

Research on the Development Status of Oil-use Peony Industry in Heze City

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Abstract The peony industry is a characteristic industry in Heze City, and oil-use peony is an emerging industry. Heze City has planned oil-use peony as a key support and development industry in the local area. The oil-use peony industry is full of treasures, but there are still many urgent problems to be solved for its sustained and healthy development: cultivation and planting, variety selection, product processing, and enterprise development, which have hindered the development of the oil-use peony industry. This paper delved into the comprehensive benefits of oil-use peony and its industrial development, providing some reference for the further development of the oil-use peony industry in Heze.

Key words Oil-use peony; Heze City; Utilization value; Problem

Peony (*Paeonia suffruticosa* Andr), belonging to *Paeonia* in Paeoniaceae, is a world-renowned ornamental and medicinal flower. Oil-use peony refers to the type of peony with strong seed setting ability that can be used to produce seeds and process edible peony seed oil, or refers to the varieties (or strains) of peony plants that produce seeds with a seed production rate $\geq 22\%$ ^[1]. In 1997, Mr. Zhao, an expert in planting peony in Heze City, first conducted experimental research on the oil-use value of peony^[2]. In 2004, Chinese Academy of Forestry Sciences and relevant institutions tested peony seeds cultivated by Mr. Zhao, and found that peony seeds were rich in oil and nutrition, which could be developed and utilized as a woody oil crop, and the content of α -linolenic acid in peony seeds was the highest among commonly used vegetable edible oil at present. α -Linolenic acid is a kind of polyunsaturated fatty acid, an indispensable polyunsaturated fatty acid that cannot be synthesized and replaced in the human body, an important component of human brain cells and histiocyte, and also known as "blood nutrient" and "plant brain gold"^[3]. In 2011, the Ministry of Health approved peony seed oil as a "new resource food". In the same year, Heze City took the lead in conducting pilot cultivation and comprehensive development and utilization, marking the beginning of the cultivation and comprehensive development and utilization of oil-use peony in China. The rapid development of the oil-use peony industry has attracted high attention from the central leadership, and Chairman Xi Jinping and Premier Li Keqiang have given important instructions for the development of oil-use peony projects. The Municipal Government of Heze City has prioritized the development of the oil-use peony industry. On September 7, 2013, the industry standard *Peony Seed Oil* led by Heze City was certified in the grain and oil industry and upgraded

to a national standard^[4]. On December 28, 2016, the former General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China approved the implementation of geographical indication product protection for "Heze Peony Seed Oil". In November 2018, the Municipal Government of Heze City issued the *Overall Plan for the Development of Peony Industry from 2018 to 2022*, which proposed to guide farmers or enterprises to gradually expand the planting area of oil-use peony. As of now, the cultivation area of oil-use peony in Heze City has reached nearly 32 670 hm², and the annual production capacity of peony seed oil has reached 29 000 t^[5]. Seed oil is not only a highly nutritious edible oil, but also an important raw material for new medicine and cosmetics. With the gradual deepening of people's research on oil-use peony, their enormous development and utilization value will push Heze peony to the whole country and even the world.

Development and Utilization Value of Oil-use Peony

Utilization value of seed oil of oil-use peony

The announcement No. 9 document of the Ministry of Health of the People's Republic of China pointed out that peony seed oil, which is made from seeds of oil-use peony by pressing, decoloring and other processing technologies, contains rich unsaturated fat acids, as well as a variety of natural pharmacological active ingredients, and has high nutritional and medical value^[6]. Through analysis of the nutritional components and various indexes in peony seed oil, it is shown that peony seed oil meets the standards for healthy edible oil in China and is an oil resource with good development and utilization value^[7]. The content of unsaturated fat acids in the seed oil of tree peony is more than 92%, and α -linolenic acid accounts for 42%, which is significantly higher than the content in soybean, peanut, olive oil and other daily edible vegetable oils^[8]. The content of α -linolenic acid in peony seed oil has important effects on improving human brain intelligence, reducing blood pressure and blood lipids, and delaying skin aging. Its

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extract contains 18 essential amino acids, trace elements, and peony flavonoids, which have high health value for the human body^[9]. In addition, multiple beneficial components such as vitamins, natural antioxidants, polyphenols and phytosterols, and various pharmacological active ingredients such as flavonoids, paeoniflorin, and astragalus were isolated from peony seed oil^[10]. These studies have proven that peony seed oil has extremely high nutritional and health value, making it the most suitable oil for human nutrition and a treasure among plant oils. Peony seed oil not only has high nutritional value, but also huge profits. The seed yield of oil-use peony is 4 500 – 6 000 kg/hm², and the protected purchase price is 26 yuan/kg; the average yield of wheat is 6 825 kg/hm², and the average price was 2.6 yuan/kg; the yield of corn is 7 410 kg/hm², and the average price was 2.2 yuan/kg; and the average yield of soybean is 2 700 kg/hm², and the average price was 6.4 yuan/kg^[11]. After comparison, the benefits of oil-use peony are more than four times that of traditional planting models, and it greatly contributes to improving the economic income of local growers, related enterprises, and even the entire city.

Utilization value of flowers of oil-use peony

Flowers of oil-use peony contain flavonoids and polyphenols such as astragaloside and gallic acid, which have the effects of regulating menstruation and activating blood circulation. The extract of peony flowers has obvious effect on scavenging free radicals. As the main medicinal component of peony, paeonol has sedative, soothing, anticonvulsant, and anti-atherosclerotic effects, and can also enhance immunity^[12]. In addition, it is found through research that proanthocyanidins contained in peony flowers are the substances with the strongest antioxidant activity known at present, 10 times of vitamin E and 20 times of vitamin C^[13], so peony flowers have high health value. The flowers of oil-use peony can be used for cooking, as well as for making peony sauce, peony pastries, peony tea, peony fruit wine, etc. They can also be made into handicrafts such as embossing and dried flowers for viewing and collection. The protein content in pollen of oil-use peony is 39%, which is 9 times that of eggs and milk, and it also contains various nutritional components including vitamins B1 and B2 and β -carotene, and can be made into series products of peony pollen.

Utilization value of root bark of oil-use peony

Medical research has shown that the root bark of peony trees contains phenolic substances such as paeonol and paeonoside, as well as active substances such as tannins, volatile oils, amino acids, and various trace elements^[15]. Pharmacological research has found that the root bark of peony trees has the effects of resisting inflammation and bacteria, reducing blood pressure and blood sugar, and regulating the cardiovascular system, and a significant protective effect on myocardial ischemia^[16]. In addition, the root bark of peony trees also has sedative and analgesic effects, and is used to treat arthritis caused by various reasons. It has the function of activating the immune system and promoting macrophage phagocytosis. The root bark of peony trees has central

hypothermia and antipyretic effects. It has the function of protecting the gastrointestinal tract and liver. Paeonol and paeonoside in the root bark of peony trees also have a significant effect on preventing thrombosis^[17].

Utilization value of leaves of oil-use peony

Scientific research has shown that the leaves of oil-use peony contain substances beneficial to human health, such as mineral salts, chlorogenic acid, and vitamin C, which can reduce pigment deposition, beautify and nourish the skin, and have effects such as calming the mind, regulating blood pressure, lowering blood lipids, preventing cardiovascular and cerebrovascular diseases, and improving immunity. They also have certain therapeutic effects on gastrointestinal dysfunction and constipation^[18]. Extracting flavonoids from peony leaves has high activity in resisting tumors, viruses, bacteria, and other pathogens. Meanwhile, using them to eliminate nitrite can not only provide additional economic value for the peony industry, but also provide new sources for the industrial production of flavonoids^[19]. In addition, peony leaves contain gallic acid, which has a good inhibitory effect on *Pseudomonas aeruginosa*, dysentery bacillus, *Staphylococcus aureus*, etc.^[20].

Comprehensive benefits of oil-use peony

Oil-use peony is a perennial small shrub, with a seed production lifespan of up to 50 years. It is known as an "iron crop" which does not need change of crops or turning soil over during their growth period, and thus achieves long-term benefits with one-time input^[21]. Peony seeds can be processed to produce high-end edible oils, daily necessities, cosmetics, pharmaceuticals, and other high-end products. After being processed into finished products, the value is higher, or peony seed oil can be exported to foreign countries to realize a higher economic value. In addition, cosmetics developed from peony petals and peony seed oil has better health and moisturizing effects than many popular international products. Moreover, oil-use peony has extremely high ornamental value, and the development of its industry can quickly drive the development of tourism in surrounding and local areas. Oil-use peony is drought-tolerant, barren-tolerant, and cold-tolerant, and has strong growth adaptability and a wide adaptation range. The trees can be planted without changing crops for decades, making them a good ecological tree species. They can effectively improve the local tourism environment, enhance biodiversity, restore and maintain capacity, and reduce losses caused by natural disasters, so they have significant ecological benefits^[22]. The planting of oil-use peony can not only drive the development of local tourism, but also give full play to the marginal utility of land, which virtually increases the country's cultivated land area, thereby alleviating the serious shortage of cultivated land resources in China and increasing farmers' income. Furthermore, the development and utilization of peony seed oil can greatly alleviate our dependence on imported edible oil, optimize dietary structure, and improve health levels.

The enormous utilization value of oil-use peony has been recognized by the public and the country. Heze City has taken the lead in formulating the national standard for peony seed oil. In

order to develop oil peonies, a series of measures have been taken in breeding, cultivation mode, large-scale planting, policy support, technical services, and other aspects. In terms of cultivation and planting techniques and mode selection, Heze City has conducted some scientific research projects such as off-season flowering and soilless cultivation, innovated new technologies on the basis of existing cultivation and planting techniques, and organized the compilation of the *Handbook of Oil-use Peony Planting and Intercropping Techniques* to help farmers and planting areas implement standardized planting and production^[23]. Moreover, Heze peony has also created various planting modes for intercropping with other plants. However, there are still many urgent problems to be solved, in order to ensure the sustainable and healthy development of oil-use peony.

Problems Faced by the Development of Oil-use Peony

Problems in cultivation and planting

Although Heze City was the first city in China to develop the oil-use peony industry, and compared with the period when oil-use peony was first planted, the planting area in Heze City has shown a trend of increasing year by year. However, overall, there are still problems with small planting areas, insufficient scale, and insufficient supply of raw materials such as peony seeds. Although it is a high-yield crop compared with other crops, due to the insufficient planting area, the seed production and processing capacity in Heze City are in a state of oversupply^[24]. Meanwhile, a standard technical system has not been formed in terms of planting time, planting density, growth period management, pest control and other aspects. Most flower farmers in Heze mainly rely on traditional cultivation techniques, facing unreasonable planting structure and lack of product innovation ability. Although the field peony cultivation and planting mode is relatively mature, the oil-use peony still follows the field planting mode of ornamental peonies. Extensive management can no longer meet the industrial production mode, and the unit yield and total yield of peony seeds are relatively low, and cannot be compared with the yields of oil soybeans. It is urgent to change the planting mode through scientific research and increase yield, so as to reduce costs, expand the market, and increase profits^[25].

Variety issues

It is determined that only two varieties of oil-use peony, Fengdan and Ziban, have been developed by understanding the actual development situation of oil-use peony in Heze City. The oil-use peony varieties planted, which are basically of the Fengdan series, have the characteristics of single variety, low purification, and seedlings not tolerant to waterlogging and herbicides, which leads to a low annual yield of oil-use peony^[26]. Due to a lack of attention and protection to the germplasm resources of wild peony, the distribution area of wild peony in their original areas has sharply decreased. A large number of wild peony scattered in forests with good site conditions are almost completely extinct, and

only scattered Fengdan and Ziban peony are found in barren soil layers such as cliffs and forest edges^[27]. The cultivation of new oil-use peony varieties is basically blank, and the cultivation of high yield and high-quality oil-use peony varieties has not yet started. Breeding and developing new oil varieties is an urgent need for industrial development.

Product processing issues

In terms of oil-use peony processing, five major categories of products have been preliminarily developed, including peony tea, peony cake, peony wine, peony seed oil, and peony daily chemical products. There are more than 20 peony seed oil processing enterprises in the city, with an annual output of about 5 000 t of peony seed oil. However, the scale is generally small, and the processing technology mainly relies on physical pressing and sub-critical extraction. There are problems including insufficient technological innovation, single product structure, obvious homogenization and uneven quality, and weak market competitiveness, and influential brands have not yet been formed^[28]. In addition, the leftovers from peony seed processing (cake, shell, seed coat) are developed and utilized insufficiently severely, without supporting molding technology, and their ineffective utilization results in a great waste of resources.

Issues related to enterprise development

In recent years, Heze has taken great strides in developing oil-use peony and formulating national standards for oil-use peony, which has been unanimously recognized internationally and domestically. However, due to the limitations of leading enterprises' technological level and their high management fees for oil-use peony, costs have increased, and product prices have also increased. After the transformation of small and medium-sized enterprises from traditional edible oil to peony seed oil production and processing, due to limitations in scale and technology, the utilization rate of raw materials is low, and the cost is also high, and there is a certain gap in product quality compared with leading enterprises, resulting in uneven quality of peony seed oil, scattered product sales locations, and various enterprises competing independently. The market share of peony seed oil is still very low^[29]. Due to the limitations of enterprises' technological capabilities and insufficient scientific research investment, the prices of the products produced by enterprises are too high. After entering the market, consumers are forced to pay too-high prices and their purchasing desire is not strong. The scientific and technological achievements of Heze oil-use peony have a single structure and are concentrated in single research, which cannot form a comprehensive research package and meet the rapid development needs of Heze oil-use peony, which is not conducive to accelerating its industrialization. In addition, the research on oil-use peony is relatively scattered, and there is a gap in the connection between basic research, applied research, and development research, leading to the phenomenon of uncoordinated and non-standard development. Especially, the research on the development of oil-use peony is relatively weak, which restricts the promotion and application of scientific

and technological achievements^[30]. Meanwhile, the understanding of the investment in oil-use peony technology has not been fully implemented, resulting in insufficient research funding for some research projects. The mechanism and system for promoting the transformation of technology investment into productivity are not sound, ultimately affecting the efficiency of Heze's investment in oil-use peony technology.

In addition, the attention paid to the early market development of oil-use peony products is clearly insufficient. The sustainable development and healthy growth of the oil-use peony industry depend on the acceptance of the developed products in the market and the smooth sales of the products. Otherwise, the benefits cannot be realized and the enthusiasm will decline. At present, the market development of oil-use peony products is just beginning, with a lack of product promotion channels, a single consumer group and insufficient awareness of oil-use peony products, which has hindered the development of the oil-use peony industry.

Suggestions for the Development of Oil-use Peony Products

Oil-use peony is an emerging industry that inevitably encounters some setbacks during its development. To solve these problems, it is necessary to expand the planting area of oil-use peony and accelerate the cultivation of high-quality germplasm resources. We need to strengthen technological innovation and establish a sound product technology system. We need to increase policy support and fully leverage the government's support, guidance, standardization, and service role in the oil-use peony industry. A standardized demonstration base for oil-use peony that combines areas, points, and lines is needed to be established based on scientific business model, scientific planning and reasonable layout. It is necessary to comprehensively promote and expand the market, and further increase the promotion of oil-use peony to popularize peony seed oil to the kitchens and dining tables of the general public.

Conclusions

Oil-use peony is a newly developed oil crop from unique resources in China. Peony seed oil extracted from the seeds of oil-use peony has extremely high nutritional value, while also promoting the prosperous development of local planting and tourism in Heze. The oil-use peony industry integrates the first, second, and third industry chains, playing a very important role in the economic development of Heze City, increasing farmers' income, protecting the ecological environment, and ensuring the balance of grain and oil supply. At present, it is necessary to conduct in-depth research on the comprehensive benefits of oil-use peony and its industrial development, further promote the true development of oil-use peony in Heze City into a peony industry chain, and form an oil-use peony industry cluster with "oil-use peony cultivation, research and development, and production" as the core, thereby helping the healthy, sustainable, and rapid development of the

oil-use peony industry in Heze City and making corresponding contributions to the economic construction of Heze.

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