extraction ability, can improve the yield, selectively extract the main components, and can ensure that the extracted components are not damaged, and the production cycle is short. At the same time, it can play an antioxidant effect and ensure the quality of the extract.<sup>5</sup> In recent years, many scholars have applied component analysis to the extraction of various components. In the research and analysis, scholars from the Royal College of technology used supercritical carbon dioxide and 5% methanol modified carbon dioxide to extract six kinds of tetraalkyl tin and seven kinds of ionic organotin compounds from the spiked topsoil samples, and analyzed the soil extracts by Gas Chromatography Atomic emission spectrometry. The retention time, minimum detectable concentration and detector linear range of nine organotin compounds (seven of the nine compounds were derived with n-amyl magnesium bromide before gas chromatography analysis). In the research and analysis, scholars from the University of Melbourne in Australia have studied the supercritical drug analysis technology. SFE can be used for the rapid extraction of oil from irradiated food (such as chicken, pork, liquid whole egg, ground beef) and irradiated mango and papaya seeds (60min), and only 10ml of n-hexane is needed to extract the sample. Using three factors and three levels box Behnken response surface design, scholars from Massachusetts Institute of Technology (MIT) studied the protein content and species in supercritical *Pueraria lobata*, and studied the influence of pressure, temperature and co solvent flow rate on the maximum influence rate of anthocyanins and phenolic compounds in *Pueraria lobata*. The response surface methodology (RSM) was used to optimize the analytical conditions of the components in *Radix Puerariae*. The optimal influence rate of the effective medicinal components in *Radix Puerariae* was obtained. Four factors were investigated: temperature, pressure, extraction time and carbon dioxide flow rate. Results the optimum extraction conditions were as follows: temperature 44.9 °C, pressure 34.9 MPa, extraction time 150.2 min, carbon dioxide flow rate 10.1.

There are a large number of studies on the composition analysis at home and abroad, but these studies rarely involve the influence of *Pueraria lobata* and high-intensity intermittent training on skeletal muscle quality and gene expression, especially in the extraction of medicinal active ingredients, and the analysis is not specific enough. In the research and analysis of this paper, the application of high-intensity intermittent training to the extraction of important effective components is of great significance to improve theoretical research and improve the quality of *Pueraria lobata* to skeletal muscle.

## ANALYSIS AND DISCUSSION

### Effects of *Pueraria lobata* and high intensity intermittent training on skeletal muscle quality and gene expression

In this study, different *Pueraria lobata* moisture content ( $10.8 \pm 0.1$ ) mm, average basic unit particle size ( $212.4 \pm 0.2$ ) mm, true density ( $1.5 \pm 0.1$ ) g / cm<sup>3</sup> were used in this study. The composition content analysis of *Pueraria lobata* was shown in Figure 1. It can be seen from the figure that the distribution of its components is relatively concentrated in the process of the influence of *Pueraria lobata* on skeletal muscle mass, mainly in 0-30 basic units.

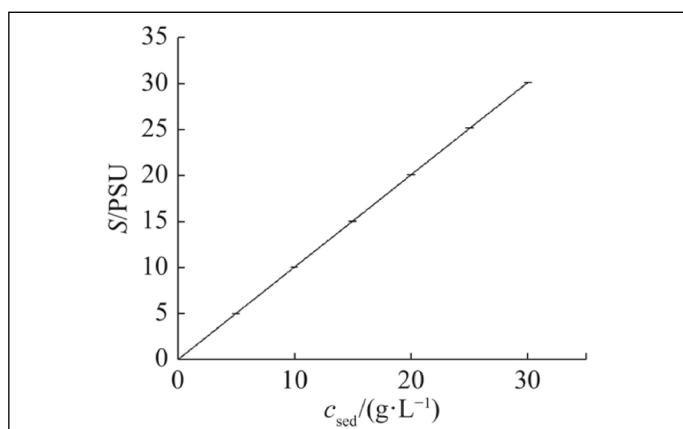


Figure 1. Composition analysis chart.

The results showed that there were some differences in the effects of different Pueraria contents and different degrees of intermittent training methods on skeletal muscle content and gene expression. Using supercritical carbon dioxide extraction method, the influence rate was  $1.3 \pm 0.1\%$ , the growth rate of skeletal muscle mass was  $3.4 \pm 0.1\%$ , and the total growth rate was  $62.5 \pm 1.2\%$ . In the first part of the differential critical carbon dioxide extraction, 1.9% of the extraction product can be improved by acetone and water extraction. In general, Pueraria lobata combined with high-intensity intermittent training had the highest effect on skeletal muscle quality, followed by Pueraria lobata and moderate intensity intermittent training.

In the process of analyzing the effect of supercritical Pueraria on skeletal muscle quality, when the analysis time is 80 minutes, the successful growth rate of skeletal muscle mass has reached 70%. When the analysis time is set at 120 minutes and the S / f parameter is set to 0.8, the quality success growth rate reaches 90%. With the improvement of the intensity of interval training, the growth rate of quality success began to gradually stabilize, as shown in Figure 2 (where *i* and *j* represent training intensity and interval type). It can be seen from the figure that the overall intensity of interval training reaches 140 minutes is the most reasonable. When the time is 280 minutes, the success rate can reach 90%. If water is the most chemical solvent, the success rate can reach 90% after 220 minutes.

In order to analyze the factors that affect the expression of skeletal muscle related genes, carbon dioxide itself has a strong polarity, because it is difficult to change the polarity only depending on temperature and pressure, so the carrier needs to be used. In the analysis of the influence of carrier on curvature, it was found that the influence rate could be improved when the carrier content and celery content were 1:5 and the extraction time was half an hour. After the addition of carrier agent, the influence rate increased, which may be due to the application of carrier agent to make the whole solvent close to the main components and facilitate the extraction of the main components. In terms of pressure, when the pressure is small, the influence rate can also be improved with the increase of pressure, but when it reaches a certain degree, it is not conducive to the drug performance of the active ingredients.

According to the Chinese Pharmacopoeia, the utilization rate of Pueraria lobata has exceeded 48.5%, which indicates that Pueraria is rich in water-soluble substances. According to the relevant research, the water-soluble substances in Pueraria lobata are mainly polyphenols, which contain more polar groups of hydroxyl groups, showing a greater hydrophilicity. Therefore, acetone and water were selected as solvents in supercritical carbon dioxide extraction. It can be seen from the extraction results that the influence rate is also increasing with the increase of polarity, and the influence rate is the highest when water

is used as solvent. At the same time, other methods are also used for comparative analysis. It can be seen that when the temperature and solvent remain unchanged, the components affected by supercritical carbon dioxide experiment can promote the change of structure and provide convenience for subsequent extraction. The experimental results of different groups (with different parameters) are shown in Figure 3.

When the fixed bed continuous extraction method was used, the total phenols extract was  $(647.5 \pm 1.9)$  mg / g, the total phenolic content was  $(493.5 \pm 2.1)$  mg / g and  $(443.7 \pm 2.8)$  mg / G under atmospheric pressure. The results of extraction effect under different parameters are shown in Figure 4. The analysis of chromatographic results without passing the reference substance shows that the injection volume of gallic acid is 0.75 ~ 10  $\mu$ g, corilagin is 0.75 ~ 10  $\mu$ g, the injection volume of corilagin is 1.25 ~ 20  $\mu$ g, and the injection volume of corzic acid is 0.75 ~ 10  $\mu$ g. After acetone extraction, the total phenolic acid effect rate can be increased by 17.6%, and the content of phenolic acid after water extraction is further increased by 10.6%.

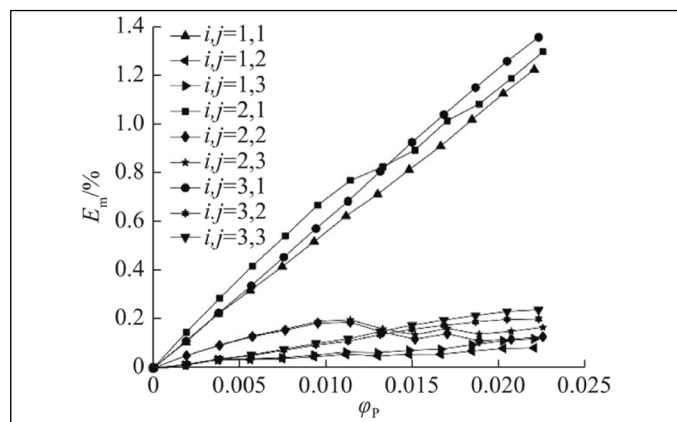


Figure 2. Analysis chart of training indicators under different parameters.

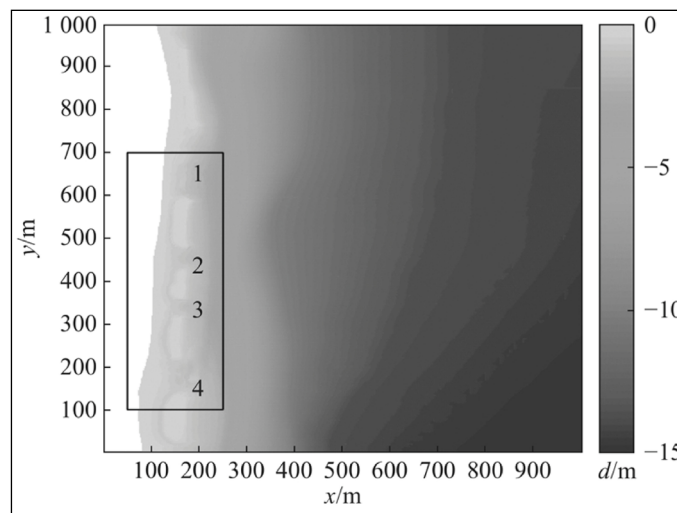
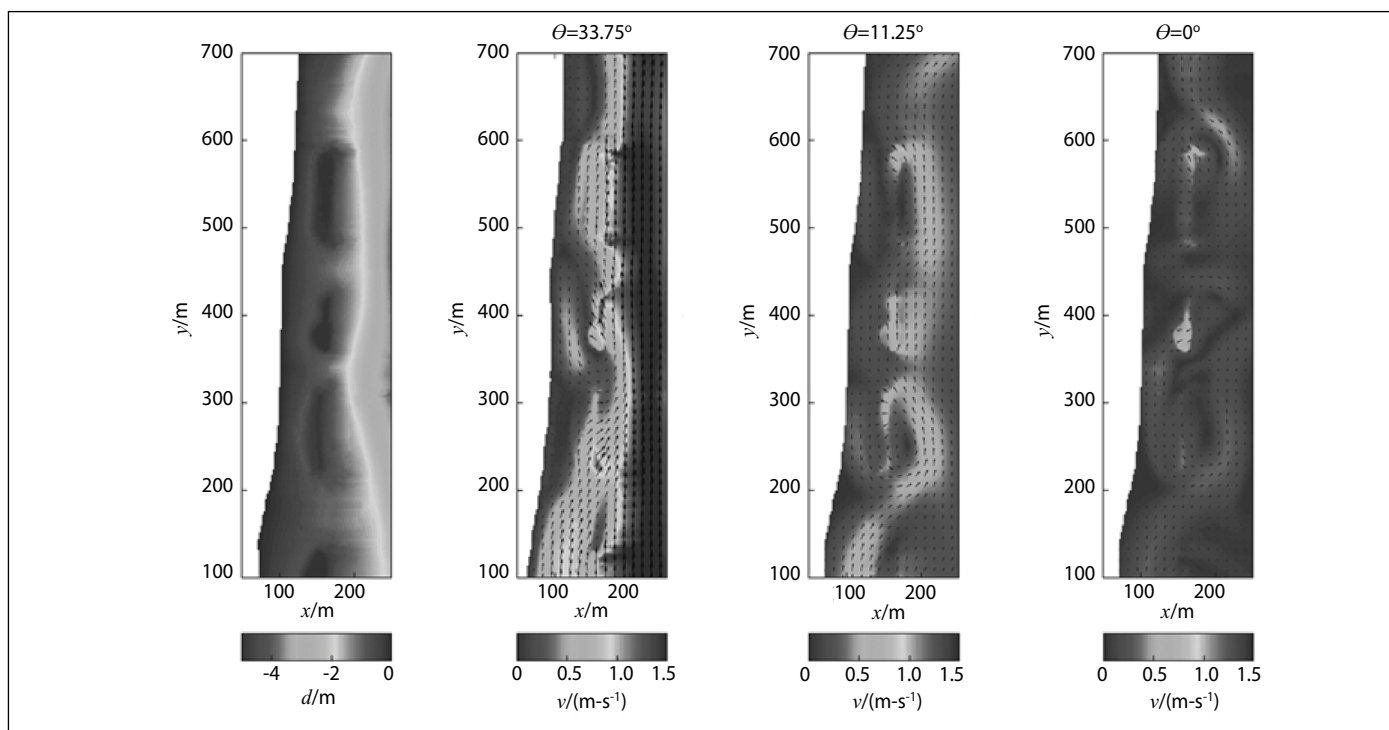


Figure 3. Experimental results of different groups (different parameters).

## CONCLUSION

The effect of traditional Chinese medicine materials on gene expression is one of the research hotspots in recent years, especially for the extraction of some volatile components. The effects of Pueraria lobata combined with high intensity intermittent training on skeletal muscle quality and gene expression were discussed. In this paper, Pueraria lobata is selected as the research object. In the application of intermittent training with different intensities, the best configuration parameters are analyzed by changing different combination methods. It is considered



**Figure 4.** Extraction effect under different parameters.

that the highest influence rate can be obtained when the content of carrier and pueraria is 1:5. In order to ensure that the effective components in *Pueraria lobata* are extracted in large quantities, the supercritical fluid extraction technology is combined with acetone extraction and water extraction, and the fixed bed continuous extraction scheme is designed. Supercritical fluid extraction and acetone and water extraction are used successively. Through the determination of the effective components of *Pueraria lobata*, the influence rate of the main components can be improved by using supercritical component analysis technology. Compared with the chemical experimental solvent, the influence rate can be improved with high-intensity intermittent training. In addition, the validity of this method has also been confirmed in the determination of

effective components in *Pueraria lobata*. It should be pointed out that there are great differences in pharmaceutical components of different *Pueraria lobata*. In the study of its effects on skeletal muscle quality and gene expression, reasonable process parameters should be selected. In addition, component analysis technology is not able to extract all the effective components of *Pueraria lobata*. In application, it is also necessary to combine it with other technologies to improve the influence rate of effective components and ensure the activity of drugs, so as to steadily and efficiently improve the quality of skeletal muscle.

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All authors declare no potential conflict of interest related to this article

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**AUTHORS' CONTRIBUTIONS:** The author has completed the writing of the article or the critical review of its knowledge content. This paper can be used as the final draft of the manuscript. Every author has made an important contribution to this manuscript. Yun Zhao, Mingang Guo: writing and execution.

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