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Analysis of the Anti-Aging Mechanism and Potential of *Angelica sinensis*

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Abstract: Aging is a multifactorial process driven by oxidative stress, telomere attrition, and chronic inflammation. In traditional Chinese medicine, *Angelica sinensis* is a blood-activating and blood-tonifying herb. The components it contains, such as ferulic acid and polysaccharides, have significant effects on anti-aging and whitening. These components achieve the ability to inhibit cell aging by eliminating free radicals, such as **DPPH**·, **ABTS**+·etc, and enhancing the total antioxidant capacity in the serum. At the same time, the anti-aging components of Angelica sinensis have a synergistic effect with substances like NMN and Res, jointly exerting antioxidant, anti-inflammatory, and immune-regulating functions, providing ideas for the application of Angelica sinensis anti-aging cosmetics and the treatment of some diseases.
Keywords: Anti-aging; Ferulic acid; Polysaccharides; Whitening; Immune regulation; Antioxidation; Anti-inflammation

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1. Introduction

1.1. The biological basis of aging

(1) Free radical theory: This theory posits that free radicals are produced during normal metabolic processes and attack the DNA of the organism, causing chain breaks, base oxidation, and mutations, thereby triggering aging [1].

(2) Telomere shortening theory: Every time a cell divides, the telomeric DNA shortens. This subsequently triggers the DNA damage response mechanism within the cell, such as the activation of the NF-kβ pathway [2], leading to an irreversible proliferation arrest state, known as “replicative senescence”.

(3) Inflammatory senescence theory: As one ages, the innate immune system becomes overactivated, resulting in elevated levels of pro-inflammatory cytokines such as IL-6, TNF-α, and IL-1β [3], while anti-inflammatory factors (such as IL-10) are relatively insufficient. This inflammation damages the DNA sequence and accelerates telomere shortening, thereby inducing cellular aging.

1.2. The history and pharmacological status of Angelica sinensis

The medicinal history of Angelica sinensis can be traced back to the Eastern Han Dynasty's "Shennong's Classic of Materia Medica," where it is described as "mainly treating cough, asthmatic attacks, and upward breathing [4]." In the Tang Dynasty's "The Complete Prescriptions for Thousand Gold" and "The Secret Prescriptions of the External Medicine," it was widely used in gynecological diseases and was called "the holy medicine for gynecology." In the Ming Dynasty's "Compendium of Materia Medica," it was recorded that Angelica sinensis could "treat headache, abdominal pain, moisten the intestines, bones, muscles, and skin, treat abscesses, drain pus and relieve pain." *Angelica sinensis* contains components such as ferulic acid and Angelica polysaccharides. Antioxidants such as ferulic acid and ligustilide can eliminate free radicals, inhibit cell apoptosis, reduce oxidation, and inhibit the apoptosis of nerve cells [5]. It can also alleviate inflammatory responses by inhibiting the NF-κB pathway, thereby closely linking Angelica sinensis with anti-aging. **Table 1** shows the chemical components of Angelica sinensis and its anti-aging potential.

Table 1. Main active components of *Angelica sinensis* in anti-aging effect [6,7]

Kind	Name	Function
Volatile oils	Ligustilide, butenyl phthalide, n-butyl lactone	Antioxidant, anti-inflammatory
Polysaccharides	Angelica polysaccharide	Moisturizing and whitening
Organic acids	Ferulic acid	Inhibit melanin production
Flavonoids	\	Reduce scar formation

1.3. The anti-aging potential of Angelica sinensis

The research found that the main component of the volatile oil in *Angelica sinensis* is ligustilide. As reported in the literature [8], ligustilide protects nerve cells through antioxidant and anti-apoptotic mechanisms, inhibits nerve cell apoptosis, and maintains the normal operation of the brain. At the same time, ligustilide can dilate blood vessels, reduce blood viscosity, and improve blood microcirculation.

Angelica polysaccharides can not only enhance the specific immunity of the body, but also improve the non-specific immunity ability by enhancing the activity of immune cells [9]. In the experiment of feeding Angelica polysaccharides to South American white prawns, continuous feeding for 12 weeks resulted in enhanced non-specific immunity of the shrimp and increased survival rate [10]. Angelica polysaccharides can enhance the immune function of the body through multiple mechanisms and have good potential for anti-aging.

Lipid peroxidation is one of the important pathways for reactive oxygen species to damage the body. Ferulic acid contains phenolic hydroxyl groups and has antioxidant activity. In the study on the mechanism of ferulic acid against lipid peroxidation [11]. It was found that it can increase the activity of enzymes such as glutathione peroxidase (GSH-PX) in liver cell cytoplasm and the content of GSH in mitochondria, protecting the structure and function of mitochondria. Mitochondrial dysfunction contributes to aging, and improving its function may mitigate age-related metabolic disorders.

2. The molecular mechanism of Rehmannia glutinosa in anti-aging

Angelica sinensis contains a variety of complex pharmacological components. Here, we take angelica sinensis polysaccharide (ASP) as an example to study the molecular mechanism of its anti-aging effect.

In the aging mechanism of cells in the body, excessive reactive oxygen species in the body cause strong oxidative stress, which can lead to aging. ASP can eliminate the oxidative bases in the body and inhibit the occurrence of the oxidative stress process, thereby inhibiting the aging process of cells. Kang *et al.* have studied that ASP has a clearing effect on four free radicals, DPPH ·, ABTS+·, ·O2− and ·OH, thereby enhancing its antioxidant performance [12]. Many studies have confirmed the antioxidant damage effect of ASP. One study shows that ASP can antagonize the aging effect of D-gal by improving the antioxidant damage and free radical clearance ability of the hippocampus [13]. Meng *et al.* [14] have confirmed that ASP can significantly increase the total antioxidant capacity (T-AOC), superoxide dismutase (SOD) activity and glutathione (GSH) content in rat serum, and can effectively reduce the content of malondialdehyde (MDA) and nitric oxide (NO) in serum, thereby achieving the purpose of inhibiting cell aging.

3. Comparative study of Danshen and other anti-aging compounds

3.1. Synergistic effect with resveratrol and NMN alcohol

In combination with resveratrol (Resveratrol, abbreviated as Res): In the serum antioxidant experiment of piglets, the presence of Res reduced the degree of serum oxidation [15]. At the same time, Res has anti-inflammatory effects. For ulcerative colitis, which often affects the mucosa and causes diffuse damage to the mucosa [16,17]. Res can reduce the level of inflammatory substance (IL)-6, maintain the relative balance of Treg/Th17, and inhibit the progression of inflammation [18].

In combination with nicotinamide mononucleotide (NMN). NMN can serve as a precursor substance for supplementation (it can act as a second messenger within cells, thereby exerting immune regulatory effects [19]). Moreover, in cells subjected to NMN intervention, the degree of chromosomal damage was significantly reduced [20].

4. Application potential and transformation research

4.1. Development of anti-aging skin care products

The active components in *Angelica sinensis*, such as polysaccharides, ferulic acid, and volatile oils, possess various beneficial effects, including excellent antioxidant, anti-radiation, anti-inflammatory, and anti-viral properties [21]. For instance, the polysaccharides themselves have good film-forming properties, which can lock in the moisture on the skin surface and exert the functions of whitening and moisturizing. There have also been some advancements in the extraction process of the effective substances. For example, the ultrasonic-assisted water extraction and alcohol precipitation method can effectively extract the polysaccharides from *Angelica sinensis* [21], and the water extraction method to extract the concentrated solution, etc., has provided strong support for helping *Angelica sinensis* enter the skincare market [22].

4.2. Progress in the treatment of diseases with Angelica sinensis

Studies have shown that when *Angelica sinensis* is combined with *Paeonia lactiflora*, its polysaccharide components can effectively prevent and treat Alzheimer's disease; Angelica sinensis also has the effect of treating diabetes. The ferulic acid in *Angelica sinensis* can affect the O-GlcNAc signaling protein (the transmission of high sugar signals), thereby enhancing the body's sensitivity to insulin [23]. In internal diseases, *Angelica sinensis* extracts, such as polysaccharides and ferulic acid, can reduce Th2 cell activation [24], block the PI3K/AKT signaling pathway, thereby

alleviating bronchial inflammatory responses, and further reducing damage to alveolar epithelial cells [24].

5. Future outlook

Research has shown that *Angelica sinensis* has potential in anti-aging. It contains components such as ferulic acid and angelica polysaccharides, which can intervene in the aging process through various pathways such as antioxidation, anti-inflammation, and regulation of immunity. It also has a considerable amount of traditional application basis and some modern experimental research evidence as support. In the future, with further research on the active ingredients and mechanism of *Angelica sinensis*, its anti-aging potential will be explored, which will surely provide more experimental evidence and ideas for anti-aging.

Disclosure statement

The author declares no conflict of interest.

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