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Schisantherin B: Review of Its Preparation, Biological Activities, Pharmacokinetics Analysis and Content Determination

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Abstracts: *Schisandra chinensis* (*S. chinensis*) is the dried mature fruit of *Schisandra chinensis* (Turcz.) Baill. Its primary active elements include polysaccharides, lignans, and other substances, and it is essential for neuroprotection, hepatoprotection, anti-inflammatory, antioxidant, and other functions. One of the components of lignan, schisantherin B (STB), is commonly extracted using ultrasonic extraction or a combination of ultrasonic and microwave techniques. The macroporous resin method is used to purify the extract at first. Pharmacological studies have shown that it has hepatoprotective, antitumor, and neuroprotective effects, among which hepatoprotective effects are more prominent, mainly by reducing the activity of intrahepatic ghrelin transaminase and improving liver damage. In addition, the pharmacokinetic analysis demonstrated that STB was well absorbed *in vivo* and was mainly in the form of passive transport in the gastrointestinal tract. The metabolic pathways in rats were also relatively diverse. At the same time, its content is related to the herb's traits, processing, storage methods, distribution, and other aspects. Therefore, the preparation, pharmacological effects, pharmacokinetic characteristics, and content determination of STB will be summarized, aiming to improve its knowledge system and provide a theoretical basis for subsequent more in-depth studies.

Keywords: *Schisandra chinensis*; Schisantherin B; pharmacological effects; pharmacokinetic; content determination.

1. Introduction

S. chinensis, a traditional Chinese medicine, has a long history of benefiting vital energy, nd generating fluids, astringent and astringent, tonifying the kidneys, nourishing the heart,

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and so on. It is often used in treating night sweats and spontaneous sweating, prolonged coughing and stra ining, diarrhea, and other conditions of kidney deficiency [1-3]. Its deciduous woody vine, in addition to the young leaves abaxially pilose and bud scales with ciliate hairs, the rest glabrous, young branches reddish-brown, old branches gray-brown, often wrinkled, flaky exfoliation, leaves membranous, the fruit is mostly irregularly spherical or compressed globular, 5-8 mm in diameter, the surface of the red, purple-red or dark red, wrinkled, apparently oily. Often produced in Heilongjiang, Jilin, Liaoning, 1200-1700 meters above sea level, such as gullies and valleys [2]. *S. chinensis* has various chemical compositions, mainly containing lignans, polysaccharides, volatile oils, and other components, with nervous system protection, anti-tumor, anti-inflammatory, and other pharmacological effects.

It has been found that the rich pharmacological effects of *S. chinensis* are closely related to the lignan components. STB protected against hepatic stellate cell senescence by mediating ferritin autophagy [3] and ameliorated arthritis in rats [4]. Schisandrin prevented ulcerative colitis by inhibiting the SGK1/NLRP3 signaling pathway [5], and STB induces HepG2 cells pyroptosis by activating NK cells mediated anti-tumor immunity [6]. However, the study of the pharmacological effects of STB mainly focused on hepatoprotective and antitumor effects, and the study of its mechanism is relatively weak. More potential pharmacological effects have not been explored. Secondly, there are systematic and comprehensive pharmacokinetic studies on schisandrol B [7], schisandrol A [8], and other monomers, while STB has been less studied in this regard. At the same time, its extraction and purification studies have only explored the ultrasonic extraction method, and most of the content determination studies are based on natural factors, so it can be seen that the extraction and purification, content determination of STB studies have certain limitations and are not comprehensive enough.

Therefore, it is necessary to summarize the existing literature reports on STB from 1976 to 2024, respectively, from the extraction and purification, pharmacological effects, pharmacokinetics, and content determination, to improve the knowledge system of STB, and provide a reference for more in-depth studies.

2. Preparation of the Extracts

2.1. Extraction of STB

Various methods can extract lignans, and factors such as extraction solvent, time, temperature, and material-liquid ratio will all affect the extraction rate. Initially, the most commonly used extraction method was the traditional solvent extraction method, which was time-consuming and consumed a lot of solvent. Subsequently, ultrasound-assisted method, enzymatic extraction method, and other extraction methods to a certain extent to make up for the shortcomings of the former method so that the lignans extraction is more efficient.

Modern research results show that lignans are one of the major components of *S. chinensis*. At present, there are more extraction methods for *S. chinensis* lignans, but fewer studies on the extraction of the monomeric components of the lignans, among which most of the extraction of STB was done by ultrasonic extraction. The 2020 edition of the Pharmacopoeia of the People's Republic of China for the content determination of the components of *S. chinensis* adopts the method of ultrasonic extraction. Zhang et al. used an ultrasonic extraction method to extract STB from *S. chinensis* and found that the yield of STB was 1.426 mg/g under the optimal process of ultrasonic temperature of 68 °C, material-liquid ratio of 1:8, ethanol mass fraction of 84%, and extraction time of 60 min [9]. The method is simple, energy-saving, environmentally friendly, time-saving, and labor-saving, and has a good extraction effect, but there are some limitations. Subsequently, Zhang et al. used an ultrasonic microwave synergistic-assisted method to extract STB, which can produce strong thermal, mechanical, and cavitation effects, thus promoting the penetration and dissolution of lignin components [10], and found that the optimal extraction process was as follows: 80% of ethanol as the extraction solvent, the material-liquid ratio of 1:20, the temperature of 60 ℃, the microwave power of 150 W, the ultrasonic power of 200 W, the extraction time of 30 min, and the content of STB obtained was 0.88% [11].

Furthermore, Liu et al. used pressure difference ultra-high pressure extraction technology (UHPE) to extract lignans, including STB, from *S. chinensis* fruits and vine stems under room temperature and high pressure. They determined the ideal solvent to use, which was 70% ethanol, 400 MPa of pressure, and 4 min pressure retention time. The dissolution of STB using this method varied depending on the site, with *S. chinensis* fruit (0.158 ± 0.082) > *S. chinensis* vine stem (0.029 ± 0.004) [12]. UHPE is frequently the method of choice for extracting natural substances because of its benefits, which include high efficiency, low macromolecule dissolution, speed, and the avoidance of structural alterations brought on by heat effects [13].

Finally, employing an ethanol-ammonium sulfate two-phase system as a green solvent, Cao et al. extracted STB by bubble-assisted dual-phase flotation. A dual-phase composition with 32.49w% salt concentration and 22.67w% ethanol concentration was found to be the optimal extraction process. This composition floated for 16.58 minutes at a rate of 68.75 mL/min and produced an extraction rate of up to 0.68 mg/g, which is 1.47 times higher than that of the conventional solvent method and is quick, environmentally friendly, and effective [14].

In conclusion, there are various extraction methods for STB. Although traditional solvent extraction method is simple to operate, it is difficult to avoid problems such as time-consumption, high solvent consumption, and a low extraction rate. Nowadays, the emergence of some new extraction methods (ultrasound-assisted method, UHPE, etc.), to a certain extent, makes up for the defects of the solvent extraction method: the extraction is more environmentally friendly, and the extraction efficiency is also increased. However, studies on the extraction methods of STB by other methods are still weak.

2.2. Purification of STB

Common solvents were used to extract the lignans of *S. chinensis*. However, these solvents are susceptible to resinification reactions, which result in low extraction rates. Impurities must be removed from the lignans to acquire the target components with greater purity.

The conventional process of alcohol precipitation is not very pure and takes a long time. On the other hand, macroporous resins, including AB-8 and HPD100, are typical varieties, have the advantages of being targeted, requiring fewer processes, and having fewer impurities.

However, the degree of purification varies depending on the type of resin. Zhang et al. discovered that the purity of the resin increased by 28.56% when the HPD100 type of macroporous resins was utilized for the initial purification of STB [9].

3. Biological Activities

Studies have shown that STB has diverse bioactivities, mainly focusing on the hepatoprotective effect, etc. The relevant pharmacological activities and mechanisms are summarized in Table 1.

3.1. Hepatoprotective Effect

STB has good efficiency in hepatoprotection by reducing the activity of related enzymes like glutamine aminotransferase (ALT) and even modifying lipid metabolism and other signaling route processes.

Bao et al. found that STB was able to attenuate CCl_4 and thioacetamide-induced liver injury in mice and rats and reduce SGPT, and its mechanism of action may be related to the reduction of ALT activity in animals with no effect on glutamic-oxaloacetic transaminase (GOT), and lactate dehydrogenase (LD) [15]. In turn, STB has good therapeutic efficacy when used to treat patients with chronic, migrating viral hepatitis [6]. In addition, after incubation *in vitro* with phenobarbital-induced rat liver microsomal suspensions and NADPH-containing buffer at the same temperature as schizosaccharomyces cerevisiae, STB can inhibit aminobilin demethylase of P-450 and benzo(a)pyrene hydroxylase (AHH) activity [16].

In addition to its action through the inhibition of related enzymes, STB also modulates signaling pathways to exert hepatoprotective effects. Among liver diseases, there exists a chronic disease closely related to obesity, hyperlipidemia, and metabolic syndrome, also known as Metabolic associated fatty liver disease (MAFLD). STB played a role in improving MAFLD by regulating the expression of key targets Akt1 and PPAR-γ in signaling pathways such as AMPK, as well as inflammation, lipid metabolism, and other pathways, for which it has a strong affinity [17]. In addition, Fan et al. found that STB can activate the progesterone X receptor and thus activate various signaling pathways, significantly reducing hepatic necrosis, aspartate aminotransferase (AST), alkaline phosphatase activity (ALP), serum total bile acids (TBA), and total bilirubin (Tbili), accelerate the metabolism of bile acids, and increase their efflux from the liver to the intestines, and ultimately, play a role in the prevention and treatment of cholestatic liver injury preventive and therapeutic effects [18]. Figure 1 illustrates the signal pathways related to the hepatoprotective effects of STB.

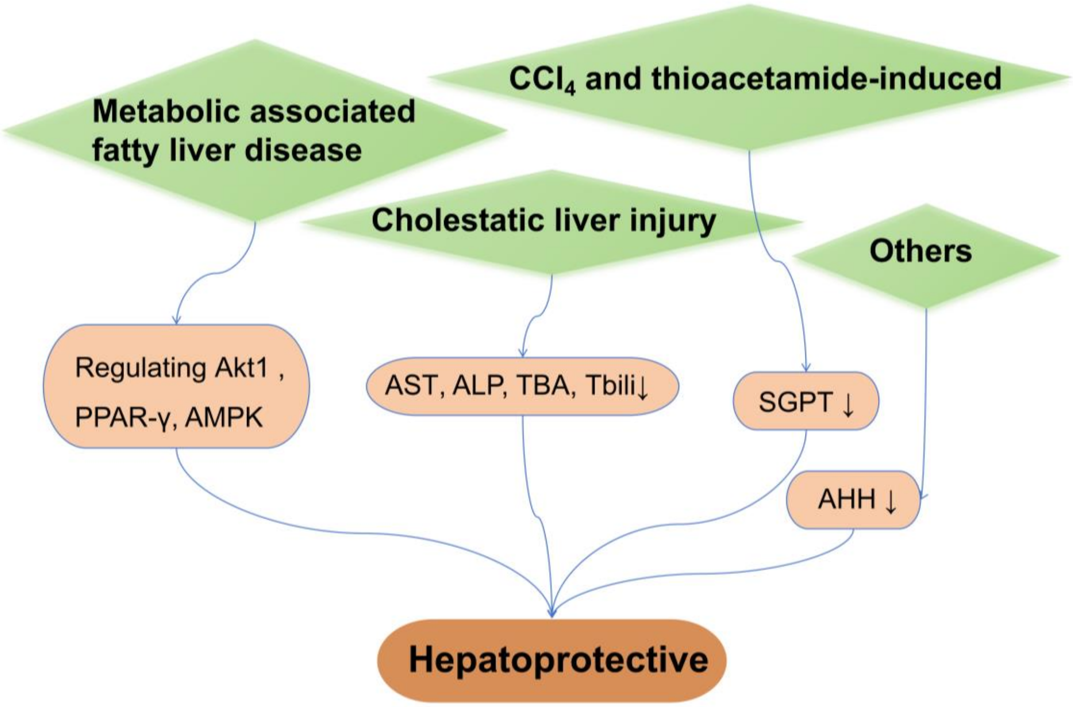

Figure 1. The signal pathways related to the hepatoprotective effects of STB

3.2. Antitumor Effect

Malignant tumors are one of the most common diseases endangering human health in today's society and remain a major clinical challenge that global medicine is trying to overcome. Studies have confirmed that some plants contain possible anti-tumor components.

Liu et al. analyzed the cytotoxicity and MDR reversal of STB alone or in combination with Adriamycin and Paclitaxel on drug-resistant A549/Tax cells and their parental-sensitive A549 cells with MTT assay and found that STB, through the substrate competitive inhibition of the drug efflux function and down-regulation of P-gp's protein level, was capable of in vitro efficiently reverse the resistance of lung cancer paclitaxel-resistant A549/Tax cells to a variety of chemotherapeutic drugs, thus favoring the treatment of lung cancer [19]. In addition, the combination of STB with low concentration of cisplatin enhanced the apoptosis susceptibility of intrinsically drug-resistant hepatocellular carcinoma Bel7402 cells by down-regulating the expression of anti-apoptotic protein Bcl-2 and up-regulating the expression level of activated Caspase-3, which significantly increased the apoptosis rate and the percentage of cells in S phase of Ble7402 cells [20].

3.3. Nervous System Protection

Central nervous system disorders are characterized by sensory, motor, and cognitive dysfunction, including Alzheimer's disease, Parkinson's disease, and depression, and their incidence is increasing every year. Currently, Chinese medicines play an important role in clinical treatment because of their multi-targets, multi-pathways, and relatively safe efficacy. Among them, STB has also shown good efficacy in neuroprotection. Xu et al. found that STB can promote the PI3K/AKT/mTOR pathway to increase glutamate transporter type 1 (GLT-1) levels and exert cognitive improvement ability, which is expected to be a therapeutic agent for depression [21]. Meanwhile, it also restored glycogen synthase kinase3β (GSK3β) activity and reduced the level of hyperphosphorylated tau protein in the hippocampus and cerebral cortex, which was protective against $A\beta_{1-42}$-induced cognitive deficits and neurodegeneration in mice [22].

3.4. Anti-asthmatic Properties

Bronchial asthma is a chronic inflammatory airway disease with high morbidity, and most of the clinical treatments use Western medications, but long-term consumption of these medications can produce side effects [23]. Lv et al. screened candidate targets of action of *S. chinensis* related to asthma through network pharmacology methods, and the most relevant compound was STB, indicating that it may inhibit the gene expression of pro-inflammatory factors through the regulation of signaling pathways such as NF-κB, PPAR, and interleukin 17 (IL-17), and thus play a therapeutic role in asthma [24].

3.5. Others

In addition to the pharmacological effects mentioned above, STB also had anti-oxidative stress [25] and improved osteoporosis.

Table 1. The pharmacology activities of STB

Biological activities	Models	Possible mechanism	Ref.
Hepatoprotective effect			
	CCl_4 and thioacetamide-induced liver injury	SGPT, ALT ↓	[15]
	CCl_4-induced liver injury	GPT ↓	[6]
	Phenobarbital-induced rat	P-450, AHH ↓	[16]
	MAFLD	Regulating the expression of Akt1, PPAR-γ, AMPK	[17]
	LCA-induced intrahepatic cholestasis	AST, ALP, TBA, Tbili ↓; progesterone X receptor ↑	[18]
Antitumor effect			
	A549 cells, drug-resistant A549/Tax cells	P-gp ↓	[19]
	Bel7402 cells	Bcl-2 ↓; Caspase-3 ↑	[20]
Nervous System Protection			
	$A\beta_{1-42}$-induced mice	Restored GSK3β, tau ↓	[21]
	Male KM mice	PI3K/AKT/mTOR pathway, GLT-1 ↑	[22]
Anti-asthmatic			
	-	NF-κB, PPAR signaling pathways	[24]
Others			
	Mouse bone marrow macrophages	NF-κB signaling pathway, osteoclasts ↓	[26]

It can dose-dependently inhibit osteoclast formation and bone resorption, intervene to reduce the level of NFATc1 mRNA gene expression in osteoclasts, and inhibit the formation of osteoclasts by modulating the expression of phosphorylation levels of proteins related to the Receptor activator of nuclear factor κ-B (RANK)-induced NF-κB signaling pathway, thus improving osteoporosis in ovariectomized mice [26].

4. Pharmacokinetics

As a traditional Chinese medicine, *S. chinensis* is rich in pharmacological effects and inevitably has to be used in combination with a variety of chemical drugs. However, *S. chinensis* contains various active ingredients, mainly lignans, and there have been fewer studies on the pharmacokinetic profiles of the single components of *S. chinensis in vivo*. Therefore, it is necessary to carry out pharmacokinetic studies on the components in compound prescriptions one by one to provide a reference for clinical dosage and treatment. Taking STB as an example, the pharmacokinetic characteristics were summarized to further understand the *in vivo* process of *S. chinensis*-containing compound prescriptions.

It was found that the major components of *S. chinensis*, such as STB, can alter the absorption and metabolism of other drugs by affecting CYP 450, P-glycoprotein (p-gp), pregnane X receptor (PXR), nuclear factor-related factor (Nrf2), and multidrug resistance-associated protein (MRP1) [27]. The results showed that the apparent permeability coefficients (Papp) and spillover ratios (Er) were all greater than 1×10^{-6} cm/s by the MDCK monolayer cell model, which showed that STB had good oral absorption, and the Er values were all between 0.7 and 1.2, and the absorption in the gastrointestinal tract was mainly based on the passive transport [28]. In addition, *S. chinensis* lignans often undergo metabolic transformations such as oxidation, demethylation, and hydroxylation in rats [29], and the main metabolic pathways of different lignan com ponents are not identical, among which STB mainly undergo metabolic transformations such as oxidation, demethoxylation, and desmethylation [30].

5. Content Determination

Studies have shown that the content of STB was affected by several factors, such as traits, processing methods, storage conditions, different regions, extraction conditions, etc. At present, the HPLC method is often used to determine the content of STB in traditional Chinese medicine prescriptions, which is simple, rapid, stable, accurate, and reliable (Figure 2), and there are very few cases in which the content of STB has been determined by the one-sided multi-evaluation method. The related studies on STB determined by the HPLC method are listed in Table 2.

Table 2. The studies related to the determination of STB by HPLC method

NO.	**Name**	**Chromatographic Conditions**	**Linear Range**	**Precision （RSD）**	**Repeatable （RSD）**	**Stability （RSD）**	**Sample Recovery/ RSD**	**Ref.**
1	Compound Wurenchun Capsules	C_{18} column, methanol-0.1% phosphoric acid, 30℃, 217 nm, 1 mL/min	0.0227 ~ 0.681 μg/μL (r = 0.9999）	1.03%	0.74%	0.84%	100.23%	[31]
2	Shenqi Wuweizi Capsule	C_{18} column, acetonitrile (5% tetrahydrofuran)-0.05% formic acid, 35℃, 230 nm, 1 mL/min	0.0717 ~ 1.4340 μg/μL (r = 0.9994）	0.65%	1.71%	1.75%	102.95%/1.63%	[32]
3	Wuzhi Tablets	C_{18} column, acetonitrile-0.1% phosphoric acid, 30℃, 225 nm, 1.0 mL/min	0.0227 ~ 0.681 μg/μL (r = 0.9999）	1.08%	0.77%	1.45%	98.62%/2.85%	[33]
4	Xiaoer Huanglong granules	C_{18} column, methanol:acetonitrile(2:1)-0.2% phosphoric acid, 40℃, 254 nm，0.8 mL/min	0.54 ~ 8.64 μg/mL (r = 0.9999）	0.20%	0.82%	1.50%	102.9%/3.7%	[34]
5	Compound Yiganling tablet	C_{18} column, methanol-0.1% methanoic acid, 0.3 mL/min	0.01 ~ 0.32 μg/mL (r = 0.9971）	＜3.3%	2.20%	＜3.5%	98.2%/1.4%	[35]

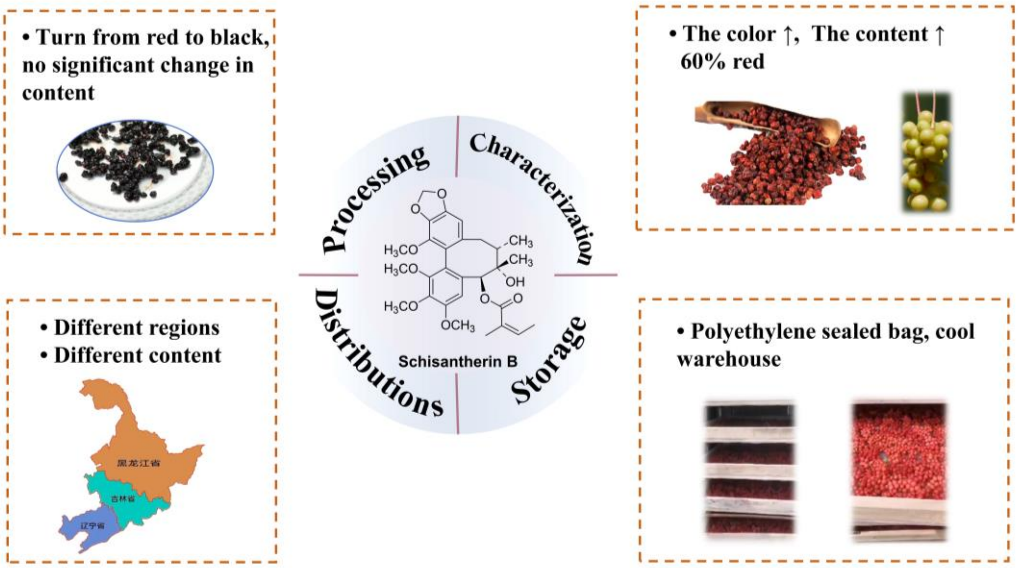

Figure 2. The content determination of STB

5.1. Characterization

Whether it is plant, animal, or mineral herbs, their shape, color, size, smell, and other characteristics are unique, and the amount of active ingredients contained in traditional Chinese medicine is also closely related to it.

The study shows that *S. chinensis* differs in color shades and contains different amounts of STB. Wu et al. evaluated the shape of *S. chinensis* by fruit diameter and color and measured the content of lignans such as STB, and found that the darker the color, the higher the content of STB in *S. chinensis*, but there was no significant regression relationship, and there was no correlation between the diameter and the content [36]. Meanwhile, Lv et al. showed that in the same harvest period of *S. chinensis*, the maturity of the fruit also affects the content of active ingredients, which STB is more affected by. STB is the largest content at 60% red, and it is significantly reduced at more than 70% red [37].

5.2. Vinegar-Processed Products

Processed traditional Chinese medicine is an indispensable part of the application of traditional Chinese medicine, so as to achieve the goal of "enhancing efficacy and detoxification", maximize the efficacy of the medicine, and ensure the safety of clinical use. After the processing of *S. chinensis*, the lignans, such as STB, were reduced to a certain extent, which may be due to the hydrolysis of the ester bond during the preparation process, resulting in the reduction of the content [38]. Dai et al. found that the samples of *S. chinensis* changed from red to black after vinegar preparation, and the content of lignans such as STB did not change significantly [39]. However, the changes were not consistent from batch to batch, but the enhancement of pharmacodynamic activities such as acidity and astringency and astringency after vinegar preparation suggests that this may be the presence of changes in the content of other classes of constituents, which may lead to the enhancement of pharmacodynamic activities [40]. It can be seen that the increase in the pharmacodynamic activity of *S. chinensis* after concocting is not only related to the change in lignan content but may also be related to the content of other components.

5.3. Processing, Storage Methods

The initial processing of the origin of the herbs and the storage of the herbs is an important part of its production and quality formation [41]. The traditional processing of *S. chinensis* is mostly sun drying, but the method is susceptible to the weather, and effective storage technology can reduce the storage process due to its own characteristics and storage environment factors on the quality of *S. chinensis*, which have adverse effects.

Chen et al. determined the effects of different processing methods on the lignan content in *S. chinensis* by UFLC-QTRAP-MS/MS and comprehensively found that the most suitable processing method was the processing method without steaming and direct hot air constant temperature drying at 45°C to 35% moisture content followed by sun drying [42]. At the same time, the most suitable storage condition for its polyethylene sealed bag as an outer packaging stored in a cool warehouse [43]. After harvesting the fruits of *S. chinensis*, the quality of the samples of *S. chinensis* treated by blanching and microwaving to destroy the enzyme activity before drying was better than that of the samples dried directly in the sun and dried, in which the content of STB was higher [44]. In addition, the content of STB in the samples of processed *S. chinensis* dried at 55 °C for 20 h was higher than that in the processing methods of 40 °C, 45 °C, and 50 °C [45], and the content of STB was higher in the drying at 50 °C compared to sun drying [46].

5.4. Distributions

The content of lignans such as STB is also related to the distribution area of *S. chinensis* and its parts. Studies have shown that the content of lignan contained in southern and northern *S. chinensis* varies from region to region [47]. In general, the lignans content of *S. chinensis* is generally higher than that of *Schisandra sphenanthera*, and it is recommended that on the basis of the single-indicator quality control of the Chinese Pharmacopoeia, a mass fraction of not less than 0.4% of *Schisandra sphenanthera* extract and not less than 0.1% of *S. chinensis* extract should be included for reference [48]. Meanwhile, although the fruits and leaves of *S. chinensis* contain similar composition, the lignans content is very different, and lignans such as STB are higher in the fruits than in the leaves [49].

5.5. Others

In addition, the composition of traditional Chinese medicine is complex and affected by a wide range of factors, and a single indicator can not fully reflect the quality of *S. chinensis*. Zhu et al. used the response surface method to analyze the effect of the material-liquid ratio and other factors on the lignans content of STB and other lignans content, and the results show that the intensity of the impact in the order of the material-liquid ratio > methanol volume fraction > ultrasound time, the optimal extraction process for the ultrasound time of 30 min, the volume fraction of methanol for 100 percent, material-liquid ratio 1:50 [50].

6. Conclusion and Perspective

In summary, the current research on STB is still relatively limited, mainly focusing on extraction and purification, pharmacological effects, content determination, and pharmacokinetics. The extraction of STB was mostly carried out by ultrasonic extraction method, which has less solvent consumption and shorter extraction time than the traditional solvent extraction method. Of course, with the continuous innovation of scholars, microwave extraction and ultrasonic extraction are often combined, which shows that the extraction rate of STB is higher than that of the ultrasonic extraction method, and even scholars have found that the use of the pressure difference to make the chemical components fully diffuse, to avoid the thermal effect leading to structural changes, to achieve the purpose of high efficiency of the extraction, and this ultra-high pressure technology is often used as the preferred method for the extraction of natural compounds [13]. However, the extraction rate of STB is still unsatisfactory, and there are gaps in the research on other methods for the extraction of STB. In addition, the preliminary purification of STB by the macroporous resin method and its further purification studies are worth exploring, thus laying the foundation for the subsequent activity studies of STB.

Second, STB has hepatoprotective, antitumor, neuroprotective, and other pharmacological effects. But sadly, the research on the pharmacological effects of STB is only superficial. For example, the hepatoprotective effect of STB is only illustrated by decreasing the activity of enzymes such as ghrelin and other enzymes in intrahepatic cells, and the antitumor effect is only manifested by promoting apoptosis through increasing or decreasing the up-regulation or down-regulation of the relevant proteins, thus exerting an antitumor effect. Other pharmacological effects have been even less well studied and have only been mentioned in a few papers. Therefore, if the mechanism of the hepatoprotective and antitumor activities of STB is explored through in vivo and ex vivo experiments as well as at the cellular and molecular levels and supplemented with the rest of the studies on its pharmacological effects, it will deepen the understanding of STB, and provide a theoretical basis for its development and utilization.

In addition, research on the active ingredients of traditional Chinese medicine will ultimately serve mankind, with the hope that the treatment of human diseases will be effective and have fewer side effects. The human body is a complex individual. Drugs in the body often need to go through the absorption, distribution, metabolism, and excretion of four processes. STB has good absorption and in the gastrointestinal tract, is often in the form of passive transport. At the same time, the metabolic pathway is also more diverse, the main metabolic pathways occur in the oxidation, demethoxylation, desubstituted and other metabolic pathways. However, the pharmacokinetic study of STB still has some limitations and is not comprehensive enough, and the current in vivo studies on it mostly involve normal animals, with fewer reports on disease models. In addition, the studies have been carried out on *S. chinensis*, which indicates that STB therein is well absorbed, the description of the absorption process is not clear, and there are gaps in the distribution and excretion studies. Secondly, herbal treatments often utilize synergistic effects between multiple drugs to achieve better therapeutic efficacy; therefore, it is more beneficial to study the pharmacokinetic characteristics of *S. chinensis*-containing combinations in humans in order to clarify the pharmacokinetics of STB in the human body.

Finally, the fruit maturity, active ingredient content, and therapeutic efficacy of *S. chinensis* vary with the same harvest period due to a variety of factors such as temperature and humidity [51-52]. It has been found that the content of STB is related to its own characteristics, processing and storage methods, and its content is often determined by HPLC, which is a sensitive, and efficient method. However, nature is inherently an uncontrollable factor, which adds to the difficulty of studying the determination of its content.

In conclusion, lignans, as the main components of *S. chinensis*, including schisandrin B, schisandrol A and Schisandrin C, have been studied relatively more [53-56], while STB has been studied only a handful of times, and its potential pharmacological effects and other aspects are worth exploring, and it is expected to be widely exploited and utilized.

Author contributions

All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

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Competing Interests

The authors declare that there is no conflict of interest.

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