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A review of Chinese medical and homologous food - fennel

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Abstract. Fennel is the dry and mature fruit of the Umbelliferae plant (Foeniculum vuLgare Mill). It is widely distributed and does not require a high growth environment; Fennel was first recorded in Tang materia medica and was originally named Huaixiang. Throughout its long history, people not only used it as a delicacy in their diet, but also discovered its medicinal value and widely applied it in clinical treatment of diseases. In China, fennel is commonly used as a food and seasoning, as well as traditional Chinese medicine; Internationally, fennel is mainly used in cosmetics and food additives. With the improvement of living standards, people are increasingly focusing on the high-yield cultivation and active ingredient research of fennel, which has given rise to some research on its components and how to achieve high-yield cultivation; Meanwhile, the variety and quantity of products related to fennel are increasing day by day. This review aims to summarize the ingredients of fennel, the research progress in cultivation methods, and the fennel products currently available on the market.

Keywords: fennel, ingredient research, traditional formulas, market products

1. Introduction

Fennel (Foeniculum vuLgare Mill) is the dried and ripe fruit of the Umbelliferae plant . Harvest fennel plants during the early ripening of fruits in autumn, dry them in the sun, and remove impurities from the fruits. Fennel has different names in different ancient texts:In the "A Hundred Herbs Illustrated Guide", it is called earth fennel, and in the "Zhu's set test formula", it is called big fennel. Fennel (fennel) originated from the Mediterranean region and was introduced to China during the Wei, Jin, Southern and Northern Dynasties. It is now cultivated in various provinces and regions of China and is also distributed in Europe, America, and western Asia; In the medicinal name of Uyghur, it is called Aripadiyang. Fennel prefers warmth, has strong heat and cold resistance, prefers sunny environments, prefers humidity and is afraid of flooding. It grows well in moderately fertile sandy loam soil. Fennel can not only be used as food (such as stir fried fennel, fennel dumplings, etc.), but also has the effects of dispelling cold, relieving pain, regulating qi and stomach. It is clinically used to treat cold hernia abdominal pain, testicular prolapse, dysmenorrhea, low abdominal cold pain, abdominal distension and pain Diseases such as vomiting and diarrhea due to insufficient food intake (Salt fennel: a Chinese medicinal herb. Take the fennel and stir fry it over low heat until the surface is deep yellow and has a burnt aroma. When there is a smell of burning, spray salt water and bake it; or mix the fennel with salt water, let it cool down, and then burn the surface over low heat until golden brown. Remove and air dry); It is said that in the late Qing Dynasty, a wealthy Russian businessman came to Hangzhou for a visit. Suddenly experiencing a hernia while enjoying the beautiful scenery. A local traditional Chinese medicine practitioner used "one or two finely ground fennel and two liang Shaoxing yellow wine for delivery"; After 20 minutes, the hernia of the wealthy businessman miraculously eased [1]. It can be seen that fennel has a certain history and value in China as a medicinal herb. This review will comprehensively elaborate on the research on the medicinal and edible homology of fennel by introducing its botanical characteristics, traditional uses, and analysis of chemical components.

2. Botanical characteristics, classification, and regional distribution of fennel

Fennel is a perennial herbaceous plant belonging to the Umbelliferae family. The plant has a height of 50-150cm and a strong aromatic aroma. The stem is upright and hollow, with shallow longitudinal grooves on the surface, covered in white powder. The upper part is mostly branched, and the basal leaves are clustered and large, reaching a length of up to 40cm. The stem leaves are small and alternate, with 3-4 feather like divisions, deep green in color. The last lobe is linear to filamentous, and the base of the petiole expands to form a sheath like embrace. The compound umbrella shaped inflorescence is terminal or lateral, with an umbrella width of 5-20cm. Each small umbrella sequence has 5-20 umbels, and each umbel carries most sessile small flowers.

The flowers are bisexual, golden, without a total bract or bract. The sepal teeth are not obvious, and the petals are 5, with a concave and inward curled tip. The stamens are 5, the pistils are 1, and the stigma is rod-shaped. Ovary inferior, 2-loculed, double hanging fruit oval or cylindrical, slightly pointed at both ends, 4.5-7mm long and 1.5-3mm wide, with a surface yellow green to grayish brown, smooth and hairless, with 2 conical stigma of about 1mm remaining at the top. When mature, it splits into 2-fruited, slightly curved, with 5 edges, and has a special aromatic odor. The flowering period is from May to September, and the fruiting period is from August to October. The fruits mature in batches [2].

There are many types of fennel, and the main cultivated ones in China are fennel, Italian fennel, and corm fennel.

Fennel is native to the Mediterranean coast and prefers warm and humid conditions with abundant sunlight. It does not require high soil conditions and grows well in moderately fertile borax soil, hills, and mountainous areas; In China, it is mainly distributed in Beijing, Tianjin, Liaoning and other places. The aroma components, volatile oil components, anethole content, and linoleic acid content of fennel from different regions vary. Haiyuan County is a traditional production area of fennel in Ningxia. Due to the local geographical environment and natural conditions being very suitable for the growth of fennel, the yield and quality of fennel produced are high (compared to other provinces and regions in terms of quality and commodity characteristics), and the planting area is expanding year by year. Its characteristics are: crude fat content of 15.98-16.8g/100g, known for its uniform particles, full texture, bright green color, and strong aroma. Fennel is rich in vitamins B1, B2, C, carotenoids, and calcium [3]. On September 13, 2010, the former Ministry of Agriculture of the People's Republic of China approved the registration and protection of geographical indications for agricultural products of "Haiyuan Fennel". In 2022, it was also included in the third batch of the National List of Famous, Special, and Excellent New Agricultural Products.

3. Study on the chemical components of fennel

3.1. Organic acids in fennel

3.1.1. Fatty acid

The fatty acid content in fennel is relatively low (18%). Researchers used the supercritical CO_2 method to extract fennel fruit and conducted Gas Chromatography-Mass Spectrometry (GC-MS) analysis, identifying 9 fatty acids, accounting for 97.80% of the total peak area. Among them, octadecadienoic acid accounted for 75.12% of the total fatty acids, octadecadienoic acid accounted for 15.18% of the total, and palmitic acid accounted for 5.34% of the total [4]. Afterwards, someone used 8 different organic solvents to extract fennel seed oil, and also used GC-MS analysis to detect a total of 18 fatty acids; When using ethanol as an extractant, 16 types of fatty acids were detected.

The types of fatty acids contained in different parts of fennel are different. Among them, fennel fruit contains about 18% fatty oil, among which coriander seed acid accounts for 60% of the total fatty oil, oleic acid accounts for 22%, linoleic acid accounts for 5.4%, palmitic acid accounts for 4%, and unsaturated fatty acids such as octadecene-5 acid, octadecene-10 acid, arachidonic acid, octadecene-enoic acid, and octadecene-dienic acid are also present.

The stems and leaves of fennel contain organic acids such as cinnamic acid, ferulic acid, caffeic acid, benzoic acid, anisic acid, vanillic acid, gentianic acid, coumaric acid, protocatechuic acid, syringic acid, erucic acid, fumaric acid, malic acid, tartaric acid, citric acid, shikimic acid, and quinic acid.

Fennel seeds are mature fruits of fennel in the Umbelliferae family, which have the effects of regulating stomach qi, dispelling cold and relieving pain. Their essential oils have windward and antibacterial effects, and can also be used as seasonings and spices; Among them, 17 types were identified through CG-MS testing, among which the highest oil content was octadecane-5-acid, accounting for 78%. 562%, followed by 18 carbon dienoic acid, palmitic acid, and stearic acid; 10 types of saturated fatty acids, accounting for 11.002%; 6 types of unsaturated fatty acids, accounting for 87.368%; Among unsaturated fatty acids, there are 5 types of monoenes, accounting for 79.016%; One type of dienoic acid, accounting for 8.352%; Unknown object, accounting for 0.054% [5].

3.1.2. Amino acid

Amino acids are an important component of fennel. Researchers detected 17 types of amino acids in fennel using an automatic amino acid detection analyzer. Amino acids with higher content include glutamic acid, aspartate, lysine, etc. The required amino acid content is also not low (about 41%).

3.2. Inorganic elements

Fennel contains inorganic major elements (K, Ca, Na, etc.) as well as essential trace elements and other elements. Alifu Abudu determined the content of Cu, Fe, Mn, and Zn in fennel, and the results showed that the Fe content was relatively high, reaching

4.61mg/g. The Mn and Zn contents were both 0.13mg/g, and the Cu content was 0.05 mg/g [4]. Afterwards, researchers used different methods to determine the elements in fennel, resulting in slight differences. The metal element content meets the standards for imported Chinese herbal medicine slices from France, but there is still some gap from the drug standards in the United States.

3.3. Volatile oil components of fennel

The main volatile oil components in fennel include anisole, anisone, limonene, anisaldehyde, and camphor. The essential oil extracted from its fruits, stems and leaves is widely used in toothpaste, perfume, soap and other essence. At the same time, fennel essential oil has a good antiseptic effect and can be used for pickling food.

It is worth noting that the content and composition of volatile oil in fennel from different regions are different.

Research in plant agriculture has confirmed that the amount and proportion of essential oils are influenced by factors such as species genetics, soil fertilization, light conditions, organs, and maturity [6].

3.4. Sterols

Fennel mainly contains stigmasterol, rapeseed oil sterol Δ7-stigmasterenol, *β*-sitosterol-*β*-D-glucopyranoside, which contains plant sterol groups in stems and leaves-β-Fructofuran glycoside [7].

3.5. Flavonoids

The stems and leaves of fennel contain anisin, kaempferol, rutin, kaempferol-3-O-rhamnoside, luteolin, isorhamnosum, etc.

3.6. Alkaloids

The content of alkaloids in fennel is 2. 9%, mainly choline and acetylcholine.

3.7. Other substances

Related studies have shown that the fruits and leaves of fennel contain a lot of vitamins, volatile alkaloids, and other substances [7]. In addition, the fruits of fennel also contain triterpenes, internal lipid compounds, tannins, flavonoids, cardiac glycosides, alkaloids, saponins, volatile alkaloids, anthraquinone, etc.

4. The nutritional value of fennel on bacteria, traditional uses, and commonly used traditional Chinese medicine formulas

Fennel has a spicy and warm nature, which is beneficial for the liver, kidney, spleen, and stomach meridians. Fennel can dispel cold and relieve pain, regulate the intestines and stomach,promote intestinal peristalsis, and is often used in diseases such as cold hernia, abdominal pain, and diarrhea. In addition, the volatile oil contained in fennel has a relaxing effect on tracheal smooth muscle and can sterilize fungal spores, avian tuberculosis bacteria, and Staphylococcus aureus [8]. Salt fennel (shaped like fennel, slightly bulging on the surface, dark yellow green or dark yellow, occasionally with burnt spots. The taste is slightly salty) can also warm the stomach and dispel cold, treat testicular prolapse, menstrual cold and abdominal pain, with a dosage of 3-6g. It should be stored in a cool and dry place.

Fennel, even as a medicinal herb, is also a food ingredient that can remove the odor in meat. It is a necessary ingredient in braised foods and is also one of the traditional seasoning ingredients in China, known as "Five Fragrance Powder". For thousands of years, fennel has been widely used in food therapy, tea drinks, and traditional Chinese medicine.

4.1. Usage in food

4.1.1. Various seasonings

Fennel can be used to mix various spice powders and seasonings, such as five spice powder, curry powder, cumin powder, etc.

4.1.2. Fennel tea

The production method is as follows: calculated by weight fraction: 220-260 parts of fennel, 5.5-7.5 parts of oolong tea, 8-15 parts of jujube honey, 0.5-1 parts of dried ginger, 5.5-7.5 parts of light bamboo leaves, 0.5-1.5 parts of Codonopsis pilosula, 0.5-0.8 parts of Cynomorium songaricum, 0.5-0.8 parts of Cistanche deserticola, 0.5-1.2 parts of goji berries, and 1.5-2 parts of licorice; Take fennel seeds to remove impurities, stir fry over low heat for 3-5 minutes until light yellow, and place them in an ultrasonic container for ultrasonic treatment. The ultrasonic frequency is 1-3 times, with each time lasting 10-25 minutes; Afterwards, take out the fennel seeds and steam them until they have a moisture content of 50%-60%. Drain and set aside; Soak other raw materials in pure water in sequence, adding 3-4 times the total amount of the 8 types of raw materials mentioned above, and extract at 30-55 ° C for 2-3 hours. Collect the filtrate and filter residue respectively. After drying, grind the filter residue into ultrafine powder for 800-1,000 days to prepare auxiliary dry powder. Concentrate the filtrate to 1/4-1/3 of the original liquid to obtain the concentrated solution. Add jujube honey to the concentrated solution, stir evenly, and obtain the auxiliary concentrated solution for later use; Sprinkle the dry powder of the above excipients evenly onto the processed fennel seeds, stir fry over low heat until the moisture content is 15-30%, pour out the fennel seeds, and then evenly spray half of the volume of excipient concentrate. Bake until the moisture content of fennel seeds is 10-15%, continue to evenly spray the remaining excipient concentrate, and bake until the moisture content of fennel seeds is 3-5% to make it [9]. Some studies have proved that fennel tea substitute has a certain effect on the recovery of intestinal function and prevention of urinary retention after anorectal surgery for women with malignant tumors.

4.1.3. Dietary therapy replaces tea drinks

(1) Fennel Yellow Wine

Boil 300g of yellow wine, brew 20g of fennel (stir fried and ground), let it warm, remove residue and drink, regulate qi and dispel cold, can treat wind cold [8].

(2) Fennel tea

6g of fennel, 500ml of water, an appropriate amount of brown sugar, boil together, then let it warm and drink tea. Can relieve menstrual pain, promote digestion, eliminate bloating, and treat bad breath.

(3) Pig Tripe and Fennel Soup

Wash the pork belly, stir fry 30g of fennel until cooked, put it in a sandbag and cook together with the pork belly, add a small amount of salt to season. Take pork belly as a measure of maturity. Use the soup several times. It can nourish the liver and kidneys, invigorate the spleen, regulate qi, and neutralize energy.

(4) Fennel Egg cakes

Stir fry 15g of fennel with 4.5g of salt until cooked and ground, then fry with two duck eggs to make a pancake. Eating rice wine together before bedtime can alleviate tenosynovitis.

4.2. Traditional Chinese medicines prepared in ready-to-use forms

There are two methods for making small fennel slices: the first method is relatively simple to process. Take the small fennel to remove impurities and fruit stems, and sieve out the ash. The second method requires taking clean fennel, mixing it well with salt water, moistening it for 1-2 hours until the salt water is completely absorbed, placing it in a hot pot, stir frying it dry over low heat (80-120 ℃), and taking it out when a fragrance escapes. Then remove from the pot and allow to cool. For every 100kg of fennel, 3kg of table salt is used, which is called salt fennel [10].

4.2.1. Fennel Pills

Stir fried fennel, fenugreek, fructus psoraleae(Stir frying) ,white keel 30g each, 45g of banksia rose, 21 walnuts (shelled), and 3 pairs of lamb kidneys (cut open, treat with 45g of salt, and bake over fire until cooked). Take it down with alcohol drunk on an empty stomach.

4.2.2. Traditional Chinese medicine for women's pre pregnancy regulation

A traditional Chinese medicine formula made from Huangjing, yam, Poria cocos, goji berries, mulberry berries, raspberries, cinnamon, fennel, cloves, and tangerine peel has been scientifically formulated, and its efficacy has been verified through experimental research and years of clinical use. It has a good effect on women of the right age, especially those who are late pregnant. (European Panten Office Traditional Chinese medicine preparation for female pre-pregnancy conditioning.)

4.2.3. Erfensan

10g of Atractylodes macrocephala (stir fried with light ginger juice, then stir fried with noodles), 7.5g of Eucommia ulmoides, Chuanduan, Yuanzhi, 5g of Achyranthes bidentata, 2.5g of Big Fennel, Xiaofennel, 7.5g of Angelica sinensis, 5g of Chuanxiong, 10g of Rehmannia glutinosa, 5g of Angelica dahurica, 7.5g of Chinese yam, 2.5g of Muxiang, 2.5g of safflower, and 7.5g of bone fat.Can treat postpartum lower back pain in women.

4.3. Medications for treating cold hernia pain

20g of Melia azedarach, 17.5g of banksia rose, 10g of Fennel, and 5g of Cornus officinalis (in soup); Long flowing water treatment.

5. Pharmacological activity and properties of fennel

Current research has shown that fennel has significant antibacterial, gastrointestinal function regulation, diuretic, choleretic, hepatoprotective, and anticancer effects.

5.1. Pharmacological activity

5.1.1. Antibacterial effect

The distillate extract of fennel has a good antibacterial effect on fungi, Hanson's yeast, and salt tolerant yeast that cause fruit decay. Researchers used fennel purchased from Xinjiang Uyghur Ethnic Hospital, weighed 1,000 g and ground it, added a 20% ethanol solution of 4,000 mL, soaked at room temperature for 48 hours, filtered, and concentrated to 153 mI. Based on the quality of raw materials, the content is equivalent to 1 g/mI, which is the original extract of fennel; Cultivate Escherichia coli, Staphylococcus aureus, Bacillus subtilis, Proteus, Bacillus thuringiensis, brewing yeast, Penicillium, and Rhizopus using its agar medium. Measure the antibacterial ability of the original extract using the filter paper method, and then mix the fennel extract with the culture medium in a ratio of 2.0%, 3.0%, 4.0%, 5.0%, and 6.0%. Inoculate using the plate chemical fiber method and conduct three parallel experiments. Cultivate under the conditions described. The Minimum Inhibitory Concentration (MIC) of the original extract is the Minimum Inhibitory Concentration (MIC) of the original extract without bacterial growth, with sterile water and 20% ethanol as the control in the experiment. The results is that fennel has antibacterial ability, with a more significant inhibitory effect on bacteria (especially Bacillus thuringiensis and Proteus) than yeast and mold, and a relatively weaker inhibitory effect on Penicillium producing brewing yeast. The antibacterial efficacy of fennel extract comes from its own active ingredients [11].

At the same time, researchers have studied the activity of fennel volatile oil against jujube black spot pathogen, observing the effects of different volume fractions of fennel volatile oil on pathogen hyphae, spores, and biomass; The test material is a gift from Tarim University, and the test strain is Alternaria tenuifolia; According to previous research by researchers, trans anethole and pinene are the main components of fennel essential oil. In this experiment, the minimum inhibitory volume fractions of fennel essential oil and its two main components against Alternaria were 0.312 and 0.625mL/L, respectively, measured by micro dilution method. The anti Alternaria effect of fennel essential oil can also be attributed to these two main components [12].

5.1.2. Regulating gastrointestinal function

Yang Hongwu et al. found through observation of the effects of Fenxiang Zhizhu Tang on the content of Nitric Oxide (NO) and the activity of Diamine Oxidase (DAO) in adhesive intestinal obstruction tissues of rats that Fenxiang Zhizhu Tang has a good therapeutic effect on adhesive intestinal obstruction in rats, and its mechanism of action is related to the protection of intestinal barrier function. The experimental method is to prepare a rat model of adhesive intestinal obstruction, which is randomly divided into a normal group, a model group, a Da Cheng Qi Tang group, and low, medium, and high dose groups of Fen Xiang Zhi Zhu Tang. Corresponding medication treatment was given on the 3rd, 5th, and 7th day after treatment, at a total of 3 time points, with 6 mice at each time point. The diseased intestinal homogenate was cut off, and the supernatant was taken. The tissue NO content and DAO activity were measured by radioimmunoassay. Result: Compared with the normal group, the model group showed an increase in tissue NO content ($p < 0.05$) and a decrease in DAO activity ($p < 0.05$); Compared with the model group, the NO content in tissues of the Da Cheng Qi Tang group, the low-dose group of Fen Xiang Zhi Zhu Tang, the medium dose group of Fen Xiang Zhi Zhu Tang, and the high-dose group of Fen Xiang Zhi Zhu Tang significantly decreased ($p < 0.05$), and the DAO activity increased ($p < 0.05$). Conclusion: Fenxiang Zhizhu Tang has a good therapeutic effect on adhesive intestinal obstruction, and its mechanism of action is related to the protection of intestinal barrier function [12]. Zhu Jinrong observed the therapeutic

effect of using fennel after cesarean section by applying hot compress to abdominal acupoints. He found that fennel can promote the recovery of gastrointestinal function, enabling the meridians to warm the meridians and promote circulation of qi and blood [7].

5.1.3. Hepatoprotective effect

The researchers' research shows that the extract of fennel perfume can significantly reduce the liver cell damage caused by carbon tetrachloride in rats, delay the process of liver fibrosis, promote the recovery of liver fibrosis, protect the liver and reduce enzymes; Improve the liver's antioxidant stress capacity and alleviate oxidative stress damage. And it can inhibit the activation of hepatic stellate cells by inhibiting the TGF/Smad signaling pathway [13].

The experiment used Uyghur herbal medicine fennel and used steam distillation to extract the effective components of fennel. 100g of fennel was placed in a double extraction device, and 15 times the amount of distilled water was added for reflux extraction for 2 hours. At the same time, the distilled liquid was collected, and the water extract was centrifuged by a high-speed centrifuge. The obtained centrifuge solution was concentrated and mixed with the distilled liquid to form a total volume of 200ml. The gavage dose is 0.3ml/100g body weight. The experimental subjects were 94 clean grade SD rats, purchased from the Animal Experiment Center of Xinjiang Medical University, weighing 170g-210g. Divide the rats into groups A, B, C, D, E. The experimental results showed that all rats in the control group survived, were in good condition, and had increased body weight; Two, three, one, and two rats in the fennel prevention group, treatment model control group, fennel treatment group, and Fuzheng Huayu treatment group respectively died at the beginning of modeling, considering acute carbon tetrachloride poisoning.

5.1.4. Anti-inflammatory effect

Researchers have studied the effects of Wentong Babu ointment (fennel, clove, cinnamon) on the levels of serum pro-inflammatory mediators in diarrhea model mice, indicating that the drug can have an antidiarrheal effect through anti-inflammatory effects. The combination of various drugs in the formula can have better anti-inflammatory effects. Among them, Group A is a simple diarrhea group, Group B is a diarrhea+drug group, Group C is a diarrhea+matrix group, Group D is a control+drug group, and Group E is a simple control group. There are 16 experimental animals in each group. There was no statistically significant difference in gender composition and body weight among the groups of animals [14].

5.1.5. Diuretic action

Researchers have shown in experiments on rat liver cirrhosis that fennel has a good potassium supplementation effect while treating ascites in liver cirrhosis, which can promote intestinal peristalsis. While treating ascites and diuresis in liver cirrhosis, it does not cause intestinal paralysis caused by low potassium [15].

5.1.6. The impact on the central nervous system

Fennel perfume decoction and volatile oil have analgesic effect on acetic acid induced pain. Researchers have selected seven traditional spice plants, including clove, Sichuan pepper, white pepper, star anise, cinnamon, white mustard, and fennel, to measure acetylcholinesterase inhibitory activity using an improved Ellman method. Acetylcholinesterase inhibitory activity was tested on spice extracts extracted using different extraction methods (reflux extraction, ultrasonic extraction, and microwave extraction), The results showed that: ethanol thermal reflux extraction (weighing 10g of spice samples into conical flasks, adding 120mL of anhydrous ethanol for 25 ℃ water bath extraction for 30 minutes, refluxing at 70 ℃ for 90 minutes to obtain crude extract, filtering three times, centrifuging, and taking the supernatant for rotary evaporation concentration at 90mbar, 45 ℃, 20rpm; until no ethanol is dripped out, the extract is diluted with 10% ethanol to 1.0mg/mL of the test solution) The acetylcholinesterase inhibition rate of the obtained spice extract is generally high; Under the same extraction method, the inhibition rate of fennel extract is second only to Sichuan pepper, reaching 39.42%; This may be related to the content of alkaloids or other active substances contained in spice plants [16].

5.1.7. Antioxidation

Fennel is a natural antioxidant that has varying degrees of scavenging and inhibiting effects on various reactive oxygen species and free radicals. Researchers conducted a study on the effect of fennel extract on lipid peroxidation in rats: 15 rats were randomly selected from 100 rats as the control group, and the remaining 85 rats were used as the model group and intervened with carbon tetrachloride (ultimately, 64 rats survived); Divide them into 4 groups (16 in each group), namely the low-dose group of fennel extract, the medium dose group of fennel extract, the high-dose group of fennel extract, and the model control

group. The doses of carbon tetrachloride (CCl_4) applied to rats in the low-dose group, medium dose group, and high-dose group of fennel extract were 0.54g/kg body weight, 1.08g/kg body weight, and 2.16g/kg body weight, respectively. Five groups of rats were orally administered once a day as follows: for the normal control group rats, distilled water suspension was used once a day for oral administration; for the low-dose group rats of fennel extract, 0.54g/kg of fennel extract+distilled water suspension was used once a day for oral administration; for the medium dose group rats of fennel extract, 1.08g/kg of fennel extract+distilled water suspension was used once a day for oral administration; for the high-dose group rats of fennel extract, 2.16g/kg of fennel extract+distilled water suspension was used once a day for oral administration. The drug was administered orally once a day to the model control group rats using distilled water suspension for a total of 8 weeks of intervention.

Conclusion: The extract of fennel seeds has varying degrees of scavenging effects on various reactive oxygen species or free radicals such as H_2O_2, O_2-, 0H -, etc. The antioxidant activity of fennel methanol extract is strong in various organic solvent extracts, and the main antioxidant active substance of fennel is phenolic compounds [17].

5.1.8. The effect on the trachea

The volatile oil of fennel has a relaxing effect on the smooth muscle of guinea pig trachea. Dissolving the volatile oil in 12% ether and administering it to anesthetized guinea pigs by gavage can increase the secretion of fluid in the trachea, and cutting off the gastric nerve does not have any effect. It is believed that this effect is not caused by gastric reactions.

5.1.9. Sex hormone like effects

Previously, the West believed that fennel had the effect of promoting milk secretion and menstruation, but now there are few experiments that can confirm this view; After 15 days of administering acetone extract of fennel to male rats, the total protein content in the testes and vas deferens decreased, while the total protein content in the seminal vesicles and prostate significantly increased. The acidity and alkaline phosphatase activity of these trachea decreased; Female rats treated with acetone extract of fennel for 10 hours showed vaginal keratinization and sexual cycle promotion, as well as increased weight of the mammary gland, fallopian tubes, endometrium, and uterine muscle layer. It is believed that fennel has estrogenic effects [18].

5.1.10. Other functions

The volatile oil of fennel and fennel brain have a central paralyzing effect on frogs, causing slight excitement to the frog's myocardium and subsequently causing paralysis. It paralyzes nerves and muscles like arrow poison, weakening the excitability of the muscles themselves. Plant polysaccharides extracted from fennel have anti-tumor effects. Volatile oil has a sterilizing effect on fungal spores, bird shaped bacteria, and Staphylococcus aureus. Dilution of the original volatile oil solution to 1:200, 1:400, and 1:800 still has an inhibitory effect on Staphylococcus aureus [19]. Fennel can antagonize the increase in chromosomal aberration rate induced by cyclophosphamide in mice. In addition, plant polysaccharides extracted from fennel have anti-tumor effects; In addition, the vascular activity test of water extract of fennel leaves was conducted in rats anesthetized with pentobarbital. Intravenous injection of freeze-dried boiling water extract of fennel leaves resulted in a significant dose-related decrease in arterial blood pressure, but did not affect heart rate and respiratory rate. The non boiling water extract only showed a slight blood pressure lowering effect. The blood pressure lowering effect of boiling water extract cannot be blocked by receptors such as splenic hormone, tetracycline, ganglia, and serotonin in the kidneys. But histamine and antagonists can block this blood pressure lowering effect at relevant doses [18].

5.1.11. Toxic side effects

The ethanol extract of fennel fruit was administered in acute toxicity (24 hours) and chronic toxicity tests (90 days) in mice, with ethanol extracts of 0.5, 1.0, and 3.0 g/kg given in acute toxicity tests and chronic toxicity doses of 100 mg/kg; There was no significant change in appearance hematology, semen analysis, body weight, and major organ weight among the treatment groups.

5.2. The medicinal properties of fennel

The medicinal properties of fennel can be summarized as spicy and warm. Can stay in the liver, kidneys, bladder, and stomach for a long time and exert its effects.

"Theory of medicinal properties": bitter, spicy;

"Tang materia medica": Spicy, flat, non-toxic;

"Materia Medica of Decoction": Entering Hand and Foot Shaoyin, taiyang meridian.

Fennel plays an important role in both traditional Chinese medicine and Uyghur medicine; Fennel can be harvested from whole grass in autumn and dried in the sun for later use;In the Compendium of Materia Medica, it is recorded that Fennel has a

mild nature, is good for regulating qi and appetizing, and is a suitable ingredient. Anise has a hot nature, can harm the eyes and cause sores when consumed frequently. It is not advisable to overuse the food. There is an ancient formula for removing bell shaped pills: two liang of fennel, four liang of ginger with skin connected. When submerged in a crucible for one volt, stir fry over low heat, add one or two salt to form the powder, and paste the pills into a paste that is large in size. Take three to fifty pills per serving, then add hollow salt and wine. This formula is originally used to treat spleen and stomach weakness, while the salt obtained from fennel is introduced into the kidney meridian, emitting evil energy. The kidneys are not affected by evil, and diseases do not arise. It is also effective in treating small intestine hernia.It is evident that fennel plays an important role in the field of traditional Chinese medicine.

6. Taboos and side effects of using fennel

Due to the pungent and warm taste of fennel, it is not suitable for people with excessive heat, yin deficiency, excessive fire, mouth and tongue sores, etc. Otherwise, it will worsen the symptoms of excessive heat and tongue sores, and even cause the occurrence of excessive stomach heat and gastrointestinal fever. In addition, patients with intestinal smooth diarrhea should not take fennel vaccine, otherwise it will worsen the symptoms of intestinal smooth diarrhea and cause abdominal distension and pain. Due to the rich fiber content in fennel, consuming too much can cause certain irritation to the gastrointestinal tract, exacerbate or induce symptoms such as gastroenteritis and gastrointestinal ulcers, leading to symptoms of bloody stools and abdominal pain in patients.

7. Biological characteristics and planting techniques of fennel

The growth habits of fennel are: (1) tolerant to continuous cropping and can be planted continuously; (2) light application of nitrogen fertilizer and heavy application of phosphorus and potassium fertilizer; (3) long soil dormancy time and slow sprouting of seeds; (4) less harmful to pests and diseases, easy to prevent; Fennel is often propagated through seeds, and it is sown in spring from March to April and in autumn from September to October. Based on the unique growth characteristics of fennel, a unique cultivation technique for fennel in Haiyuan, Ningxia has been developed. The sowing period is in early April (no later than late April), with a planting amount of 1.5kg per mu; Choose a wheat stubble and plow it promptly after the wheat harvest, Before and after 6 plowing and raking sessions to increase the amount of white dew in the sun dried field; the second is beneficial for soil moisture preservation, achieving a fine and loose soil with loose soil above and solid soil below; combined with plowing, apply 2000-2500kg of high-quality agricultural fertilizer such as grass and wood ash or 50kg of oilseed cake fertilizer per mu; during irrigation, pay attention to flexibly controlling the number of watering sessions according to natural rainfall and soil moisture, and replenish 1 water during the flowering period (especially in dry years, if there is no natural rainfall after flowering, refill 1 water) ; When the fruit turns yellow green and has a light black vertical line from August to October, choose a sunny day to harvest the aboveground parts, thresh and lift them clean. Mature fruits can also be picked and dried in the sun. At the same time, due to the wide distribution of fennel, different regions have developed cultivation methods that are suitable for local climate characteristics according to their different environments. For example, in order to adapt to the needs of industrial structure adjustment in Kashgar, promote agricultural yield and farmers' income, standardize the mechanization technology of fennel cultivation, including selecting thoroughly desalinated sandy loam soil for planting, and planting wheat, corn, or beans in the previous crop; At the same time, there are also requirements for seed types, mechanical requirements, and mechanical sowing techniques [20]. At the same time, there is also the technology of intercropping cotton with fennel on the edge of the Taklamakan Desert. After years of trial and improvement, significant economic benefits have been achieved, achieving the maximum benefit of cotton fennel interaction [21].

8. Product statistics and research on fennel market

8.1. Fennel seed oil

The colorless or light yellow liquid obtained by steam distillation of fennel under normal pressure has a strong pungent and herbal aroma, a slight fruity aroma, rose aroma, green aroma, and earthy aroma, giving it the flavor of tobacco and anise, and increasing its sweetness. In the food industry, fennel seed oil is mainly used as a seasoning and edible spice, and is not used for flavoring in tobacco, wine, candy, toothpaste, oral hygiene products, and some soap varieties [22]. The researchers used gas chromatography-time-of-flight mass spectrometry to analyze the aroma components of fennel seed oil, and calculated the relative content of each aroma component using peak area normalization method. A similarity search was performed on the mass spectrometry data corresponding to each spectral peak in the NIST standard mass spectrometry library, and a total of 34 components were identified using the retention index method. The sum of peak areas accounted for 99.89% of the total peak area. The main aroma components (peak area relative percentage) of fennel seed oil are (E)-anisole (80.405%), limonene

(4.176%), α-Pinene (3.198%), α-Shuiqinene (3.096%), Fenketone (2.107%), Laurene (1.024%), β-Water celery ene (0.869%), β-Pinene (0.541%), etc.

8.2. Uyghur medicine fennel soft capsule

Soft capsules refer to capsules made by dissolving or dispersing a certain amount of liquid drugs or solid drugs in suitable excipients to prepare solutions, suspensions, emulsions, or semi-solids, and sealing them in spherical or elliptical soft capsule materials. They are suitable for drugs with fat solubility, low melting point, and unpleasant odor. Mix the volatile oil of fennel with sunflower oil and O D. O is prepared as the content in a 1:4 ratio, and is sol in a ratio of gelatin: glycerol: water = 1:0.5:1, then pressed into pellets. The ratio of soft capsule shell is water: glycerol: water = 2:1:2 [23].

In addition, there are also fennel powder for seasoning and fennel tea for human consumption on the market.

9. Application of fennel in cosmetics

Fennel can also be combined with other substances to form a combination that can have anti-corrosion and bactericidal effects, which can be applied in cosmetics, including: 10% to 50% saponin extract, 5% to 40% spore extract, and 5% to 70% cortex pseudolari extract.

10. Conclusion

As a traditional Chinese medicinal herb, fennel has still attracted a large number of researchers to conduct detailed research in modern times, mainly focusing on biological characteristics, high-yield cultivation techniques, chemical composition analysis, biological activities, etc. However, research on pharmacological effects and their mechanisms of action is relatively limited and not deep enough, and further research, development, and rational utilization are needed.In addition, there are also many products related to fennel on the market now, which can help modern people understand and appreciate this traditional medicinal herb with the same source of food and medicine, and feel the profoundness of traditional Chinese medicine culture. We hope that more similar products will appear in the future!

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