New Development Trend of Edible Fungus Industry in China

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Abstract We elaborate support system of edible fungus industry from outlook on ecological economic development, legislation and standardization of variety approval, multiple-function innovation platform of industrial development research, and perfect talent cultivation and education system. Besides, we analyze the development trend of edible fungus industry from competitive advantages, position and role in national food security, industrial development trend driven by internal demand, diversified industrial development model, division of labor within the industry, and expansion of industrial chain. Then, from the point of zoning and planning of edible fungus industry, we put forward suggestions that it should start from modern industrial system and take the industrial cluster development and optimization as guidance. In addition, we present technical innovation direction of industrial development. It is proposed to strengthen propaganda, build industrial cultural atmosphere, and expand social cognition degree of edible fungus industry to promote its redevelopment. Finally, it is expected to promote international influence of edible fungus industry through experts appealing for policy support.

Key words Edible fungus, Industrial development, New trend

In recent 10 years, the edible fungus industry in China plays a certain role in increasing farmers' income and solving recycle of plant and animal production wastes during the rural development, and receives close attention from state leaders, experts and scholars. Both government and scholars believe that the edible fungus industry takes the ecological circular economy theory as guidance, and has made huge contribution to adjusting planting structure, deepening utilization of wastes, speeding up process of modern agricultural industrial system, promoting increase of farmers' income, improving dietary structure, improving health, and increasing foreign exchange earnings from export. However, present edible fungus industry still has some blindness and it lacks systematic understanding and strategic planning of industrial development status. We introduced current operation status of support system for edible fungus industry, analyzed new development trend of edible fungus industry, and made some predictions about development of edible fungus industrial system.

1 Current operation status of support system for edible fungus industry

1.1 Common understanding of development of ecological circular economy The ecological circular economy is an economic development model that utilizes resources and protects environment to the utmost extent. Traditional agricultural industrial model consists of "crop production and animal production". It is known to all that two elements are unstable in system operation. The traditional agricultural industrial model is an extremely unbalanced and non-sustainable industrial development model. With introduction of edible fungus production into the original two-dimensional production elements, it will form a stable agricultural circular system containing three elements "crop production, animal production and edible fungus production"[1]. This system not only speeds up matter cycle and energy cycle in nature, but also promotes resource of by-products of animal and plant production, energy saving and emission reduction, as well as ecological environmental protection. The development goal of ecological circular economy can be realized and negative effect of plant and animal on ecological environment can be reduced through taking plant and animal by-products as production substrate of edible fungus.

1.2 Legislation and standardization of variety approval The intellectual property right protection for variety of edible fungus in China mainly includes patent system and new variety protection system. The patent system mainly protects variety of edible fungus, seed selection and edible fungus production. The plant new seed protection system provides special protection for new seed of edible fungus[2]. With gradual increase of new seed of edible fungus, it is required to standardize policies and laws and regulations of variety approval and seed protection[3]. In this stage, many laws and regulations are issued, including *Provisional Administrative Measures on National Edible Fungus Variety* and *Administrative Measures on Edible Fungus Variety*. Besides, many preservation, research and management institutions are established, including China Center of Industrial Culture Collection (CCICC) and Agricultural Culture Collection of China (ACCCC) of China Committee for Culture Collection of Microorganisms (CCCCM), as well as Edible Fungus Center of ACCCC[5]. On the basis of variety approval, procedures for variety approval of edible fungus are further standardized, such as variety declaration, regional test, and

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approval. Finally, it is expected to set up mechanism for restraint of researchers' enterprises', or individual behavior, manage varieties and supervise approving authority, to further normalize variety market of edible fungus production and lay a solid foundation for legislation of edible fungus protection in China.

1.3 Establishment of multiple-function innovation platform of industrial development research through policy support Establishment of National Edible Fungus Technical System Development Platform, Edible Fungus Industrialized Engineering Center of Ministry of Education, and National Edible Fungus Engineering Research Center lays solid scientific foundation for development of edible fungus industry. On the basis of this, the National Key Technology Support Program in the Eleventh Five Year Plan period is set up at the state level, to incorporate " research and development of key technologies for upgrading of edible fungus industry" into key support, and to provide great financial, facility and manpower support for development of edible fungus industry, in combination with innovation platform of edible fungus industrial technical system.

Different from 973 Project and 863 Project set up by State Ministry of Science and Technology, the national modern agricultural edible fungus industrial technical system focuses on problems of production technologies and technical development during operation and development of edible fungus industry. Technical system of edible fungus industry shall be built to ensure that functional research offices and post experts can be closely combined with local edible fungus industry. It is expected to timely handle problems of edible fungus production and processing system badly in need of solution through rapid feedback mechanism.

Under the leadership of operation mode of national edible fungus industrial technical system, Sichuan Province firstly established the edible fungus industrial system and research team, which forms the industrial development innovation system with edible fungus industry as lead and coordinated with the state, provinces, cities and local places.

1.4 Establishment of perfect talent cultivation and education system The edible fungus industry is a labor intensive and technology intensive industry, and its development is closely related with cultivation of technical personnel. By now, the edible fungus industry has established multiple level (college, university, master, doctor, and post-doctor) specialized personnel cultivation and education system, and laid excellent foundation for talent reserves of edible fungus industrial development. At present, Jilin Agricultural University firstly completed multiple level talent cultivation and education system. Other universities will also move towards standardized, systematized and multiple level talent cultivation and education in near future. The development of edible fungus industry provides practice base and jobs, while the establishment of Edible Fungus Industrialized Engineering Center of Ministry of Education and National Edible Fungus Engineering Research Center will provide scientific and technical innovation platform for development of edible fungus industry. Under the leadership of outlook on ecological circular economic development, with promotion and guidance of edible fungus industrial technical system, and according to development demand of edible fungus industry, it is required to establish talent cultivation specification, target, content and method, to satisfy follow-up development demand of the industry to the utmost extent, and to lay solid foundation for talent reserve of industrial development.

2 New development trend of edible fungus industry in China

With over three decades of development, the support system for development of edible fungus industry is becoming better and better, which has been shown in policies, sciences and technologies, education and development outlook. At present, the edible fungus industry in China has basically realized output increase with expansion of production scale. The industrial chain constantly extends, industrial cluster is increasingly optimized, and product processing is continually deepening.

2.1 Comparative advantage of edible fungus industry and steadily increase of output Edible fungus industry adopts wastes of animals and plants as raw material. Its production process features low cost, short cycle, high benefit (high bioconversion ratio and low transpiration efficiency), and high input-output ratio. According to report of New Countryside Commerce, for one hectare of arable land planting edible fungus, the net output can reach 427 500 yuan, which is 3.8 times of tomato planted in big canopy, 29.4 times of cotton, 53.8 times of corn and 67.1 times of wheat with same area[4]. For single-cropping agricultural production in three provinces in the northeast of China, it is able to realize annual production of greenhouse and outdoor double-cropping production (black fungus).

According to statistics carried out by China Edible Fungi Association for 26 provinces, autonomous regions and municipalities directly under the central authority, the edible fungus output reached 20.206 million tons in 2009, 10.6% higher than that in 2008; the output was up to 110.33 billion yuan, 27.6% higher than that in 2008. In recent nine years, the output of edible fungus has an annual increase of 1.26 million tons (from 6.637 million tons in 2000) with an increase rate of 18.97%[5]. According to statistics of China Edible Fungi Association, in 2010, there are 189 counties that have output value of edible fungus over 100 million yuan, over 500 counties planting edible fungus, and both take on a trend of increase. The above data indicates that China's edible fungus industry is stepping into rapid development period. Along with perfection of support system of edible fungus industry and full play of after-effect of industrial support, China's edible fungus industry will increase in scale, benefit, output and quality.

2.2 Great responsibility in national food security system Under influence of expansion of industrialization and urbanization, and ecological projects as conceding the land to forestry, returning cultivated land to grassland and returning arable land to lake, the effective arable land resources constantly decrease and it will influence the national food security. As summed up by academician, Liyu, the edible fungus industry features not competing for food with humans, not competing for

land with food, not competing for fertilizer with land, not competing time with farming, and not competing resources with other industries, to realize the goal of turning grass into gold, harm into good, waste into wealth and clean production[6]. The protein content of (dry) edible fungus products is about 30 to 40%. Their functions are irreplaceable in balancing protein. At the same time of plant and animal production to obtain grain, meat, eggs and dairy, about three billion tons of wastes are produced annually. If turning 5% of these wastes into production of edible fungus, calculated at bioconversion of 60%, it is able to obtain 18 million tons of dry edible fungus (80% water content). The protein content in edible fungus is calculated at 35% of dry weight, equivalent to an increase of about 6 million tons edible protein, or an annual increase of 12 million tons lean meat, 18 million tons eggs, 72 million tons fresh milk protein content[7]. Besides, edible fungus is rich in vitamin, dietary fiber, and amino acid. These show that the edible fungus industry plays an irreplaceable role in balancing national dietary structure.

From the point of national grain security strategy, Premier of the State Council Wen Jiabao presided over executive meeting of the State Council on April 8 of 2009, discussed and approved *National Grain Production Capacity by* 50 *Billion Kilograms* (2009 – 2020)[8]. For crop farming, the output of by-product (straw) of crop production will increase 60 million kg, in other words, the total output of crop straw will be up to 760 billion kg. From current situation of crop straw utilization, about 40 to 50% are used as domestic fuel, about 25 to 35% for cultivation, 1 to 5% for industrial materials, and the rest 15 to 20% are burned, discarded or returned to farmland[9]. If we take half of the rest 10% straws (about 76 billion kg) to edible fungus production, 22.8 billion kg edible fungus can be produced, calculated at bioconversion of 60%. According to data issued by State Statistics Bureau on April 29 of 2011, per capita consumption of edible fungus is 17 kg calculated at total population of 1.34 billion. This lays a solid foundation for popularization of healthy and scientific diet mode " meat, vegetable and fungus".

It is shown that China's edible fungus industry will play a significant role in the national food security system. However, the present per capita consumption of edible fungus remains 1.0 to 1.5 kg annually in China, which is 30 to 50% of that in developed countries (generally 2.0 to 5.0 kg annually)[10]. So there is a great space to expand.

2.3 Thinning of labor division within edible fungus industry and constant extension of industry chain Industry chain includes four dimensions, namely, value chain, enterprise chain, supply-demand chain and space chain[11]. The industry chain extends to upstream and connects with support system of industrial development, forming foundation of industrial development; it expands to downstream and enters to product processing and market sections. With development of edible fungus industry, the labor division within edible fungus industry becomes more and more thinning, forming gradually functional subsystem of edible fungus industry development, and its structural attribute and value attribute become prominent. For example, around development of edible fungus industry, it establishes multiple level integrated talent cultivation system and research institutions of edible fungus technical products. In middle stream, there appear specialized production enterprises of edible fungus, specialized fungus pack production and supply enterprises, and professional edible fungus production technical service team. In downstream, there forms edible fungus sales agent team, levels of distribution center of edible fungus products, and primary and deep processing enterprises. Finally, it forms one-line industrial development service integrated with " technical support, production means supply, production, processing and sales". The industrial chain gradually extends, and industrial added value constantly gets internalized. In recent years, under influence of industrial development source-sink relation flow effect, regional flow of labor resources within the industry springs up in all areas. For instance, only Lishui of Zhejiang Province has over 40 000 specialized farmer technicians. They shift to extended regions from central areas of edible fungus production. For merely this section, the annual labor cost reaches 1.2 billion yuan, and each person earns about 30 000 yuan on average[6]. Labor division within the industry lays solid foundation for specialized development of the industry. Extension of industrial chain realizes dynamic development trend of industry with ability of constantly producing surplus-value.

2.4 Gradual trend of multi-element coexistence of cultivation model Biological development follows the law of " Natural Selection and Survival of the Fittest", forming the biosphere and regional distribution of the same biology and different strains, as well as production management model suitable for specific regional features. Diversified natural geographic conditions determine multidimensional index division system of edible fungus cultivation model, which takes on multiple element cultivation coexistence development. As per requirement of fungus variety for substrate, the edible fungus can be divided into wood rotting mushroom and straw rotting mushroom; as per intensity of sunlight and difference of cultivation and management condition, it can be divided into outdoor full-light cultivation, outdoor semi-light cultivation and bionic cultivation under forest; as per curing degree of culture, it can be divided into cultivation on un-sterilized substrate, cultivation on sterilized substrate, cultivation on compost or cultivation on semi-sterilized substrate; as per production unit and production scale, it can be divided into small-scale cultivation, factory type middle scale cultivation, and factory type large scale intensified cultivation; as per mechanization level, it can be divided into large-and-middle-scale full automatic mechanized, middle-scale full automatic mechanized production, small-scale semi-automatic mechanized production and manual operation. As per organization and management style, it can be divided into self-management with farmer as subject, joint management with cooperative organization as subject and enterprise-oriented management with company as subject[1,3,6]. In the course of marketization, China's edible fungus cultivation mode develops gradually

to standardized, moderate scale farmer joint operation on certain inclusive basis. Under influence of labor intensive feature of edible fungus industry and rising of labor cost in recent years, full-automatic or semi-automatic middle-and-small-scale mechanized production will certainly becomes alternative of manual labor. This will play significant role in edible fungus industry absorbing labor employment, promoting organizational development of farmers, increasing farmers' income, improving ecological environment, and lifting happiness index of rural residents' living, finally making the edible fungus industry become a sunrise industry with fresh and dynamic element.

2.5 Limitless potential of steady development of cultivation variety[12] According to statistics, at present, China has over 2 000 kinds of wild edible fungus, over 100 kinds of domestication edible fungus, and over 60 commercialized edible fungus[3]. Apart from shiitake fungus, *Auricularia auriculajudae*, *Agaricus bisporus*, *Pleurotus ostreatus*, and *Enoki mushroom* which take more shares of edible fungus market, with support of research and development system, rare varieties such as *Pleurotus eryngii*, *Bailing mushroom*, and *Agrocybe aegerita* enrich cultivation types in recent years. Lack of input in policy, capital and manpower leads to survey, collection, preservation, development and utilization of wild edible fungus resources lagging behind demand of industrial development. Consequently, the low richness and low genetic foundation of edible fungus resources hardly satisfy current and future market demands, especially development of liquid strain suitable for large-scale development lags behind international level.

2.6 Deep processing representing future development direction According to estimation of processing enterprises, for 1 kg mushrooms, the output value after primary processing can increase two to three times, and after deep processing, the output value can increase 10 to 20 times. At present, China's edible fungus processing is mainly fine processing and primary processing with supplement of deep processing. Here, the fine processing refers to the course of packaging and directly entering the market from simple pickup (dust and foreign matter removal) of edible fungus products purchased from production base. Primary processing refers to the course of simple processing (sugar soaking, salt soaking, and puffing) on the basis of fine processing to form Lentinula edodes sweety with low sugar content and canned edible fungus, as well as leisure foods or instant foods made of residual mushroom or leftovers. Deep processing means the course of producing fungus products (such as edible fungus health-care products, wine products, drinks, medicines, or cosmetics, *etc.*) with specific functions through certain processing of fine processed edible fungus products.

Now, the edible fungus processing enterprises is upgrading from primary processing to deep processing of edible fungus products. Some enterprises develop to new high-tech fields, like medical development of fungus products. However, since the edible fungus industry in China is still very young, there are few specialized personnel suitable for deep processing of edible fungus products, and technology and achievement reserves need to be further strengthened.

3 Prediction about development of edible fungus industrial system

3.1 Strengthen zoning and planning of edible fungus industry Agriculture is a complex production system consisting human, living things and environment. It is material production department mixed with economic reproduction and natural reproduction, forming multiple departments, multiple level and multiple target of agricultural zoning system. No matter from horizontal or vertical, industrial zoning needs conforming to coordination laws of different nature, economy and region between human, living things and environment, and industrial regional zoning according to local natural, economic and social conditions. Industrial planning takes the theory of industrial cluster development as guidance, plans development layout from industrial system, industrial structure, industrial chain, spatial distribution, economic and social environmental impact, and implementation scheme, to improve overall benefit and continuity of industrial development. From the development of edible fungus industry in China, we put forward following suggestions.

3.1.1 It is to plan main producing region with different varieties according to difference of natural and geographic conditions. Living things conform to the law of " Natural Selection and Survival of the Fittest". Different varieties of edible fungus have selection and fitness of natural and geographic conditions and production conditions. Under common influence of natural, material, social and policy capitals in regions, there form conditions favorable to development of specific edible fungus variety, and form main producing regions. For example, hedgehog hydnum and Pleurotus ostreatus of North China, dried mushroom of Inner Mongolia Autonomous Region, black fungus of the Northeast, and shiitake fungus of Zhangjiakou and Fujian[13]. The above is difference of development formed due to trans-regional resource difference. For one province, it also conforms to this principle. For instance, in Jilin Province, the eastern part is rich in forest resources, while middle and western parts are abundant with crop straws. Based on this, academician and Professor Li Yu of Engineering School of Jilin Agricultural University has put forward the edible fungus development strategy of " eastern wood and western straw" [14].

3.1.2 It is to bring into play natural endowment of regional resources and lay foundation for strategic transfer of industry. Edible fungus industry in southern regions is earlier than northern regions in China. Under conditions of many years production and hot and moist in main producing regions in southern regions, accumulation effect of mixed fungus leads to deterioration of production environment and increase of control risks for quality safety of edible fungus products. Northern regions have richer animal and plant by-products as raw material resources of edible fungus production, forming material capital to support development of edible fungus industry. Irreplaceable cold resource and edible fungus strain resources in Changbai Mountain and Daxing Anling Mountain Ranges and Xiaoxing Anling

Mountain Ranges form natural capital of industrial development. Rich rural labor force and scientific workers form human capital of industrial development. In the course of the above capital optimization, the industrial development pattern of "south mushroom shifting to north" appears. Such industrial development trend determined by natural endowment is independent of man's will and is the basis of industrial strategic transfer.

3.1.3 It is to make industrial planning from cluster of modern industrial system. During industrial planning, it is required to take the scientific outlook on development as guidance, and make overall planning from the level of industrial cluster development of modern industrial system (comprehensive system integrated with material supply, resource development, ecological protection, economic development, cultural continuity and market service), to ensure cluster development of the edible fungus industry[15]. To realize the goal of industrial cluster development, industrial planning needs considering scale of industrial development, quantity and quality of production substrate for respective development scale, and means of guarantee. Besides, it is also necessary to consider that industrial development demands can be satisfied by relevant support conditions of industrial development abilities, including transport and communication ability, processing ability of product processing enterprises, service ability of technical service departments, research and development ability of technical research and development organizations, market sales ability, as well as external environmental conditions necessary for industrial development, such as support measures and efforts of local government, perfection of credit guarantee system, and relation between departments[1,6].

3.1.4 It is to coordinate the relation between industrial development and ecological balance. Along with development of edible fungus industry, especially expansion of production scale of wood rotting mushroom, tendering of production forest in some areas lags behind demand of edible fungus production for substrate, and the conflict between fungus and wood is gradually prominent. Therefore, it is required to take scientific outlook on development as guidance and make integrated development planning of relevant industries, to form coordinated development of industries and realize win-win of industrial development and ecological balance. For example, Qingyuan County of Zhejiang Province produced 550 million bags of shiitake fungus from 1986 to 1995. The annual consumption of wood for mushroom reaches over 200 000 m^3, which is 1.8 times of the county's annual wood output (110 000 m^3), threatening ecological balance[13]. Nevertheless, at the same time of supporting development of edible fungus industry, Qingyuan County establishes forest ecology, forest industry and forest security systems, to restore unbalanced ecology. For example, the survey result of this county in 2004 indicates that compared with 1997, the total forest accumulation at the end of 2003 reached 5.999 million m^3, which has an increase of 1.216 m^3. The forest coverage reaches 83.6%, having an increase of 1.2%. These realize coordinated development of forest resource, environment and industry[16].

3.1.5 It is to make planning of protection zone for substrate resource, to ensure richness of genetic foundation. At the same time of planning of edible fungus industry and steadily promoting development of edible fungus industry in main producing regions, it is required to bring the construction of substrate resource protection zone into schedule, to ensure innovation ability of edible fungus industry. Yunnan is one of provinces with richest wild edible fungus resources, also one of 12 representative regions that have richest biological diversity in the world, providing conditions for growth and reproduction of different kinds of fungus[17]. Energetic popularization of manual cultivation of edible fungus in this region will speed up loss of traditional local fungus variety, narrow the genetic foundation, and further reduce improvement and innovation abilities of new variety. For protection substrate resource of edible fungus and improving genetic foundation, it is required to establish the protection zone of substrate resource and determine its strategic position at the level of legislation. Therefore, we should start from overall situation of development of edible fungus industry, make planning of protection measures for substrate resource, establish substrate resource security protection indicator system, and raise development capability of edible fungus industry.

3.2 Build industrial cultural atmosphere and expand social cognition degree of edible fungus industry Compared with traditional farming and cultivation, the edible fungus industry is a younger industry in China[6]. Public cognition is weak in edible fungus industry and industrial development features, so it is required to build industrial cultural atmosphere through diverse propaganda. For example, Jilin Agricultural University establishes Friends of Mushroom to raise public cognition of knowledge and culture of edible fungus industry. It is expected to realize its impact on public cognition and attitude, and create industrial development atmosphere oriented towards demands. To build edible fungus industrial culture, it also needs such media as radio and TV, to launch subject activities such as talking about mushroom and health, small mushroom but big industry, and circular economy and sustainable development, as well as series lectures on cooking of edible fungus.

3.3 Raise technological innovation ability and promote industrial development The edible fungus industry is a technology intensive industry. Its development is inseparable from support of science and technology. Technological innovation of edible fungus industry is penetrated into every sections of industrial development, including innovation of production process, production facilities, as well as production model, *etc.*

3.3.1 We should promote research and development of middle and small scale practical machinery. The intensification level and organizational degree is relatively low in China, and production model with farmers as units will still take up subject position for a long term. Along with social economic development, aging of rural labor forces and great trend of new generation farmers' migration to cities, advantages of China's rural labor forces in price is losing. To realize development of labor inten-

sive edible fungus industry, we should research and develop practical small and medium sized machinery to raise the labor productivity level.

3.3.2 We should strengthen transformation of edible fungus production facilities. It is proposed to carry out edible fungus production on the basis of vegetable greenhouse facilities. The conditions are different for vegetable and edible fungus. Vegetable growth needs temperature, sunlight and CO_2 favorable to photosynthesis, while edible fungus growth need slight light, temperature difference and CO_2 favorable to sporocarp growth[18]. Therefore, it is required to carry out technological transformation of functions of existing facilities at the need of such environmental condition as temperature, sunlight, air and heat for growth of edible fungus.

3.3.3 We should care about research and development of technologies for health protection of edible fungus farmers. Along with social development, both society and producer are increasingly paying close attention to demand of production safety. Production of edible fungus is operated in germfree environment. Excessive and repetitive use of sterilizing agents leads to skin allergy and respiratory track disease of edible fungus farmers. Therefore, at the same time of developing sterilizing technologies and caring about sterilizing effect and production safety, it is necessary to put producers' health in the position with utmost importance, and to research and develop more safe and healthy sterilizing products.

3.4 Strive for national preferential policy to support industrial development In the situation of developing globalization, the development of China's edible fungus industry is inseparable from international influence. At present, Japan, South Korea and other countries provide 40 to 50% fixed assets subsidy and export subsidy for production of edible fungus, to alleviate pressure of fungus farmers in production input. Their industrial development is benefited from national policy support. In China, however, 95% of producers of edible fungus are small farmers, whose production investment ability is limited, and production conditions are poor, facilities are backward, scale is small, technological level is low, management is extensive, and market risk is high. Chinese government should assign great responsibility to edible fungus industry in the national food security system, and provide preferential policies for development of edible fungus industry, to ensure international competitive power of industrial development and promote mechanization, large-scale, industrialization and standardization of edible fungus industry.

3.5 Promote standardization construction of raw material base and improve quality of edible fungus products By now, the standardization construction for raw material of edible fungus is not well valued by edible fungus enterprises, leading to difficulties in guaranteeing stability and safety of edible fungus quality. Therefore, relevant departments should attach adequate importance to standardization construction for raw material of edible fungus, and establish standardized production process, to improve quality of edible fungus products.

References

[1] LU M, LI Y. Present status and future prospects of the mushroom industry in China[J]. Acta Edulis Fungi, 2006, 13(1): 1 – 5. (in Chinese).

[2] LI J. Edible fungi strain intellectual property protection and present situation analysis[J]. China Invention & Patent, 2007(3): 48 – 49. (in Chinese).

[3] LI Y. Present situation and prospect of Chinese edible mushroom industry[J]. Journal of Jilin Agricultural University, 2008, 30(4): 446 – 450. (in Chinese).

[4] CUI Y. Comparison of Edible fungi industry status between China and South Korea[N]. New rural Business Daily, 2009 – 10 – 14. (in Chinese).

[5] ZHANG JX. Science and development of Edible fungi industry in China[J]. Beijng: China Agriculture Press, 2009: 45. (in Chinese).

[6] LI Y. Development trend of Edible fungi industry in China[J]. Edible and Medicinal Mushrooms, 2011, 19(1): 1 – 5. (in Chinese).

[7] MAO CF. Mushroom and grain times[J]. Shanghai: Shanghai Joint Publishing, 2009: 19. (in Chinese).

[8] The state council approval the additional 1 000 tons of grain production capacity planning[EB/OL]. (2009 – 04 – 08). http://news.xinhuanet.com/newscenter/2009 – 04/08/content_11151247.htm. (in Chinese).

[9] ZHONG HP, YUE YZ, FAN JW. Characteristics of crop straw resources in China and its utilization[J]. Resources Science, 2003, 25(4): 62 – 67. (in Chinese).

[10] China CFNA specialty Ministry. Edible mushroom exports will remain steady growth[EB/OL]. (2008 – 03 – 31). http://cccfna.mofcom.gov.cn/aarticle/c/200804/20080405456330.html. (in Chinese).

[11] WU JM, SHAO C. Research on formation mechanism of industry chain: "4 +4 +4" model[J]. China Industrial Economy, 2006(4): 36 – 43. (in Chinese).

[12] LI Y, LU M. Development trend of Edible fungi industry in China[J/OL]. http://www.jinnong.cc/analysis/market – trend/shiyongjun/2010/content_314511.shtml. (in Chinese).

[13] BAI KY. The value of edible mushroom resources and the potentiality in their development[J]. Journal of Hengshui Normal College, 2001(3): 54 – 56. (in Chinese).

[14] LU M, LI Y. Analysis of condition and strategy of the edible mushroom industrial development in Jilin Province[J]. Journal of Jilin Agricultural University, 2005, 27(2): 229 – 232. (in Chinese).

[15] ZHANG MZ. Study on characteristics and development tendency of modern industry system[J]. Contemporary Economy & Managemen, 2010, 32(1): 42 – 46. (in Chinese).

[16] ZHANG CW, ZHANG CY, CHEN ST. Constructing three systems of green Qingyuan[N]. China Green Times, 2005 – 11 – 22(02). (in Chinese).

[17] ZNAG M, LI XJ, ZHOU YK. Biological diversity of Yunnan Edible fungi and its resource protection[J]. Edible Fungi of China, 2005, 24(6): 3 – 6. (in Chinese).

[18] LI Y, YU HL. Advances in researching for the effect of illumination on the growth and development of Edible fungi[J]. Edible Fungi, 2011(2): 3 – 4. (in Chinese).

[19] HE Z. An Exploratory analysis of cooperation model change in the process of tomato industrialization in Xinjiang, China[J]. Asian Agriculture Research, 2010, 2(2):33 – 36.

[20] SHAO LQ, LI F. Application of shift-share method in the analysis of industrial structure of the county economy[J]. Journal of Anhui Agricultural Sciences, 2011, 39(33): 20747 – 20749, 20919. (in Chinese).

[21] HU ZD, WANG KW, BO X, *et al.* Impact of small-scale production mode on citrus industry of Hunan Province, China[J]. Asian Agriculture Research, 2010, 2(3):38 – 40.