RESEARCH ARTICLE

Application of sea buckthorn extract in cosmetics for its antioxidant and anti-aging effects

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Sea buckthorn (*Hippophae rhamnoides* L.), as a multifunctional natural plant, is rich in various bioactive substances in its fruits and seed oil, especially known for its antioxidant and anti-aging effects. The aim of this research was to explore the antioxidant and anti-aging effects of sea buckthorn extract in cosmetics and to conduct in-depth research on its application in the cosmetics industry. The scavenging abilities of sea buckthorn extract on 2,2-diphenyl-1-picrylhydrazyl radical (DPPH free radical) and hydroxyl radicals were evaluated through *in vitro* antioxidant activity tests. In addition, the human skin application tests were conducted using cosmetic samples prepared in the laboratory to evaluate their safety and anti-aging effects. The research results indicated that sea buckthorn extract had significant antioxidant activity, which could effectively eliminate free radicals, enhance cellular antioxidant capacity, and reduce environmental damage to the skin. Adding sea buckthorn extract to cosmetics could significantly enhance the antioxidant and anti-aging functions of the product. The skin application tests proved that it had good safety and user acceptance, which also indicated that sea buckthorn extract had enormous market potential and application value as an active ingredient in cosmetics.

Keywords: sea buckthorn extract; antioxidant; anti-aging; cosmetics; active ingredient.

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Introduction

With the improvement of people's living standards and the enhancement of health awareness, the demand for cosmetics has gradually shifted from simple cleaning and beautification to nursing products with health functions. Among them, preventing skin aging and protecting the skin from external harm are the focuses of particular concern for consumers [1, 2]. Natural plant extracts have been widely studied and applied due to their excellent biological activity and relatively low side effects. Sea buckthorn (*Hippophae rhamnoides* L.) is a deciduous shrub or small tree that grows in cold and arid regions. Its fruits and oils are considered a beneficial natural resource for health. Sea buckthorn extract is rich in vitamin E, vitamin C, flavonoids, and various unsaturated fatty acids. These ingredients have been proven to have strong antioxidant and anti-inflammatory effects. Especially with its antioxidant properties, sea buckthorn demonstrates great potential in preventing skin aging and repairing oxidative damage [3, 4]. In the field of cosmetic science, studying how to use natural plant extracts to develop safe and effective skincare products has become a hot topic.

Numerous scholars have conducted relevant research [5]. Dammak *et al*. proposed the use of microalgae organisms to prepare

environmentally friendly cosmetics for the protection of human skin. The 90-day acceleration stability was analyzed under two different thermal experimental conditions at 25℃ and 40℃. The results showed that the acidity and alkalinity of all the formulas proposed in the research were within the normal pH range of human skin, and the cosmetics had high antioxidant activity [6]. de Lima Cherubim *et al*. analyzed the importance of phenolic compounds in human beauty and dermatology and summarized the actual mechanism of action and combination composition of phenolic substances. Ultimately, it was believed that the use of phenolic extracts could serve as a practical alternative to modern cosmetics and ensure a commitment to sustainability concepts [7]. Jiang *et al*. analyzed the physicochemical properties, oxidative stability, and cellular anti-inflammatory potential of sea buckthorn pulp during the refining process. It was found that both oxidation stability index (OSI) value and anti-inflammatory potential were significantly increased, and there was a very significant relationship between the phenol concentration in sea buckthorn and the OSI value and cellular anti-inflammatory potential [8]. Wang *et al*. specially developed a database to analyze the plant chemical components of sea buckthorn. The database contained a total of 106 nutritional components and 74 biological activities, providing a detailed introduction to the health functions, antioxidant, and anti-inflammatory mechanisms of sea buckthorn and its extracts. More cost-effective products were expected to be developed through this database [9]. Tkacz *et al*. proposed a method for identifying and detecting plant components using ultra-high performance liquid chromatography triple quadrupole mass spectrometry (UHPLC QqQ MS/MS) to analyze the chemical composition and characteristics of sea buckthorn plants. The prostaglandins and plant furans in sea buckthorn plants were first measured. The results found that sea buckthorn juice had anti-enzyme and antioxidant abilities, and these two abilities were significantly related to the selectivity of plant components [10]. All those results from the past research indicated that the study of sea buckthorn extract could provide new ideas for cosmetic additives and helped create a new generation of anti-aging cosmetics.

Although there are many methods for extracting and purifying sea buckthorn leaf flavonoids, the extraction rate and purification rate are not high. In order to improve the extraction rate and utilization value of sea buckthorn leaf flavonoids and polysaccharides, this study used ultrasound-assisted extraction of sea buckthorn crude polysaccharides and tested the best extraction conditions. The secondary purification through AB-8 macroporous adsorption resin and AR polyamide resin was then performed to purify sea buckthorn flavonoids before analyzing the components of the purified product using LC-MS coupled analysis. Based on the antioxidant properties of sea buckthorn extract, the application in cosmetics was explored, and the actual effect in anti-aging was evaluated. It was expected to develop the application potential of sea buckthorn extract through this research to provide new ideas for the research and development of new products in the cosmetics industry, and ultimately to provide consumers with safer and more effective anti-aging cosmetics choices and improve the product quality and the market competitiveness of cosmetics industries.

Materials and Methods

Acquisition and determination of sea buckthorn polysaccharides

Sea buckthorn polysaccharides are bioactive substances extracted from sea buckthorn and belong to the polysaccharide category. Polysaccharides are high molecular weight carbohydrates composed of ten or more monosaccharides connected by glycosidic bonds. Sea buckthorn polysaccharides are one of the important physiological active components in sea buckthorn, mainly present in the fruits, leaves, and bark of sea buckthorn. Sea buckthorn used in this research was purchased from the Xinjiang

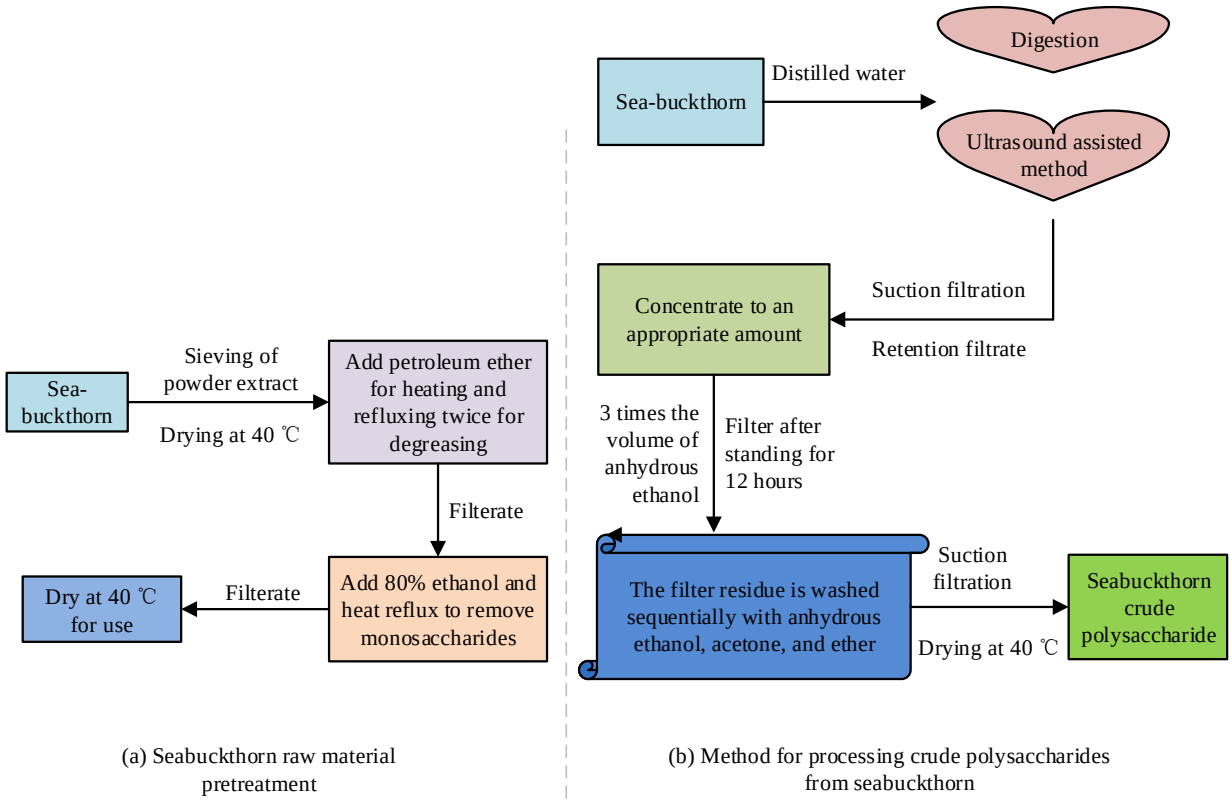


Figure 1. Pretreatment process of sea buckthorn raw materials (a) and treatment of sea buckthorn crude polysaccharides (b).

Hualing Comprehensive Market (Urumqi, Xinjiang, China). Two different extraction methods were combined to optimize the extraction steps of sea buckthorn and obtain the crude polysaccharide (Figure 1). 1 mL of the crude polysaccharide extraction solution was then diluted with distilled water. The sulfuric acid phenol method was used to determine the concentration and content of the polysaccharide in the liquid [11, 12]. The extraction rate of crude sea buckthorn polysaccharides was calculated as follows.

$$Rate(\%) = \left[\left(C \times V \times N \right) / W \right] \times 100\% \quad (1)$$

where *Rate* (%) was the extraction rate. *C* was the concentration of polysaccharides in the solution. *V* was the volume of the extraction solution. *N* was the dilution ratio. *W* was the quality of sea buckthorn powder.

Extraction and determination of flavonoids from sea buckthorn

Sea buckthorn leaves with good appearance and no mold were elected to be soaked in 70% ethanol solution overnight to degrease them before putting into a 50℃ drying oven to dry. When sea buckthorn leaves demonstrated a constant weight, they were crushed through an 80-mesh sieve using CXP-100 multifunctional crusher (Shanghai Shengxi Pharmaceutical Machinery Co., Ltd, Shanghai, China) and continuous dried in Lyo-1 CIP vacuum freeze dryer (Shanghai Dongfulong Instrument Co., Ltd, Shanghai, China) before it was ready for effective extraction of the crude extract of flavonoids (FSL) [13-16]. 0.5 g of sea buckthorn leaf powder was mixed with 60% ethanol in a 50 mL centrifuge tube. The flavonoids of sea buckthorn leaves were effectively extracted using XH-300A microwave ultrasonic combined extraction instrument (Beijing Xianghu Technology Development Co., Ltd., Beijing, China). The

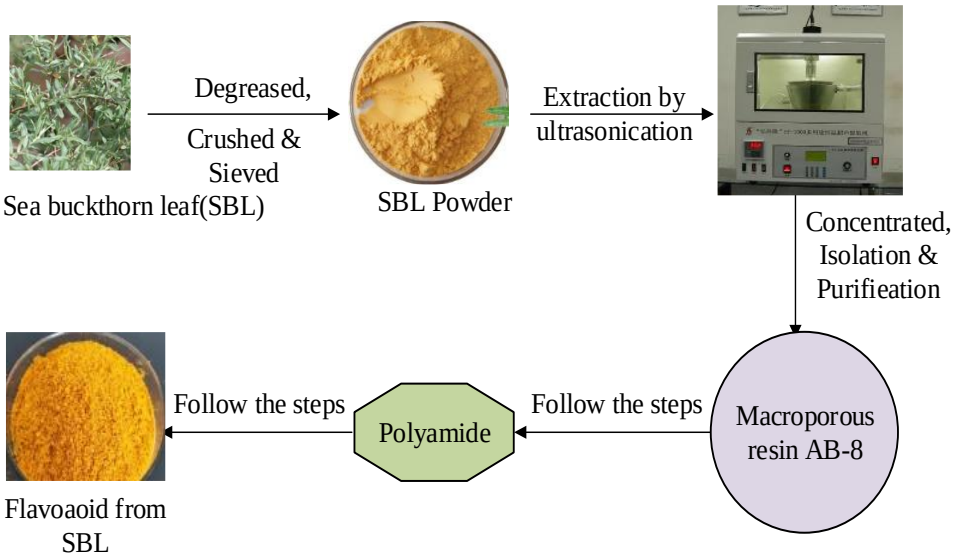


Figure 2. Separation and purification process of flavonoids from sea buckthorn leaves.

extracts were centrifuged at 8,000 rpm for 5 minutes [17, 18]. The supernatant was cooled down to room temperature and re-centrifuged at 8,000 rpm for 10 minutes. The flavonoid extract in the supernatant was measured using $NaNO_2$-$Al(NO_3)_3$-NaOH colorimetric method. The extraction rate of flavonoids was calculated below.

$$\text{Flavone yield}(\%)=\left[(V\times C\times D)/m\right]\times 100\% \quad (2)$$

where Flavone yield (%) was the extraction rate of flavonoids (%). *V* was the total volume of the sample solution (mL). *C* was the concentration of flavonoids (mg/mL). *D* was the dilution ratio of the solution. *m* was the sample mass (g).

The flavonoids from sea buckthorn leaves were then separated and purified using the procedures shown in Figure 2. The crude extract of flavonoids (FSL) from sea buckthorn leaves was first preliminarily purified using AB-8 macroporous resin (Tianjin Bohong Resin Technology Co., Ltd., Tianjing, China) with 100 g of wet resin being added to the SB-C18 chromatographic column (5 cm × 4.6 mm) (Thermo Fisher Scientific, Waltham, MA, USA), sample concentration of approximately 1 mg/mL, and a flow rate of 2 mL/min. The sample volume was twice the column volume (2BV). After standing still for 4 hours, wash with distilled water until the washout had no ethanol odor and became clear. Subsequently, 50% ethanol of equal volume (2BV) was used for elution with an elution rate of 2 mg/mL, and the purified liquid after elution was collected. 100 g of wet packed AR polyamide resin (Tianjin Yanhai Chemical Co., Ltd., Tianjing, China) was used for secondary purification of FSL with the mass concentration of the added sample about 6 mg/mL, the flow rate of 2 mg/mL, and the amount of 2BV. The loaded sample was allowed to stand for 4 hours. The column was cleaned with distilled water until the liquid was washed out without ethanol odor. 70% ethanol of equal volume (2BV) at a rate of 1mL/min was used to elute the content, and purified liquid was collected after elution. The eluents were concentrated by rotary evaporation using RE 5298A rotary evaporator (Shanghai Yarong Biochemical Instrument Factory, Shanghai, China) and dried in DHG-9246A electric constant temperature blast drying oven (Hengping Medical Equipment Co., Ltd, Huangshi, Hubei, China) to obtain sea buckthorn leaf flavonoid powder.

Table 1. Subjects' skin irritation reactions.

Skin adverse reactions		Integral	Skin adverse reactions		Integral
Erythema and eschar	No erythema	0	Edema	No edema	0
	Mild erythema	1		Mild edema	1
	Obvious erythema	2		Obvious edema	2
	Moderate to severe erythema	3		Moderate edema	3
	Severe to mild scab formation	4		Severe edema	4

Evaluation of anti-aging and antioxidant effects of sea buckthorn extract

The Fenton method was used to determine the hydroxyl scavenging ability [19, 20]. 5.0 g of sea buckthorn extract was dissolved in ultrapure water to obtain different concentrations of 0.01, 0.02, 0.03, 0.04, 0.05, and 0.06 mg/mL [21, 22]. 100 μL of each 5 mmol/L $FeSO_4$, 5 mmol/L salicylic acid, and sea buckthorn extract were mixed and stood for 15 minutes before adding 100 μL of 5 mmol/L H_2O_2 solution to stand for another 30 minutes. The absorbance of 510 nm wavelength was then measured using T6 New Century UV-visible spectrophotometer (Beijing Puxi General Instrument Co., Ltd, Beijing, China), and the hydroxyl clearance rate was calculated as:

$$Y = [1 - (Ai - Aj) / Ac] \times 100\%$$

where Ai was the absorbance of the reaction solution of sea buckthorn extract. Aj was the absorbance of the reaction solution replaced by ultrapure water. Ac was the absorbance of the reactant of ultrapure water.

The rebound degree of human skin

The rebound degree of human skin typically measures the skin's ability to return to its original state after pressure or stretching. To evaluate the effect of sea buckthorn extract in cosmetics on the degree of skin rebound, 20 volunteers including 10 males and 10 females aged from 25 to 53 years old were included in this study with the approval of the Ethical Review Board (IRB) of Qingdao Technical College (Qingdao, Shandong, China). All participants were qualified to meet the "Diagnostic Criteria and Treatment Principles of Cosmetic Contact Dermatitis" and signed informed consent forms. The inner sides of the participants' left and right arms were used as the testing area, while the corresponding side was the control area. The experiments were carried out at 22 ± 1°C and humidity of 50 ± 5%. The face cream skin care products were evenly applied to the test areas once in the morning and once in the evening with the test duration of 14 weeks. During the testing period, participants were advised to avoid using other cosmetics in the testing areas. The skin numerical changes before and after the use of the tested products were recorded continuously through 0, 1, 2, 5, and 14 weeks. The participants washed their skin and sat for 20 minutes before starting the assessment.

Safety evaluation and stability effect evaluation of human skin application testing

0.5 g of face cream was smeared on the forearm fixation area of each participant and fixed with a spot tester for 4 hours before rinsing off the residue with warm water [23, 24]. The skin reactions in the application area were observed and recorded at 1, 24, 48, and 72 hours after cleaning based on the skin irritation reactions table (Table 1). The stability was evaluated using sensory and physicochemical indicators including heat stability, low temperature resistance, and centrifugal testing. The sensory evaluation mainly referred to whether the texture of face cream was exquisite, whether the color was consistent, and whether it had a moderate fragrance. The heat stability was tested by putting a certain amount of face cream into a 25 mL color comparison tube and keeping at 45℃ for 24 hours, before cooling down to room temperature to check the condition of face cream. The low-temperature stability test was performed by placing the intact face cream under

-15℃ for 24 hours, and then at room temperature to observe its condition. The centrifuge test was to put face cream in a 10 mL centrifuge tube and centrifuge at 2,000 rpm for 30 mins before observation.

Analysis of data related to rebound degree

SigmaStat 3.5 intelligent statistical software (Systat Software, San Jose, California, USA) was used to evaluate the changes of skin elasticity and brightness of the subjects, and then to judge the antioxidant and anti-aging effects of the prepared face cream.

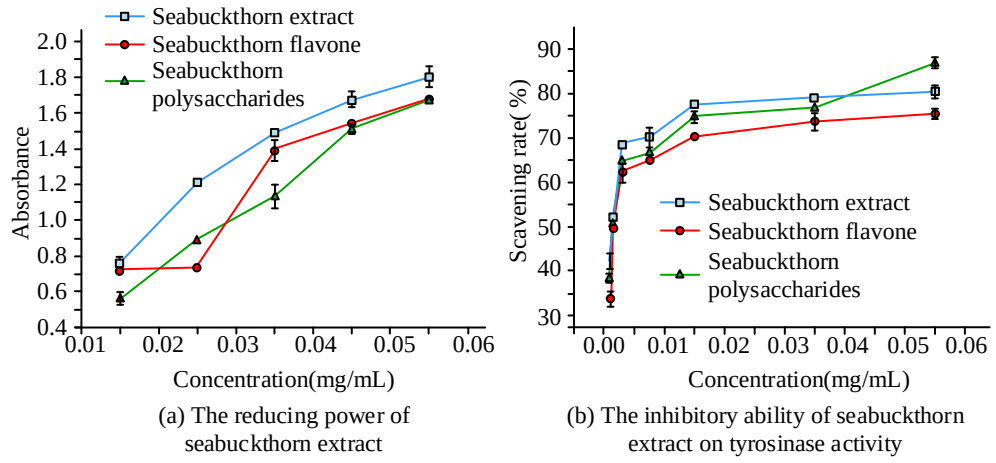
Determination of bacteria, microorganisms, and heavy metals

Bacterial concentration was determined using the disk diffusion method. The sample solution was spread on an agar plate, and then a piece of paper containing a known concentration of bacterial culture solution was placed on the sample plate. The antibacterial effect of the sample was evaluated by measuring the diameter of the inhibition zone formed around the paper. The total viable number of bacteria was determined by counting the number of colonies formed on each appropriately diluted sample agar plate after incubation. Mold and yeast contamination of samples were determined by observing and counting the formed mold and yeast numbers after incubation on an inoculated agar plate after appropriate dilutions. The multi-tube fermentation method was used to determine the presence of intestinal flora such as *E. coli* in the sample to evaluate the hygienic status of the sample, while specific detection method was applied to detect *Pseudomonas aeruginosa*. Heavy metal content was determined using inductively coupled plasma mass spectrometry (ICP-MS), which was suitable for the simultaneous determination of multiple heavy metal elements with high sensitivity and selectivity.

Results and discussion

Determination of reducing power and inhibitory effect of tyrosinase activity

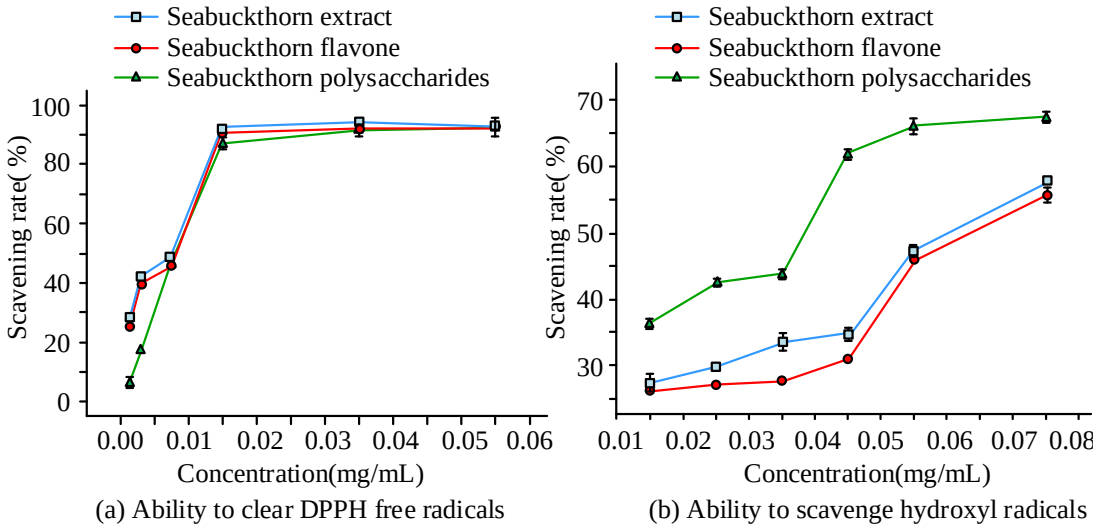
The analysis of the reducing power and tyrosinase activity inhibition effect of sea buckthorn extract showed that, within the concentration range of 0.0150 to 0.0550 mg/mL, the absorbance of all three samples increased with increasing concentration (Figure 3a). Specifically, in the concentration range of 0.0150 to 0.0250 mg/mL, the absorbance of sea buckthorn extract and sea buckthorn polysaccharides increased significantly. Within the concentration range of 0.0250 to 0.0450 mg/mL, the absorbance of sea buckthorn flavonoids increased faster than that of sea buckthorn polysaccharides and slightly slower than that of sea buckthorn extracts. At a concentration of 0.0150 mg/mL, the absorbance of sea buckthorn extract reached 0.722, which was higher than that of sea buckthorn flavonoids (0.706) and sea buckthorn polysaccharides (0.541), respectively. The order of reducing power performance of the samples was then determined as sea buckthorn extract > sea buckthorn polysaccharide > sea buckthorn flavonoids. In the concentration range of 0.0010 to 0.0550 mg/mL, the inhibitory effects of sea buckthorn extract, sea buckthorn flavonoids, and sea buckthorn polysaccharides on tyrosinase activity all increased with increasing concentrations, showing a linear upward trend (Figure 3b). At the lowest concentration of 0.001 mg/mL, sea buckthorn extract exhibited a 42.21% inhibitory effect on tyrosinase activity, which was higher than 34.79% and 34.68% of sea buckthorn flavonoids and polysaccharides, respectively. As the concentration increased from 0.0010 to 0.0030 mg/mL, the inhibitory effects of three samples on tyrosinase activity were significantly enhanced. However, when concentration increased to a certain extent, the increase in inhibition efficiency slowed down. At the highest concentration of 0.0550 mg/mL, the inhibitory effects of sea buckthorn extract and sea buckthorn flavonoids were similar, with 79.45% and 76.10%, respectively, while the inhibitory effect of sea buckthorn polysaccharides was the best, reaching 87.67%. The IC_{50} value of each



(a) The reducing power of seabuckthorn extract

(b) The inhibitory ability of seabuckthorn extract on tyrosinase activity

Figure 3. Analysis of the reducing power and tyrosinase activity inhibition effect of sea buckthorn extract.



(a) Ability to clear DPPH free radicals

(b) Ability to scavenge hydroxyl radicals

Figure 4. The ability of sea buckthorn extract to scavenge free radicals.

sample indicated the inhibitory ability of each sample on tyrosinase activity as sea buckthorn polysaccharides (0.0014 mg/mL) > sea buckthorn extracts (0.0015 mg/mL) > sea buckthorn flavonoids (0.0017 mg/mL). The scavenging ability of extract on DPPH free radicals was shown in Figure 4a. Within the measured concentration range of 0.0050 to 0.0550 mg/mL, the scavenging effect of the sample on DPPH free radicals increased with increasing concentration. The scavenging rate of DPPH free radicals increased from 28.76 to 94.21%, especially for sea buckthorn extract. At the highest concentration of 0.0550 mg/mL, the efficiencies of sea buckthorn extract, sea buckthorn flavonoids, and sea buckthorn polysaccharides in scavenging DPPH free radicals were similar, reaching 93.58, 93.21, and 94.45%, respectively. The IC_{50} values of the three samples showed their clearance abilities as sea buckthorn extract (0.0074 mg/mL) > sea buckthorn polysaccharides (0.0081 mg/mL) > sea buckthorn flavonoids (0.0083 mg/mL), which indicated that sea buckthorn extract performed better than others. The scavenging ability of sea buckthorn extract on hydroxyl radicals was shown in Figure 4b. In

the concentration range of 0.0050 to 0.0750 mg/mL, the sample's ability to scavenge hydroxyl radicals increased with increasing concentration. In the lower concentration range of 0.0150 to 0.0350 mg/mL, the scavenging efficiency of the sample towards hydroxyl radicals gradually increased. In the concentration range of 0.0350 to 0.0450 mg/mL, the clearance ability was significantly improved. After exceeding the concentration of 0.0450 mg/mL, the clearance rates of the three samples were basically stable. At the highest concentration of 0.0750 mg/mL, sea buckthorn polysaccharides showed the best clearance efficiency of 66.87%, while the clearance efficiencies of sea buckthorn extract and sea buckthorn flavonoids were 57.58% and 54.95%, respectively. Based on the IC_{50} value, the performance of sea buckthorn polysaccharides (0.0384 mg/mL) in scavenging hydroxyl radicals was superior to that of sea buckthorn extracts (0.0609 mg/mL) and sea buckthorn flavonoids (0.0649 mg/mL), indicating that sea buckthorn polysaccharides had the most significant effect.

The rebound degree of human skin

The time for the skin to return to its original state after releasing from the certain amount of pressure on the skin was measured. The participants were divided into four groups that received different treatments of sea buckthorn polysaccharides (group 1), sea buckthorn flavonoids (group 2), sea buckthorn polysaccharides and flavonoids (group 3), and sea buckthorn extracts (group 4). The changes in skin elasticity of the subjects were observed. Set the range of rebound testing from 0 - 100%, the skin rebound degree in each group showed an upward trend with the increase of testing days, indicating that sea buckthorn extract did not cause adverse effects on human skin (Figure 5). The sea buckthorn polysaccharides group showed a slower change in skin rebound, indicating that sea buckthorn polysaccharides influenced the skin. When the experiment reached 14 weeks, all groups demonstrated the highest degree of skin rebound. The skin rebound degrees of each group were 81.25, 87.59, 92.77, and 96.28%, respectively. The sea buckthorn extracts group demonstrated the most significant and the highest degree of skin rebound, which indicated that sea buckthorn extract could enhance the elasticity of the skin. It also indicated that the skin was nutrients enriched, functioning normally, and having a certain degree of anti-aging ability.

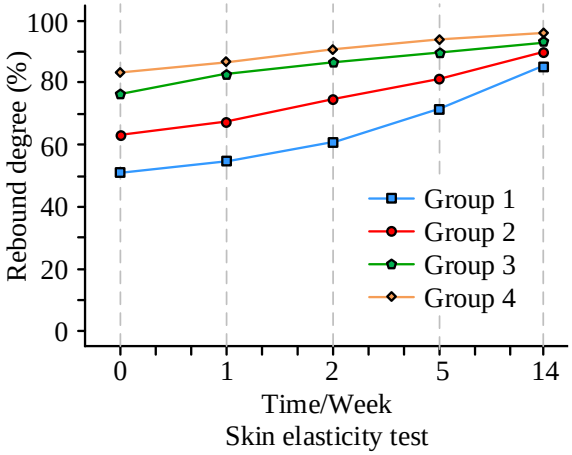


Figure 5. Skin elasticity test of subjects.

Comparison with other anti-aging and antioxidant cosmetics

Two brand products including Estee Lauder (Bridgeport, Pennsylvania, USA) and Pechoin (Shenzhen, Guangdong, China) were chosen in this study for comparison with proposed face cream. The results showed that the reduction abilities of all products increased with the increase of concentration. The restoring power was ranked as Estée Lauder > homemade cosmetics > Pechoin. According to IC_{50}, the scavenging abilities of DPPH radicals and hydroxyl radicals were ranked as Estée Lauder > homemade cosmetics > Pechoin (Figure 6). The homemade cosmetics with sea buckthorn extract showed antioxidant properties, and the overall antioxidant effect was similar to that of Estée Lauder and Pechoin. The results suggested that sea buckthorn extract could be used as a natural and environmental friendly antioxidant ingredient, combined with other antioxidant substances, in the fields of beauty and skincare.

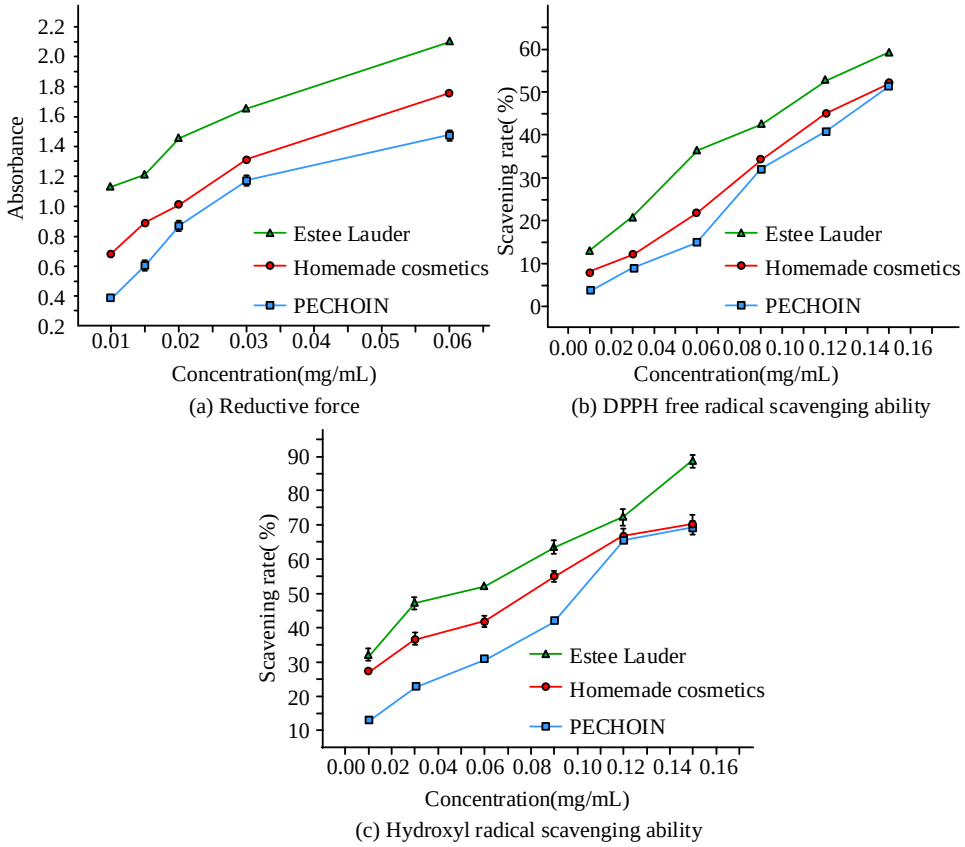


Figure 6. Comparison results with other anti-aging and antioxidant cosmetics.

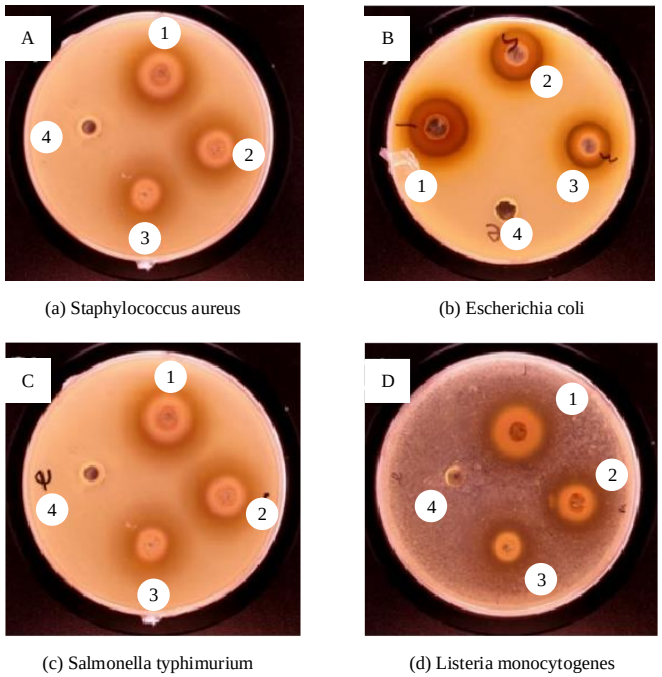


Figure 7. Inhibitory effects of different concentrations of sea buckthorn extracts on four types of bacteria. **1.** 0.2 mg/mL. **2.** 0.3 mg/mL. **3.** 0.4 mg/mL. **4.** 0.6 mg/mL.

Table 2. Microbial index measurement results.

Testing items	Limit value (CFU/g)	Detection result
Total bacterial count (CFU/g)	≤ 1000	10
Total number of molds and yeast (CFU/g)	≤ 100	Not detected
Pseudomonas aeruginosa	Not detected	Not detected
Fecal coliform group	Not detected	Not detected

Table 3. The test results of heavy metal indicators.

Testing items	Test method	Limit value (mg/kg)	Detection result
Hg	Inductively coupled plasma mass spectrometry (ICP-MS) determination method	≤1	Not detected
As	Inductively coupled plasma mass spectrometry (ICP-MS) determination method	≤10	Not detected
Pb	Flame atomic absorption spectrophotometry	≤40	Not detected

Safety and stability assessment

The safety test showed that none of the participants showed any signs of redness or swelling in the testing areas. The stability test showed that homemade cosmetics had delicate sensory properties, uniform texture, and emitting faint aroma. Through heat and cold resistance tests, it was confirmed that the homemade cosmetic did not exhibit any oil and water separation and had good heat and cold stability. The centrifugation test showed that there was no obvious chromatographic phenomenon in the homemade cosmetics, which further confirmed the good stability of the homemade cosmetics.

Antibacterial test

The inhibitory effects of sea buckthorn extract at different concentrations on four types of bacteria were shown in Figure 7. The results showed that sea buckthorn extract exhibited significant inhibitory effects on different bacteria with the inhibitory area diameters of 17.24 ± 0.69, 16.52 ± 0.08, 13.11 ± 0.09, and 11.41 ± 0.18 mm against *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhimurium*, *Listeria monocytogenes*, respectively. The results indicated that sea buckthorn extract exhibited effective inhibitory effects on all four bacteria, especially on *Staphylococcus aureus*.

Microbial indicator determination

The results of microbial index determination were shown in Table 2. The total number of bacteria detected in the prepared cosmetics did not exceed 1,000 colony forming unit (CFU)/g. However, mold and yeast, *Pseudomonas aeruginosa*, and fecal coliform were not detected, which indicated that the microbial indicators of the prepared cosmetics did not exceed the standard, and the hygiene quality of the cosmetics products met national standards.

Heavy metal indicator detection results

The contents of lead (Pb), mercury (Hg), and arsenic (As) in the sample were tested (Table 3). The results showed that the content of the three heavy metals in the sample was 0 mg/kg, which was within the safe range of national standards and would not cause harm to human skin.

Conclusion

This study comprehensively analyzed the antioxidant and anti-aging effects of sea buckthorn extract and verified its potential application in cosmetics. The results proved that sea buckthorn extract had excellent free radical scavenging ability under *in vitro* conditions, which could effectively enhance the antioxidant

level and reduce oxidative stress damage. Adding sea buckthorn extract to cosmetic formulas not only enhanced the antioxidant and anti-aging properties of the product, but also enhanced its market competitiveness and consumer experience. The safety and effectiveness of sea buckthorn extract in cosmetics had been further confirmed through human skin application testing. This study also indicated that an appropriate amount of sea buckthorn extract could maximize its effectiveness while ensuring the stability and safety of the product. Overall, the research and application of sea buckthorn extract not only broadened the source of raw materials in the cosmetics industry, provided consumers with more choices, but also provided new ideas for the comprehensive utilization of sea buckthorn resources. Future research can further explore the application effects of sea buckthorn extract in different types of cosmetics, as well as its synergistic effects with other active ingredients, to better serve modern cosmetic science and consumer needs.

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