RESEARCH PAPER

Aspen Bark-Based Phytocomplexes: Applications in Health Nutrition

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ABSTRACT
This article provides a comprehensive analysis of the development, technological optimization, and standardization of innovative dietary supplements derived from aspen bark (Populus tremula) extract. The study substantiates the critical relevance of utilizing this botanical resource as a potent source of bioactive phenolic glycosides-specifically salicin-alongside flavonoids and polyphenolic compounds, which are essential for the prevention and adjunctive therapy of diverse metabolic disorders. Integral to the research are the detailed quality control methodologies and the empirical results of chemical profiling conducted via High-Performance Liquid Chromatography (HPLC), ensuring precise identification of active markers. The work meticulously delineates the multi-stage technological manufacturing schemes and proprietary formulations for two distinct delivery systems: 'Ekorsol +' granules and the high-potency 'Ekorsol – Forte +' capsules. By establishing rigorous standardized organoleptic and physicochemical parameters-ranging from moisture content and disintegration rates to quantified thresholds for salicin and flavonoids-the research confirms the products' full compliance with contemporary safety and efficacy mandates. Ultimately, these phytocomplexes represent a scalable advancement in pharmaceutical technology, offering standardized therapeutic solutions within the global health nutrition and nutraceutical segments for metabolic health management.
Keywords: Aspen bark, Populus tremula, Phytocomplexes, Salicin, metabolic disorders, Nutraceuticals, Pharmaceutical technology, Standardization, HPLC
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INTRODUCTION

Natural biologically active substances (BAS) and their complexes are widely used as specialized products and dietary supplements in the prevention and comprehensive treatment of various metabolic disorders. One such source is aspen bark (Populus tremula), an accessible and widely distributed raw material ingredient [1-5].

Aspen bark and its specific components (inner bark/bast and outer bark) contain a broad spectrum of BAS possessing various functional properties [6-10].

From the perspective of practical medicine, phenolic glycosides, flavonoids, and polyphenolic compounds are of greatest interest. The primary natural phenolic glycoside is salicin, whose therapeutic effect is associated with its oxidation in the body to salicylic acid [10-15]. Other representatives of this BAS group, such as salicortin, tremuloidin, and tremulocin, have also been identified and utilized.

Among phenolic compounds, flavonoids are noteworthy due to their biological activity. N-cresol and 2-methylhydroquinone have been isolated and identified from bast and bark extracts; these substances are capable of inhibiting the growth of undesirable microorganisms, thereby performing protective functions [16-19].

Within the flavonoid group, studies have focused on luteolin, rutin, naringenin, and its 7-methyl ether—sakuranetin, which possesses gastroprotective properties [20-22]. Other discovered flavonoids, such as chrysin, rutin, hyperoside, and quercitrin, also exhibit individual functional profiles, opening prospects for their use in the development of specialized products and dietary supplements [9-12]. Tannins represent the polyphenolic compounds.

Given the pharmacological properties of the aforementioned BAS, aspen bark is widely used in traditional and scientific medicine as a means of preventing and treating numerous diseases [16-20].

MATERIALS AND METHODS

Moisture mass fraction: Determined using an "Elvis 2" analyzer by drying at 85°C to a constant mass for 15 minutes [23-33].

Solubility: A 2 g sample of the supplement is dissolved in 50 cm³ of purified water. The granule must dissolve completely within 10 minutes.

Quantitative determination of simple phenols calculated as salicin: Performed according to the Guidelines for Methods of Control of the Quantity and Safety of Biologically Active Dietary Supplements (R 4.1.1672-03).
Determination of total flavonoids calculated as luteolin: According to GOST 21908.
Determination of disintegration for hard gelatin capsules (according to Appendix 3 of the "Capsules" article, State Pharmacopoeia XI, ed. 2):
The test is conducted on a laboratory identifier consisting of a basket assembly with glass tubes 77.5–80.0 mm long (2 mm thickness, 21.5 mm diameter); a 1 m³ liquid vessel; a thermostatic device maintaining temperature at 37±2°C; and an electromechanical device providing reciprocating motion in a vertical plane (frequency 28–32 cycles/min, distance 50–60 mm). Glass tubes are fixed vertically by two plastic disks. For testing, one capsule is placed in each tube, then submerged in the vessel at 37±2°C with 0.1 N hydrochloric acid solution. Capsules must disintegrate within 15 minutes [34-42].
Determination of total flavonoids calculated as rutin:
An exact sample (0.5 g) is dissolved in a volumetric flask (25 cm³) in 50% ethanol, brought to the mark with alcohol, and stirred (Solution A). The resulting solution is placed in a 10 cm³ volumetric flask, 1 cm³ of 2% aluminum chloride solution in 95% ethanol is added, and the volume is brought to the mark. After 30 minutes, optical density is measured on a spectrophotometer in a 10 mm cuvette at a wavelength of 415 nm. The reference solution is 1 ml of Solution A with 1 drop of acetic acid, brought to the mark in a 10 cm³ flask with 95% ethanol.
Simultaneously, the optical density of the Rutin Reference Standard (RS) is measured. For this purpose, an exact weight (0.05 g) of pre-dried rutin (3 hours at 130–135°C) is dissolved in a 100 cm³ volumetric flask in 85 cm³ of 95% ethanol, heated in a water bath until completely dissolved, cooled, brought to the mark, and stirred. 0.5 cm³ of this solution is placed in a 10 cm³ volumetric flask, 0.5 cm³ of 2% aluminum chloride solution is added, and the volume is brought to the mark with ethanol.
The flavonoid content is calculated using the formula:
$x = \frac{D \cdot m0 \cdot 25 \cdot 10 \cdot 100}{D0 \cdot m}$, where
D – optical density of the test solution;
D0 – optical density of the rutin RS solution;
m – mass of the test sample, g;
m0 – mass of rutin, g.
Studies of the chemical composition of aspen bark were conducted using HPLC with the detection of UV-absorbing substances (Milichrom A-02 chromatograph, Prontosil-120-5 C18AQ reverse-phase columns).

RESULTS AND DISCUSSION

Studies of the aspen bark chemical composition were conducted at the physicochemical laboratory of "Biolit" LLC. **Figure 1** shows a chromatogram of the aspen bark extract, indicating the retention volume of salicin (689 nm), the key biologically active component of the supplement [43-53].

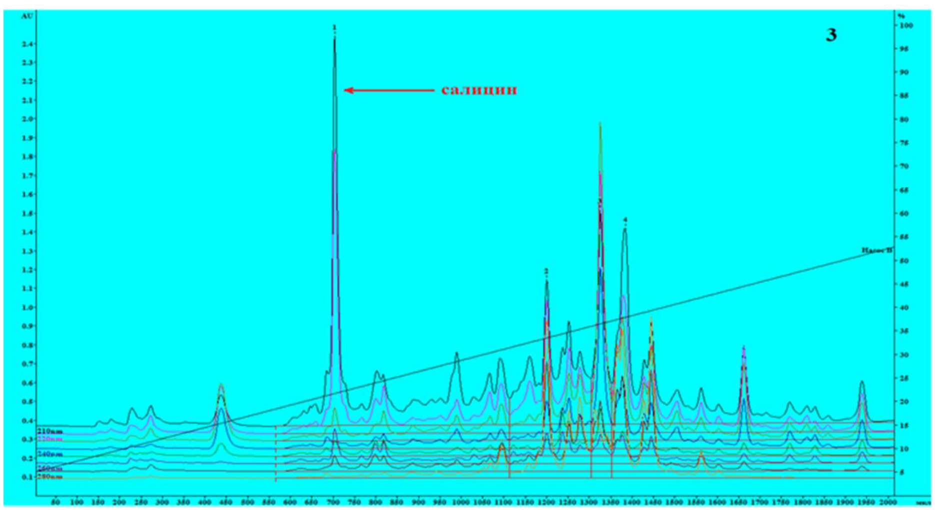

Figure 1. Chromatograms of aqueous extracts of aspen bark

Biologically active phytocomplexes based on aspen bark extract have been developed and registered as dietary supplements: "Ekorsol +" and "Ekorsol – Forte +".
Granulated form "Ekorsol +". Composition per 1 g of product: aspen bark extract (Populus tremula) – 0.25 g; golden thoroughwax herb (Bupleurum aureum) – 0.01 g; glucose (sorbitol, fructose, lactose) – 0.74 g.
Appearance: a homogeneous granulated free-flowing mass.
Established regulated organoleptic characteristics: appearance – granules with a diameter of 1.0 to 4.0 mm, absent of foreign mechanical impurities; color – light to dark brown; taste – bitter; odor – specific [54-64].
Physicochemical indicators are presented in **Table 1**.

Table 1. Regulated physicochemical indicators of the "Ekorsol +" phytocomplex.

Indicators	Characteristics
Solubility in water, min, max	10.0
Moisture mass fraction in granules, %, max	10.0
Content of simple phenols calculated as salicin, %, min	0.5
Total flavonoids calculated as luteolin, %, max	0.5

Production Technology. Presented in **Figure 2**. The process begins with raw material preparation based on the analysis of accompanying documents, labeling, and identification.

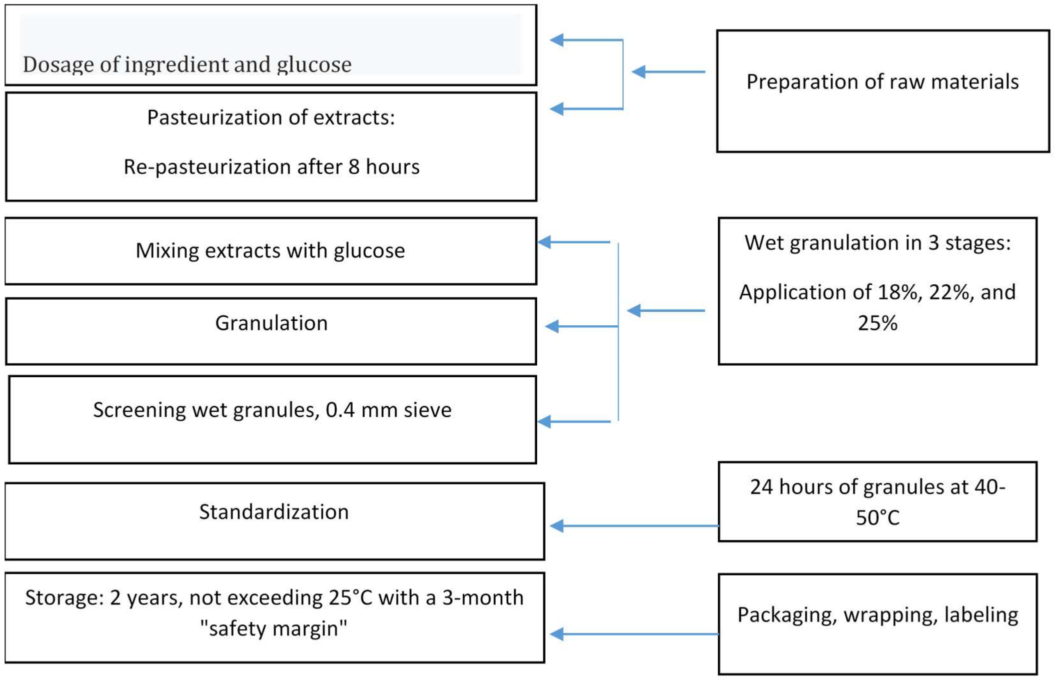

Figure 2. Technological scheme of " "Ekorsol " production

Initial extracts and glucose are dosed according to the recipe. Thick extracts are loaded into a reactor-sterilizer, pasteurized at 85°C for 3 hours, and then drained into clean, labeled containers. The pasteurization process is repeated after 8 hours, followed by microbiological analysis. The material is then sent to the wetting stage (wet granulation) in 3 stages: application of 18%, 22%, and 25% extract solutions. Extracts are pre-mixed with glucose in a mixer. The wet granulate is sifted through a 0.4 mm sieve and transferred to a drying chamber (45–50°C). After standardization for organoleptic, physicochemical, and hygienic safety indicators, the product is filled, packaged, and labeled.

Capsulated form "Ekorsol – Forte +". Product recipe per 1 capsule (0.6 g): dry aspen bark extract (Extractum cortices tremulae) – 0.425 g; dry golden thoroughwax herb extract (Bupleurum aureum) – 0.01 g; MCC (microcrystalline cellulose) – 0.049 g; rutin – 0.001 g; talc – 0.005 g; aerosil – 0.01 g.

Production Technology. Consists of the following main stages **(Figure 3)**.

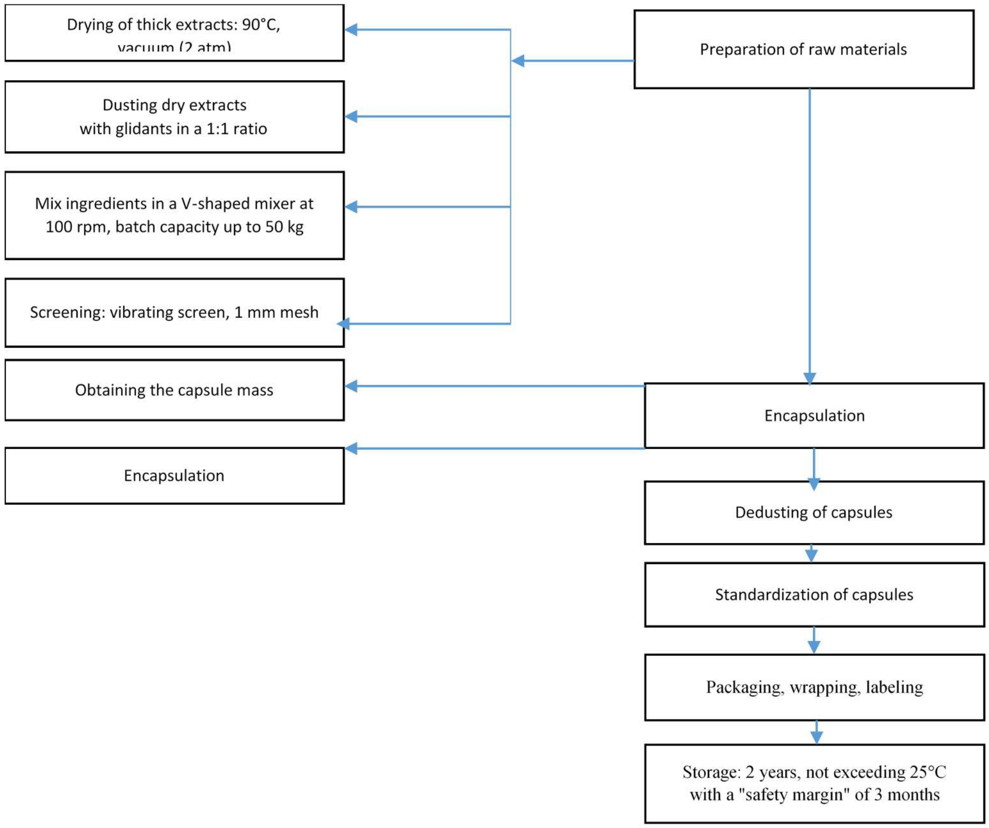

Figure 3. Technological scheme of production of dietary supplement "Ekorsol - Forte +"

Raw material preparation includes the production of dry extracts using vacuum-pulse drying at 90°C in a vacuum (2 atm). To obtain 85 kg of dry aspen bark extract, 200 kg of thick extract is required per 100 kg of "Ekorsol-Forte +"; for dry golden thoroughwax herb extract, these values are 2.0 : 5.0 : 100, respectively. Due to the high hygroscopicity of dry extracts, they are powdered with gliding agents (talc, aerosil) in a 1:1 ratio before mixing all ingredients. Dosing and mixing are performed in a V-shaped mixer at 100 rpm with a load volume of up to 50

The finished mixture is sifted through a 1.0 mm mesh vibrating sieve and transferred to the encapsulation stage. After filling on an encapsulation machine, the finished supplement is de-dusted, standardized according to technical documentation requirements, filled, packaged, and labeled.

Regulated organoleptic quality indicators: appearance of capsule contents – powder; color – light to dark brown with permissible dark and light inclusions; taste and odor – characteristic.

Physicochemical characteristics are presented in **Table 2**.

Table 2. Regulated physicochemical quality indicators of the "Ekorsol – Forte +" phytocomplex.

Indicators	Characteristics
Content of simple phenols calculated as salicin, %, min	1,0
Flavonoid content calculated as rutin, %, min	0,5
Moisture mass fraction, %, max	5,0
Disintegration of hard gelatin capsules, min, max	15,0
Average weight of capsule contents, g	05±10%

The developed phytocomplexes have found application as a means of correcting metabolic disorders in various diseases.

CONCLUSION

In summary, this research confirms that phytocomplexes derived from Populus tremula offer a scientifically grounded, scalable approach to managing metabolic health through standardized nutraceutical delivery. By integrating rigorous HPLC analytical techniques with controlled pharmaceutical manufacturing-ranging from granulated to encapsulated delivery systems-the study ensures both therapeutic consistency and consumer safety. The high concentrations of bioactive phenolic glycosides, particularly salicin, underscore the significant potential of these extracts in professional clinical settings. As the nutraceutical industry embraces evidence-based formulation, the standardization of aspen bark products provides a reliable framework for future dietary interventions, reinforcing the necessity of high-quality botanical processing in contemporary medicine.

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Ethics statement: None

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