

# Development of Multifunctional Health Food Based on Smilax Glabra Extract

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**Abstract:** With the increasing demand for health management, the development of functional foods based on natural plant extracts has received widespread attention. Due to its medicinal and edible properties, the Smilax glabra extract has become an ideal raw material for multifunctional health foods. Therefore, a new type of chewable tablet based on Smilax glabra extract is developed by optimizing the preparation process of Smilax glabra extract. The study first uses single factor experiment and response surface method to optimize the ethanol content, ratio of raw materials to liquids, and ultrasonic treatment time in the production process. Through experiments, the optimal process for preparing Smilax glabra chewable tablets is identified. The experimental results showed that the developed chewable tablets met the standards in terms of physical and chemical properties as well as the content of bioactive ingredients. The average total flavonoid content was 12.46%, and the average Astilbin content was 0.03494 mg/g, demonstrating good formability and quality. The research not only enriches the application of Smilax glabra in the field of health food, but also provides a new approach for the modern development of traditional medicinal materials.

**Keywords:** Smilax Glabra Extract, Astilbin, Health Food, Chewable Tablets, Food Development

## Introduction

With the increasing health awareness, the demand for health products among the population is growing day by day (Alexander et al., 2022). In today's society, the pace of life is fast and work pressure is increasing, resulting in the majority of people being in a sub healthy state and suffering from chronic diseases. Multi-functional health foods are receiving increasing attention due to their ability to meet specific health needs (Sundermann et al., 2023). As a traditional Chinese medicinal herb, the rich nutritional content and unique medicinal value of Smilax glabra provide a broad space for the development of new health foods (Shahrajabian et al., 2023). With the deepening of modern medicine, researchers have discovered that the main active substance in Smilax glabra is Astilbin, which has various biological activities such as antioxidant, anti-inflammatory, and immune regulation. These components have shown great potential in regulating body functions, enhancing immunity, and other aspects (Sun et al., 2023; Wu and Zhao, 2024). However,

how to effectively transform these natural ingredients into consumer acceptable health foods is currently a problem that needs to be studied.

Currently, many scholars have conducted research on the efficacy of extracts from Smilax glabra. Wang et al. used Astilbin, a Smilax glabra extract, as a prebiotic. Its effects on high-fat diet mice were explored through multiple omics methods. The experimental results showed that Astilbin could reduce body weight, insulin resistance, and inflammation in mice, improve intestinal microbiota ecology, protect intestinal barrier, and prevent obesity related damage and metabolic disorders (Wang et al., 2022). Shen and Li (2022) used network pharmacology methods to study the therapeutic effect of Smilax glabra extract on myasthenia gravis. The active ingredients and their targets were searched in a database to construct a "component-target" network, and conducted protein interaction and enrichment analysis. The experimental results indicate that the extract of Smilax glabra could treat myasthenia gravis by regulating multiple key targets and signaling pathways. Hwang (2023) studied the

anticancer effect of ethanol extract in *Smilax glabra* on oral cancer using methods such as cytotoxicity analysis and fluorescence microscopy detection. The experimental results showed that the ethanol extract had an inhibitory effect on cancer cells, could induce apoptosis of cancer cells, and was non-toxic to normal cells, demonstrating its anti-cancer potential. Patel (2023) conducted research and analysis on scientific data in the database to explore the medical value of flavonoids in *Smilax glabra*. The results showed that it had pharmacological activities such as anti-inflammatory and anti-tumor, and had therapeutic potential for diseases such as cervical cancer and liver injury, confirming its biological importance in the medical field. Liu et al. (2023) combined the Astilbin extracted from *Smilax glabra* with citric acid to improve the oral absorption rate of Astilbin. The experimental results showed that the combination enhanced the anti-psoriasis effect of Astilbin and significantly increased the Astilbin concentration in mouse plasma. In vitro experiments showed an increase in Astilbin absorption and a decrease in efflux ratio. Yin et al. (2022) explored the therapeutic effect of *Smilax glabra* extract on hyperuricemia and renal fibrosis through quantitative proteomics, staining analysis, and gene expression detection. The experimental results indicated that the extract could reduce uric acid levels and improve renal fibrosis by downregulating collagen related signaling pathways. It is a potential effective treatment for hyperuricemia and its associated renal fibrosis. Botelho et al. (2023) proposed a method for extracting and identifying compounds from the leaves of plants in the genus *Poria*. Through experiments, it was found that the extract of Astilbin extracted from *Poria* leaves had high pharmacological application value, with functions such as anti-tumor, auxiliary hypoglycemic activity, and immune activity. The experimental results indicated that this method could extract much Astilbin from the leaves of *Smilax glabra*. Liang et al. (2023) used the *Smilax glabra* extract, estrogens, as a treatment method for radiation-induced lung injury. The experimental results showed that the extract of *Smilax glabra*, estrone, could reduce radiation-induced cell apoptosis, DNA damage, inflammatory response, and reactive oxygen species levels, significantly improved lung injury, and had the potential to become a protective and therapeutic compound for lung injury. Fang et al. (2024) investigated the effect of Astilbin in *Smilax glabra* extract on sepsis induced cardiomyopathy. By establishing a three-dimensional sepsis model, it was found that Astilbin could reduce myocardial injury and susceptibility to ventricular fibrillation. The experimental results showed that Astilbin worked by activating and inhibiting different pathways, which was a potential target for the treatment of septic cardiomyopathy.

In summary, the extract of *Smilax glabra* has various pharmacological effects and has a wide range of clinical applications. How to efficiently extract and fully utilize

the active ingredients in *Smilax glabra* is currently a challenge. Traditional extraction methods such as reflux extraction have problems with low efficiency and high cost, while emerging ultrasonic extraction technology has shown advantages in high efficiency and speed (Thilakarathna et al., 2023). Based on this, the study optimizes the preparation process of *Smilax glabra* extract through ultrasound assisted technology to improve the extraction efficiency of Astilbin. Then, *Smilax glabra* chewable tablets are developed. The research aims to promote the application of *Smilax glabra* in the modern health food industry and provide new ideas for the research and development of health foods related to *Smilax glabra*. The innovation of the research lies in systematically optimizing the key factors affecting the Astilbin extraction efficiency through single factor experiments and response surface methods, in order to improve the Astilbin extraction efficiency. Then, multifunctional health food chewable tablets based on *Smilax glabra* extract are developed, and the quality control and bioactive ingredients of the chewable tablets are analyzed to ensure the stability and effectiveness of the product.

## Materials and Methods

### *Experimental Materials and Instruments*

The experimental materials used for optimizing the preparation process of Astilbin extracted from *Smilax glabra* include *Smilax glabra* slices and anhydrous ethanol. The main experimental instruments used include crushers, chromatographs, and drying ovens (Gasmi et al., 2024). The main raw material used in the production of *Smilax glabra* chewable tablets is the alcohol extract Astilbin, extracted in the previous section. The excipient materials include starch, dextrin, microcrystalline cellulose, and mannitol (Patel and Shah, 2022). The main instruments used include desktop tablet presses, electronic scales, etc. The detailed experimental materials and instrument model manufacturers are shown in Table 1.

### *Experimental Method for Optimizing the Preparation Process of Smilax Glabra Extract*

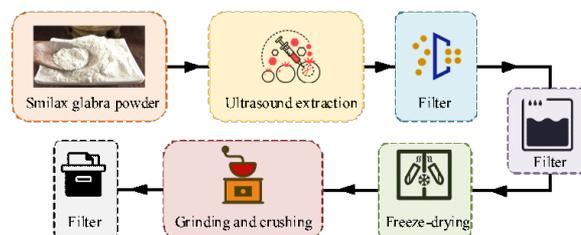
In the development and utilization of natural products, extraction technology is a key step in obtaining active ingredients. This is not only related to the quality and efficacy of the product, but also an important component of green economy and sustainable development (Oh, 2023; Wu et al., 2023). Although the traditional reflux extraction method is mature, emerging technologies such as ultrasonic extraction are gradually gaining favor due to their high efficiency and speed. Ultrasonic extraction utilizes cavitation effect to destroy plant cell structure, effectively releasing active ingredients.

**Table 1:** Preparation of Smilax glabra extract materials and instruments for optimization experiment

Experimental materials		Experimental instruments		
Material	Manufacturer	Instrument	Model	Manufacturer
Sliced medicinal herbs of Smilax glabra rhizome and rhizome	Hezhong Biochemical Manufacturing Co., Ltd	Multi-functional crusher	HK-15B	Guangzhou Xulang Machinery Equipment Co., Ltd
Ethanol (analytical alcohol)	Sinopharm	Chromatograph	Serian 6000 series	Tianmei Group Engineering R&D ZX (TREC)
Methanol (chromatographic alcohol)	Fisher Scientific	Analytical balance	FA/MAseries	Shanghai Jingke
Phosphoric acid	Sinopharm	Rotary evaporator	RE-2000E	Xi'an Hepu Biotechnology Co., Ltd
Astilbin reference substance	Nanjing Yuanzhi Biotechnology Co., Ltd	Drying oven	DHG-9420A	Shanghai Yiheng Scientific Instrument Co., Ltd
Glacial acetic acid	Kelon Chemicals Co., Ltd	Electronic balance	WT series	Changzhou Wantai Tianping Instrument Co., Ltd
Starch	Shanghai Mack Biotechnology Co., Ltd	Ultrasonic cleaning machine	KUDOS series	Shanghai Kedao Ultrasonic Instrument Co., Ltd
Pregelatinized starch	Shandong Fujiao Group	Tablet Brittle Hardness Tester	CJY-2C	Shanghai Yellow Sea
Dextrin	Shandong Futian Pharmaceutical	Tablet press	GZP-35	Shanghai Tianhe Pharmaceutical Machinery Co., Ltd
Microcrystalline cellulose	Weihai Chenyuan Biotechnology	/	/	/
Steviol glycoside	Anhui Huaheng Biotechnology Co., Ltd	/	/	/
Xylitol	Shandong Furuida Pharmaceutical Group	/	/	/
Crystalline maltitol	Anhui Mingguang Xueji Biotechnology Co., Ltd	/	/	/
Anhydrous citric acid	Henan Oasis Chemical Industry	/	/	/
Magnesium stearate	Jiangsu Runhong Pharmaceutical Group	/	/	/

Compared with traditional methods, it exhibits better selectivity and operational convenience (Luksta and Spalvins, 2023). This extraction method not only improves efficiency, but also reduces the consumption of chemicals and energy, which is in line with the development concept of green economy. Therefore, optimizing its extraction process is crucial for ensuring the efficacy of Smilax glabra and the development of multifunctional health food. In order to optimize the extraction process, the study first used a single factor experimental method to analyze various factors that affect the extraction amount of Astilbin from Smilax glabra extract. Subsequently, the study adopted a three-factor three-level response surface analysis method to further comprehensively analyze these factors to select the most suitable process conditions for extracting Astilbin. The study first preprocessed the sliced medicinal materials of Smilax glabra rhizome to obtain Smilax glabra powder.

During pretreatment, first, an appropriate amount of Smilax glabra medicinal material is weighed and dehydrated. Then, these medicinal materials are crushed and screened using a 60 mesh sieve to obtain a uniformly fine Smilax glabra powder. The extraction process of Smilax glabra extract adopts ultrasonic assisted technology. The process steps are shown in Figure 1.



**Fig. 1:** Ultrasonic extraction process of Smilax glabra

## Development Process of Multifunctional Health Food Based on Smilax Glabra Extract

As a traditional Chinese medicinal herb, *Smilax glabra* has various effects such as clearing heat and detoxifying, promoting diuresis and reducing swelling, and lowering blood lipids. Modern scientific research has also confirmed these effects (Hussain et al., 2022). The Astilbin extracted from *Smilax glabra* has various significant biological activities, including inhibition of coenzyme A reductase and aldose reductase, which can protect the liver, relieve pain, and resist edema. Therefore, it has become a hot ingredient in the development of multifunctional health foods (Bajaj and Gupta, 2023). The most commonly used type of medication in multifunctional health foods is chewable tablets, which have the advantages of accelerating the dissolution and absorption of drugs, and convenient administration (Yee et al., 2024).

Based on this study, taking Astilbin, an extract of *Smilax glabra*, as the basis, the manufacturing process of *Smilax glabra* chewable tablets is developed.

During the preparation process of *Smilax glabra* chewable tablets, its polysaccharide components are prone to inhaling air moisture and becoming damp. Therefore, the study mixes the alcohol extract with anhydrous ethanol in a ratio of 1:3 for alcohol precipitation treatment, and then stores it in a refrigerated environment for 24 hours. The upper liquid is evaporated and concentrated, and then treated using vacuum freeze-drying. After treatment, the obtained solid is crushed and sieved for subsequent use. The fillers for chewable tablets include starch and microcrystalline cellulose, which need to be ground and sieved (Hemavathy et al., 2022). According to the Chinese Pharmacopoeia, the daily dosage of *Smilax glabra* is 15 to 25g, so the minimum dosage for the experiment is 15g (Tang et al., 2023). The preparation process of *Smilax glabra* chewable tablets is shown in Figure 2.

The production process of *Smilax glabra* health product chewable tablets is shown in Figure 2. Firstly, the Astilbin is extracted from *Smilax glabra*, followed by concentration and drying treatment. Then, the filler required for the chewable tablets is added and mixed evenly, ground into particles, and finally dried and pressed using a dryer. After production, the chewable tablets need to undergo fluidity testing on dry particles, referring to the fluidity testing method for dry particles specified in the Chinese Pharmacopoeia. The fluidity of dry particles is evaluated by measuring the size of the angle of repose. The angle of repose is shown in Equation (1):

$$\alpha = \arctan\left(\frac{H}{R}\right) \quad (1)$$

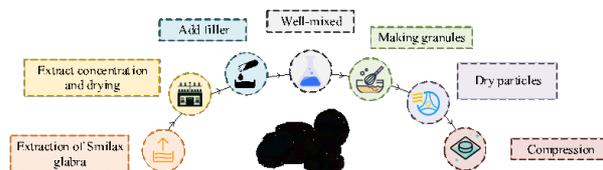


Fig. 2: Preparation process of *Smilax glabra* chewable tablets

In equation (1),  $\alpha$  is the angle of repose.  $H$  is the height of granular materials.  $R$  is the width of granular materials. Next is the bulk density test of dried granules of *Smilax glabra* chewable tablets. The bulk density is shown in Equation (2):

$$\rho = \frac{m}{v} \quad (2)$$

In Equation (2),  $v$  is the volume of dried *Smilax glabra* granules, measured by a graduated cylinder.  $m$  is the mass of dried *Smilax glabra* granules, measured by a balance.

### Optimization of *Smilax Glabra* Extract and Analysis of Health Food Development Process

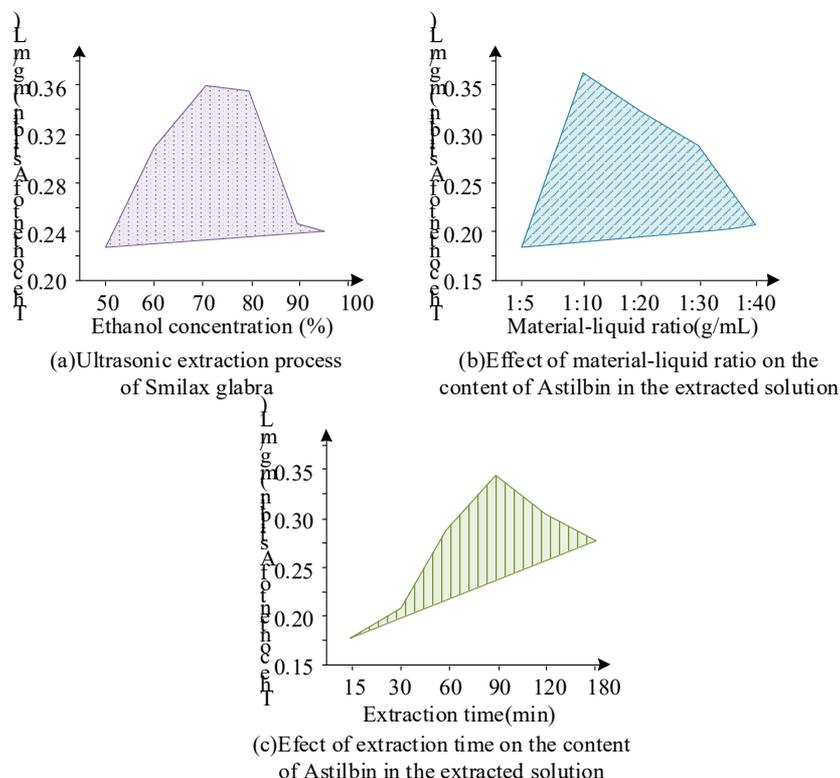
#### Single Factor Experimental Analysis on the Preparation Process Optimization of *Smilax Glabra* Extract

To explore the optimal extraction process of Astilbin from *Smilax glabra* extract, a univariate experimental method is used to investigate the effects of different factors on the extract content during preparation. In the experiment, the materia-liquid ratio is kept constant at 1:20 (g: mL). The effect of different ethanol concentrations ranging from 50% to 95% on extraction efficiency is tested. At the same time, the ethanol concentration is kept at 80% to investigate the effect of different extraction time periods on extraction efficiency. In addition, based on fixed ethanol concentration and extraction time, the influence of different material-liquid ratios on extraction efficiency is analyzed. All experiments are conducted in three parallel trials to ensure the accuracy and reliability of the results. The specific effects of each factor on the Astilbin content are evaluated by calculating the average value. The effects of different factors on the Astilbin content in *Smilax glabra* are shown in Figure 3.

Figure 3 shows the effects of different factors on the content of Astilbin in the *Smilax glabra* extract. Figure 3 (a) shows the effect of different ethanol concentration ratios on the Astilbin content. The extraction amount of Astilbin reached its peak when the ethanol concentration was 80%. This indicated that a moderate increase in

ethanol concentration helped to enhance the solubility of Astilbin. However, when the ethanol concentration exceeded 80%, the Astilbin content began to significantly decrease. Therefore, in the experiment, the Astilbin concentration was initially set at 80% as the ideal ratio for extraction solvent. Figure 3 (b) shows the effect of different proportions of material-liquid ratios on the

Astilbin content. The Astilbin content first increased and then decreased with the increase of material-liquid ratios. The results showed that the extraction efficiency was optimal when the material-liquid ratio of Smilax glabra extract was 1:10. Figure 3 (c) shows the effect of the extraction time on the Astilbin concentration in Smilax glabra.



**Fig. 3:** Effects of different factors on the Astilbin content in Smilax glabra extract

As the extraction process time prolonged, the Astilbin concentration gradually increased until it reached its peak at 90 minutes. The results indicated that setting the extraction time to 90 minutes could achieve the maximum Astilbin content. In this experiment, ethanol concentration, Material-liquid ratio, and extraction time are used as research factors, and the Astilbin content in the extraction solution is used as the response value. The response surface analysis experiment is conducted using the three factor three-level response surface analysis method, and the experimental results are shown in Table 2.

Table 2 shows the effects of ethanol concentration, material-liquid ratio, and extraction time on the Astilbin content. According to the data in Table 2, there were significant differences in the Astilbin content in the extraction solution under different experimental conditions, but their content ranged from 0.0525 to 0.0625 mg/mL, indicating that changes in experimental factors had a significant impact on the extraction efficiency. The

data for scheme number 12 was relatively good. After analysis, the optimal process conditions for extracting Astilbin were determined to be a 1:10 material-liquid ratio, 70% ethanol concentration, and an extraction time of 90 minutes.

### Screening of Development Process for Multifunctional Health Food Based on Smilax Glabra Extract

The study first conducts experiments on fillers and the proportion of main and excipient to select the most suitable ratio for pharmaceutical production. In the screening of fillers, the powder of Astilbin alcohol extract is mixed with fillers. Then, add 95% ethanol for wet granulation, pass through an 18mesh sieve, dry, and use a 14mesh sieve to round the granules. In the experiment of the ratio of main and excipient drugs, the study first mixes Astilbin with different fillers. The obtained powder is filtered through an 80mesh sieve.

**Table 2:** Experimental results of optimization scheme for extraction of Astilbin from Smilax glabra

Scheme No	Ethanol concentration (%)	Material-liquid ratio (g/ml)	Extraction time (H)	Astilbin content (mg/ml)
1	0	1	-1	0.0575
2	1	0	1	0.0610
3	0	0	0	0.0592
4	-1	1	0	0.0608
5	0	-1	1	0.0623
6	-1	0	-1	0.0617
7	1	1	0	0.0525
8	0	0	0	0.0557
9	-1	-1	0	0.0610
10	0	1	1	0.0615
11	1	-1	0	0.0600
12	0	-1	-1	0.0625
13	0	0	0	0.0621
14	-1	0	1	0.0603
15	1	0	-1	0.0560

Then, the wet process is used for granulation, and the wet particles are passed through an 18mesh sieve. Finally, the obtained particles are dried. In this process, the quality and hardness of the chewable tablets become key factors in evaluating whether the formula ratio is optimal. The experimental results are shown in Table 3.

Table 3 shows the results of using different filler combinations and ratios of main and excipient materials in the preparation of Smilax glabra chewable tablets. From the data in the table, the Smilax glabra chewable tablets made with the filler combination of Scheme 5 had better effects and their hardness met the pharmaceutical standards. Among the four main drug to excipient drug ratio schemes, only the chewable tablets produced in schemes 3 and 4 could be molded, but the chewable tablet hardness in scheme 3 did not meet the standard. Therefore, the filler combination used in the preparation of Smilax glabra chewable tablets is microcrystalline

cellulose + pre gelatinized starch, with a main drug ratio of 3.4 and an excipient material ratio of 6.6. On the basis of determining the filler combination and the ratio of main and excipient drugs, experiments are conducted on the taste and dry particle fluidity of chewable tablets by adding different sweetener dosages and wetting agents. The experimental results are shown in Table 4.

Table 4 shows the experimental results of different sweetener dosages and wetting agents used in the preparation of Smilax glabra chewable tablets. The study sets up four different sweetener addition schemes, and only the Smilax glabra chewable tablets produced using Scheme 4 had a moderate sweetness and sourness. Among the chewable tablets made with three different concentrations of ethanol wetting agents, only the chewable tablet made with Scheme 1 had better dry particle fluidity, while the other two schemes had poorer fluidity. Therefore, the study selected a combination of 0.05% citric acid+0.75% crystalline maltitol+0.25% xylitol as seasonings, while using 70% ethanol as the wetting agent. Based on the experimental data presented in Tables 4 and 5, the optimal preparation process for Smilax glabra chewable tablets could be determined. Firstly, 0.205g of Smilax glabra alcohol extract was accurately measured, followed by the addition of 0.239 g of pre gelatinized starch. Finally, it is uniformly mixed and stirred. Then, add 0.06g of microcrystalline cellulose and continue stirring until uniform, then pour in an appropriate amount of 70% ethanol to prepare the soft material. The soft material is made by wet granulation, and the wet granules are dried in a drying oven at 50 °C for 7 minutes. Afterwards, a 14 mesh sieve is used for whole granules. Xylitol, crystalline maltitol, and citric acid are added to adjust the acidity and sourness of the chewable tablets. The sweetener dosage added is 0.03g, 0.045g, and 0.015g, respectively. After thorough mixing, the tablets can be compressed to obtain the Smilax glabra chewable tablets.

**Table. 3:** Results of different filler combinations and the proportion of main and excipient materials in the preparation of Smilax glabra chewable tablets

Scheme	Filler combination	Chewable tablet status	Hardness
1	Soluble starch+microcrystalline cellulose	Uneven appearance, not yet formed	19N Not up to standard
2	Dextrin+Microcrystalline Cellulose	Unformed	24N Not up to standard
3	Dextrin+starch	Difficult to form and prone to breakage	27N Not up to standard
4	Pre gelatinized starch+dextrin	Molding and uneven appearance	35N Not up to standard
5	Microcrystalline cellulose+pre gelatinized starch	Good molding effect with smooth surface and neat edges without any defects	43N reach the standard
Scheme	Ratio of main drug to excipients	Chewable tablet status	Hardness
1	6:4	Unformable, rough surface	Not up to standard
2	5:5	Unformed	Not up to standard
3	4:6	Forming, rough	Not up to standard
4	3.4:6.6	Forming, smooth surface	reach the standard

**Table 4:** Screening results of sweetener dosage and wetting agent

Scheme	Sweetener addition	Taste of chewable tablets
1	1% Aspartame	Excessive sweetness
2	1% sucrose	Excessive sweetness
3	1% Stevioside	Excessive sweetness
4	0.05% citric acid+0.75% crystalline maltitol+0.25% xylitol	Moderate sweetness and sourness
Scheme	Wetting agent	Dry particle fluidity of chewable tablets
1	Ethanol concentration is 70%	Better
2	Ethanol concentration is 90%	General
3	Ethanol concentration is 95%	Worse

*Quality Control and Bioactive Ingredient Analysis of Smilax Glabra Chewable Tablets*

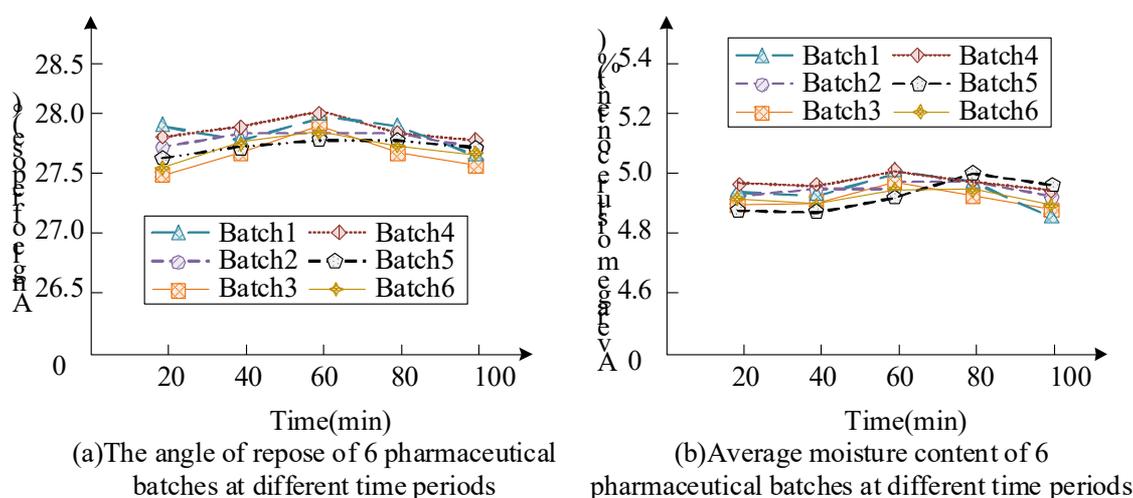
The physical and chemical properties of dry granules are crucial for the tablet formation of Smilax glabra chewable tablets during wet granulation process. For this purpose, the moisture content and angle of repose of three batches of dried granules of Smilax glabra chewable tablets are measured in detail. The experimental results are shown in Figure 4.

Figure 4 shows the angle of repose and average moisture content of 6 pharmaceutical batches at different time periods. Figure 4 (a) shows the angles of repose of 6 pharmaceutical batches at different time periods. From the

data in the figure, the angles of repose of the three batches of Smilax glabra chewable tablets all fluctuated between 27.5° and 28°. When measured again at the 100th minute, the angles of repose were still within this range. The data at the 60th minute was used for average calculation, and the obtained angle of repose was 27.89°, which was smaller than the specified angle. The results indicated that the chewable tablet met the standards for fluidity testing. Figure 4 (b) shows the average moisture content of six pharmaceutical batches at different time periods. From the data in the figure, the average moisture content of the chewable tablets produced in three batches was below 5% at different time periods when measured. The average calculation was based on the data at the 100th minute, and the obtained angle of repose was 4.93%°, which met the production standards for Smilax glabra chewable tablets. After measuring the dry granules of Smilax glabra chewable tablets, an experiment is conducted to the quality of Smilax glabra chewable tablets. Figure 5 shows the prepared Smilax glabra multifunctional health product chewable tablets.

Figure 5 shows a picture of the produced Smilax glabra chewable tablets. The surface of the chewable tablets was flat, the particle color was consistent and the edges were regular, the color was brown, the taste was moderately sweet and sour with a slight bitterness. The hardness and weight difference of each piece of 6 batches of Smilax glabra chewable tablets are examined. The experimental results are shown in Figure 6.

Figure 6 shows the hardness and weight difference of six batches of Smilax glabra chewable tablets. Figure 6 (a) shows the hardness of six batches of Smilax glabra chewable tablets, with hardness values of 39N, 40N, 42N, 43N, 41N, and 42N for each batch, and a mean value of 41.66N.



**Fig. 4:** The average moisture content and angle of repose of three pharmaceutical batches at different time periods



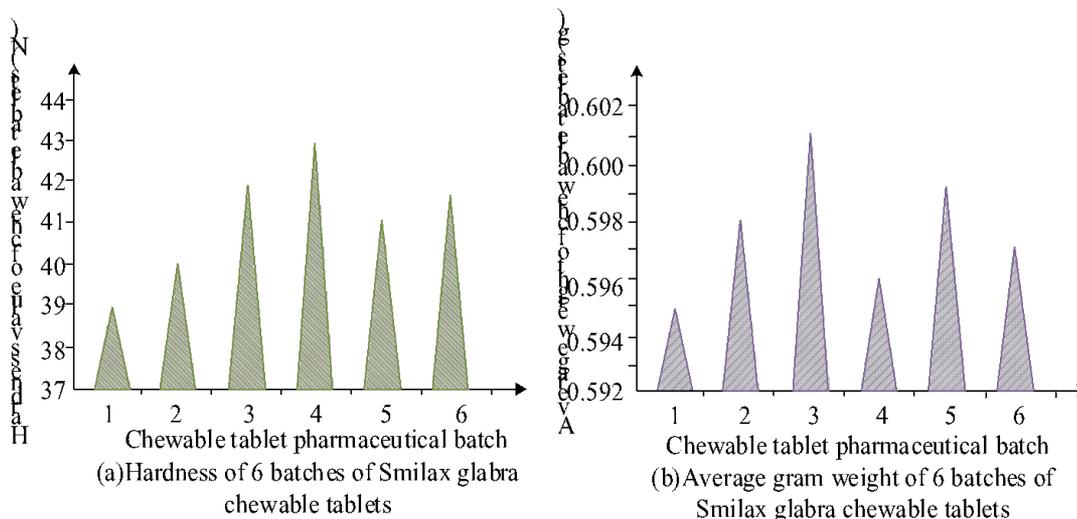
**Fig. 5:** Picture of the produced *Smilax glabra* chewable tablets

This result was consistent with the hardness requirements for chewable tablets in the Chinese Pharmacopoeia. Figure 6 (b) shows the average weight of 6 batches of *Smilax glabra* chewable tablets, with 15 tablets per batch. From the figure, the average weight of each batch was within the range of 0.570 to 0.630, and the relative deviation of the calculated average weight of each batch was less than 5%, which met the requirements of the Chinese Pharmacopoeia. The study uses high-performance liquid chromatography to determine the content and investigate the specificity of *Smilax glabra* chewable tablets. The experimental results are shown in Figure 7.

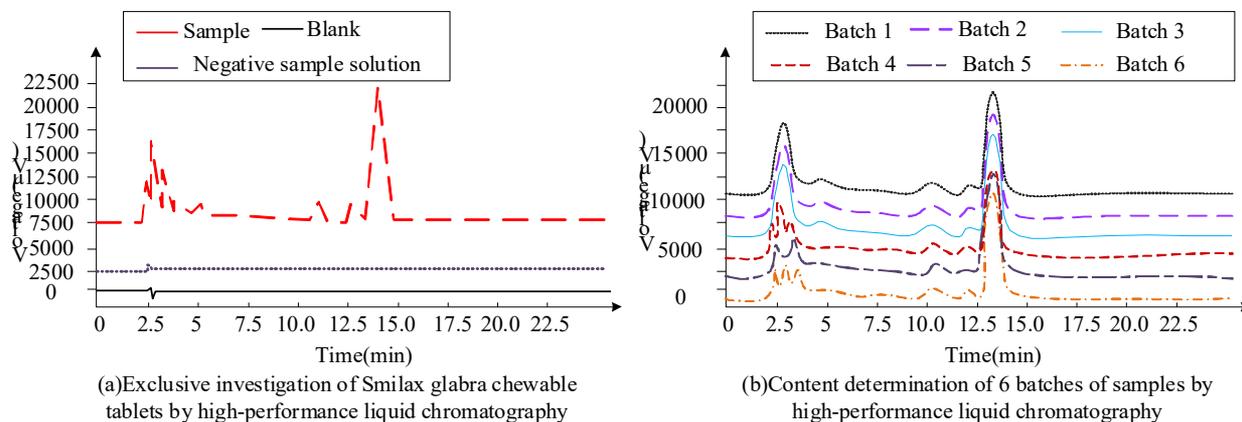
Figure 7 shows the results of content determination and specificity investigation of *Smilax glabra* chewable tablets. Figure 7 (a) shows the High-Performance Liquid Chromatography (HPLC) used to investigate the specificity of *Smilax glabra* chewable tablets. The chromatographic peaks of *Smilax glabra* chewable tablets had good separation from adjacent impurity peaks, and the negative control solution did not interfere within the corresponding retention time,

indicating the presence of Astilbin in the prepared *Smilax glabra* chewable tablets. Figure 7 (b) shows the HPLC chart of the content determination in 6 batches of samples, with an average content of 0.4367 mg/g. Considering variables such as the source, processing, and storage of medicinal materials, the content standard was set at 80% of the average value of the four batches of samples, calculated as  $0.4367 \times 0.8 = 0.3493$  mg/g. The average content detection results of flavonoids and Astilbin in *Smilax glabra* chewable tablets are shown in Figure 8.

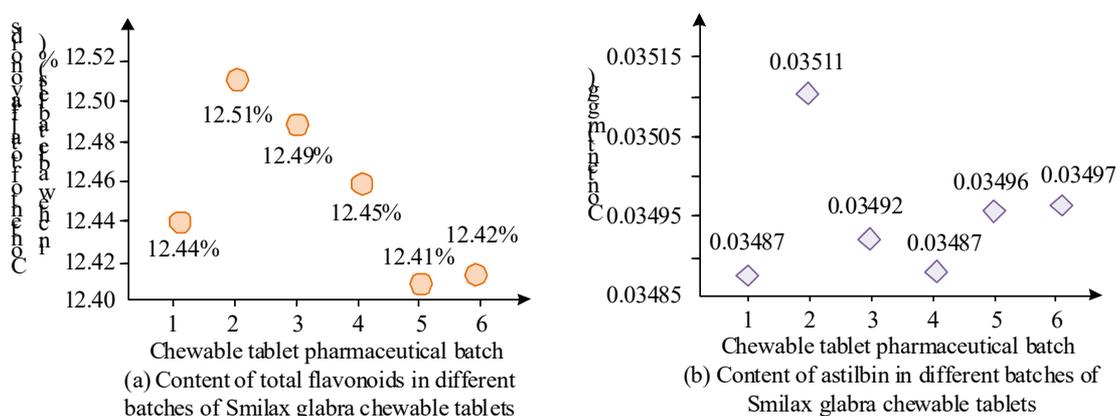
Figure 8 shows the average content detection results of flavonoids and Astilbin in *Smilax glabra* chewable tablets. Figure 8 (a) shows the total flavonoid content in different batches of *Smilax glabra* chewable tablets. The total flavonoid content in each batch of *Smilax glabra* chewable tablets was above 12.40%. After calculation, the average total flavonoid content of the five batches was 12.46%. Figure 8 (b) shows the Astilbin content in different batches of *Smilax glabra* chewable tablets. Based on the data in the figure, the Astilbin content in 6 batches of *Smilax glabra* chewable tablets fluctuated between 0.3487 and 0.3511 mg/g. After calculation, the average Astilbin content in these 6 batches of *Smilax glabra* chewable tablets was 0.03494 mg/g. The designed preparation process of *Smilax glabra* chewable tablets can maintain relatively stable flavonoids and Astilbin in different production batches. The results confirm that the prepared *Smilax glabra* chewable tablets can be used as a multifunctional health food containing bioactive ingredients.



**Fig. 6:** Test results of hardness and weight difference of 6 batches of *Smilax glabra* chewable tablets



**Fig. 7:** Content determination and specificity investigation of Smilax glabra chewable tablets



**Fig. 8:** Average content determination results of flavonoids and Astilbin in Smilax glabra chewable tablets

## Conclusion

Smilax glabra has traditional effects such as clearing heat and detoxifying, promoting diuresis and reducing swelling, while modern science has proven that it also has antioxidant and anti-inflammatory activities. Especially, Smilax glabra contains various bioactive ingredients such as Astilbin, which are suitable as functional ingredients in health foods. Therefore, the study proposed to optimize the preparation process of Smilax glabra extract to improve the extraction efficiency. Then, the production process of multifunctional health product chewable tablets based on Smilax glabra extract was developed. The experimental results showed that in the optimized preparation process, the optimal process conditions were determined through single factor experiments and response surface methods, including a 1:10 material-liquid ratio, 70% ethanol concentration, and 90 minutes of extraction time. This process can significantly improve the Astilbin extraction efficiency. The developed chewable tablets met the

standards in terms of physical and chemical properties as well as the content of bioactive ingredients. The average total flavonoid content was 12.46%, and the average Astilbin content was 0.03494 mg/g, demonstrating good formability and quality. The results confirmed the potential of Smilax glabra chewable tablets as a multifunctional health food containing bioactive ingredients. The limitation of the study is that laboratory test results have shown that chewable tablets have good formability and quality, but consumer acceptance and market feedback have not been validated. Future research can explore the actual effects of Smilax glabra chewable tablets in different populations, as well as how to further enhance the market competitiveness of the product.

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## Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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