Detection and Monitoring of Key Hazard Factors for Quality and Safety of Characteristic Berries and Standardized Production Technology and Application

Tao WANG[1], Jinyu ZHAO[1], Yanling REN[1], Min ZHANG[2], Lidan MA[4], Zhi LI[3], Youwen TIAN[2], Haibin FU[5], Xingning WANG[3]

1. Guizhou Light Industry Technical College, Guian 550025, China; 2. Shenyang Agricultural University, Shenyang 110866, China; 3. Guiyang Customs Comprehensive Technology Center, Guiyang 550002, China; 4. Dandong Customs Comprehensive Technology Center, Dandong 118000, China; 5. Shenyang Customs Technology Center, Shenyang 110866, China

Abstract Blueberry, kiwifruit, *Rosa roxburghii*, and raspberry are the characteristic fruits planted in Guizhou Province. However, in recent years, harmful factors such as plant diseases and insect pests, pesticides and heavy metal residues have affected the quality and safety of blueberry, kiwifruit, *R. roxburghii*, raspberry and other berries. These problems mainly include the frequent occurrence of plant diseases and insect pests, pesticide residues and heavy metal pollution, which not only seriously affect the quality and safety of berries, but also restrict the healthy development of berry industry. Therefore, it is very important to study the detection and monitoring of key hazard factors affecting the quality and safety of blueberry, kiwifruit, *R. roxburghii* and raspberry, as well as the standardized production technology. Using literature analysis, field investigation, questionnaire survey, comprehensive analysis, SWOT analysis, laboratory testing and other methods, this paper made a comprehensive and in-depth study of the berry industry in Guizhou Province. Through the analysis of the current situation of the berry industry in Guizhou Province, the problems and shortcomings in the planting, management, sales and other aspects of the industry were revealed. In order to solve these problems, a series of practical measures were put forward, including strengthening pest control, optimizing pesticide application technology, and strictly controlling heavy metal pollution, so as to ensure the healthy and stable development of berry industry. The implementation of these measures will help to improve the overall quality level of the berry industry in Guizhou Province.

Key words Berries, Plant diseases and insect pests, SWOT, Countermeasure, Guizhou Province

1 Introduction

With health awareness deeply rooted in the mind of the people, healthy lifestyle and consumption trends have become a new trend. Benefited from a number of supportive policies, China's consumer market is recovering steadily. In the current market environment, consumers' interest in traditional low-price and unsalable agricultural products has weakened, and they prefer green, healthy and high-end agricultural products. Relying on its unique agricultural resources and ecological advantages, Guizhou Province is ushering in new development opportunities and is committed to building a world-class "green food brand" and exploring the high-end development path of the fruit industry. Under the new development pattern, the market demand of high-end agricultural products at home and abroad has tremendous potential. In order to meet people's growing demand for a better life, Guizhou Province actively promotes green organic agriculture and expands high-end markets at home and abroad, which not only helps to promote the transformation and upgrading of agriculture, but also actively responds to and serves the national strategy.

Due to its high economic value, high economic benefits and strong cold tolerance, berry fruits show great potential for development and are gradually emerging as a hot industry attracting much attention. Berry is a kind of fruit developed from ovary, which is juicy and soft in texture, including strawberry, grape, blueberry, kiwi fruit and pomegranate. Studies have shown that berry postharvest diseases caused by preharvest pathogen infection, postharvest mechanical damage and microbial infection lead to economic losses as high as 20% to 30%. These diseases include soft rot caused by *Botrytis cinerea* and anthracnose caused by *Colletotrichum gloeosporioides*[1]. Therefore, it is very important to effectively prevent and control the rot diseases of berry fruits. Since the first introduction of blueberry in Majiang County at the end of the 20th century, the blueberry planting industry has achieved leapfrog development. By the end of 2023, blueberry planting has spread over more than 70 counties (districts and cities) in 9 cities (prefectures) of the province, with the planting area exceeding 153 000 ha and the annual output jumping to more than 100 000 t, ranking in the forefront of the country. The output value of fresh blueberries exceeded 2.19 billion yuan, and promoted the vigorous development of tourism and deep processing industries, with a compre-

Received: March 12, 2024 Accepted: April 29, 2024
Supported by Project of Science and Technology Development Center of the Ministry of Education of China (2022YFD1601704); Research Program of Huang Yanpei's Vocational Education Thought of China Vocational Education Association (ZJS2024YB181); Project of China Institute of Electronic Labor (Ceal2023269); New Generation Information Technology Innovation Project of High Education Institutions Scientific Research and Development Center of the Ministry of Education of China (2022IT120).

hensive output value of more than 3 billion yuan. The prosperity of this industry has not only directly led to the employment of more than 100 000 people, but also indirectly affected the livelihood of more than 2 million people upstream and downstream, with an annual output value of more than 1 billion yuan, which has injected strong impetus into the economic development of Guizhou Province[2]. Therefore, it is of great significance to study the detection and monitoring of key hazard factors for quality and safety o characteristic berries and the standardized production technology and application in Guizhou Province.

2 Research methods

In this study, literature analysis, questionnaire survey, field investigation, comprehensive analysis, SWOT analysis and laboratory testing were used to analyze the development status of berry industry in Guizhou Province. Combined with the actual situation of berry industry in Guizhou Province, SWOT analysis was carried out, and the advantages and disadvantages, key hazards of quality and safety, opportunities and threats of development of berry industry in Guizhou Province and even the whole country were analyzed in depth, and countermeasures were put forward.

3 Research results

3.1 Key factors affecting industrial development

3.1.1 Low degree of standardized production. The standardized production level of some berry orchards in Guizhou and even in the whole country is not high, the life span of fruit trees is shortened, and the input-output ratio is reduced. The problems are mainly due to the lack of high-quality varieties, improper cultivation techniques and excessive use of chemical fertilizers and pesticides. The standardization of orchard management should be improved to avoid the decline of yield, life and stress resistance caused by unreasonable planting and pruning techniques. It is necessary to promote scientific management methods and improve traditional planting patterns. At present, the management of fruit seedlings in some orchards is not standardized, and there is no effective supervision system, resulting in uneven quality of fruit seedlings. The quality of fruit trees is prominent, and low-grade fruits account for a large proportion. Excessive fertilization causes soil compaction and rhizosphere diseases, which affect fruit quality. Fruit growers neglect pest monitoring and prevention, resulting in poor disease control effect and high cost. Pesticide residues affect the health of consumers, restrict the development of agricultural products market, especially affect the sales.

3.1.2 Low degree of industrialization. (i) The infrastructure is relatively backward. Some orchards have inadequate infrastructure, resulting in poor resistance to natural disasters, especially the serious problem of frost damage. Water conservancy facilities are scarce, and few orchards can be irrigated, which affects the yield. Storage facilities are inadequate and large-scale storage bases are lacking.

(ii) Low level of science and technology. The scientific and technological level of some berry industries lags behind, the development of deep processing industries is insufficient, and there is a gap with the international level. Scientific research and breeding are mainly based on introduction, lacking germplasm resource evaluation and molecular genetic research. The service system of science and technology extension is not perfect, and there is a lack of efficient talent introduction and training.

(iii) Lack of leading enterprises and organizations. The development of some berry industries is limited by resources and infrastructure, and the lack of standardized processing bases leads to the decentralization of processing industries and the lack of raw material bases for enterprises, which affects the enthusiasm of fruit growers. There is a lack of cooperation among fruit growers, and a complete integration model of production and marketing has not been formed.

3.1.3 Quality standards are not uniform. Although quality standards have been promulgated in some parts of the country, the berry processing industry still faces the problem of inconsistent quality standards, which to a large extent fails to meet the stringent demands of the national and international markets, limiting the export potential of berries. Therefore, the development of berry industry in Guizhou Province needs to be broken through urgently, among which how to develop products with high added value and high-tech content has become a key issue to be solved urgently. This will not only help to enhance the market competitiveness of berry products in China, but also promote the optimization and upgrading of industrial structure.

3.1.4 The ability to resist risks is not strong. In order to encourage the development of the berry industry, the government of Guizhou Province provides insurance services to farmers who plant 0.33 ha or more, aiming to reduce the impact of natural disasters and pests and diseases on berry yields and enhance farmers' ability to resist risks. According to the 2022 *Blueberry Insurance Implementation Plan*, the insurance fee was 1 500 yuan/ha, with subsidies provided by governments at all levels, and farmers would pay 450 yuan/ha. When the loss of berries exceeds 10%, fruit growers can obtain compensation of up to 30 000 yuan/ha. However, in our field survey, we found that berries were threatened by more than 20 kinds of pests and diseases, some of which were difficult to prevent, such as root rot and fruit fly pests, which posed a serious threat to the yield and quality of blueberries. For example, in 2022, due to drought, blueberry fruit trees in some places were damaged in large areas, and many growers reported a shortage of funds and frustrated confidence. Considering that the cost of berry planting and subsequent improvement is as high as 120 000 – 150 000 yuan/ha, the current insurance compensation is obviously insufficient[3]. This makes it difficult for fruit growers to guarantee the yield and quality of berries when facing losses, thus affecting the extension and development of the berry industry chain. Therefore, it is necessary to further improve the berry insurance policy and improve the level of protection to support the healthy development of the berry industry.

3.2 Standardized production technology and application countermeasures

3.2.1 Establishing a technical system for the detection and control of diseases and insect pests of characteristic berries, and formulating technical standards. It is necessary to establish the standard system of berry production under international standards, and promote the standardized agricultural development model of the whole industrial chain. The standard system should be built as the core indicator of the berry industry, promote the cooperation between local leading enterprises and foreign-funded enterprises, and promote the concept and technology of modern agricultural development. In addition, it is necessary to build a product standard system in line with local reality, covering planting, production, storage, transportation, processing and marketing. Furthermore, Guizhou Province should establish a standardized demonstration base and gradually build a high-quality development standard system for the berry industry in the whole province.

Guizhou Province should improve the quality inspection and certification mechanism of agricultural products, and enhance the quality assurance of "characteristic berries". It is necessary to streng then the certification of "three certificates plus one registration", and improve the quality standards of berries by certification agencies inside and outside the United Nations. Through incentives or subsidies, it is necessary to encourage business entities to participate in the certification, and promote the quality certification of berry products in an all-round manner. Also, it is necessary to establish traceability system, reverse promote industrial standardization and standardization, and enhance the credibility of berries. Finally, Guizhou Province should establish a berry origin traceability platform based on block chain technology, integrate demonstration products to agricultural products traceability management, support the construction of standard system, and learn successful experience to promote the development of professional traceability platform.

3.2.1 Making innovation in high-throughput detection methods for pesticide and heavy metal residues in characteristic berries. It is recommended to improve and optimize the pretreatment technology of extraction and purification of pesticide residues in characteristic berries. In order to solve the problems of too many steps, cumbersome and time-consuming pre-treatment of pesticide residues in agricultural products, an automatic purification, concentration and derivatization device should be designed and invented, which can be purified, concentrated and derivatized online, and the extract is directly analyzed on the machine after being processed by the device, which will greatly improve the efficiency of detection. Besides, in order to meet the requirements of large-volume elution and pollution reduction in the detection of pesticide residues in agricultural products, a solid phase extraction device can be designed, invented and provided, which is suitable for the purification and enrichment of various compounds and greatly improves the work efficiency of pretreatment in the detection of pesticide residues in agricultural products. It is recommended to use the internationally advanced accelerated solvent extraction, gel chromatography combined with matrix dispersion purification and matrix dispersion solid phase extraction as pretreatment methods to extract and purify pesticide residues in agricultural products. Guizhou Province should establish a suitable pretreatment purification extraction method for pesticides, fungicides, herbicides and other chemical pesticide residues, to realize the automation of sample pretreatment for systematic analysis of pesticide multi-component residues in agricultural products, and to innovate in the extraction and purification of pesticide residues in agricultural products. Compared with the traditional method, the established pesticide residue detection pretreatment technology is simple, more convenient, quicker and more efficient, the consumption of detection consumables is small, the detection cost is obviously reduced, and the extraction efficiency and the purification effect of the pesticide residue in agricultural products are greatly improved.

3.2.2 Establishing a high-throughput screening and quantitative detection technology for 100 pesticide residues in characteristic berries. Gas chromatography-tandem mass spectrometry (GC-MS/MS-MRM), high performance liquid chromatography-tandem mass spectrometry (LC-MS/MS-MRM) and other technologies can be used to develop and optimize high-throughput accurate detection methods for pesticide residues such as pesticides, acaricides, herbicides, fungicides and plant growth regulators in raspberry, *R. roxburghii* and *Schisandra chinensis*, to realize the high-throughput screening, confirmation and quantitative detection of target pesticide residues in agricultural products, the sensitivity, accuracy and efficiency of detection have been significantly improved compared with traditional detection methods, the lowest detection limit should reach 0.002 5 – 0.010 0 mg/kg, and the detection ability should reach the international advanced level. And it is necessary to provide a reliable technical support for solving that problem of detection and analysis of multiple pesticide residue in the environment of berries and producing areas.

3.2.3 Establishing protection technology system for characteristic berry industry. At present, there are relatively few and loose standards for pesticide residues in berries, which may lead to the risk of dumping foreign substandard berries into the Chinese market at low prices, pose a threat to consumers' health, disrupt the order of the domestic market and hinder the healthy development of related industries. With the intensification of international trade competition, pesticide residue limit standards have gradually become an important part of technical barriers. When formulating the pesticide residue limit standards for berries, food safety, it is required to take into account actual production conditions and other factors, and study deeply the impact of pesticide residues on foreign trade. Standard formulation should ensure safety, especially according to the actual situation of major foreign berry producing countries, and formulate standards that conform to the characteris-

(To page 41)

for family moral education. At the same time, it should do a good job in top-level management, integrate the information collected during the process of "school education supervision" and "family education guidance", establish an instant feedback mechanism, and form a closed loop of educational information exchange.

References

[1] TIAN HS. On several issues of school moral education field[J]. Theory and Practice of Education,1995(4): 51 - 54, 8. (in Chinese).

[2] WANG W. Research on the construction of moral education system in primary and secondary schools from the perspective of moral education field [J]. Educational Science Research,2021(6): 81 - 87. (in Chinese).

[3] MO FP. Concept definition and characteristics analysis of moral education field[J]. Academic Exchange,2005(10): 16 - 19. (in Chinese).

[4] DONG PS. Problems and solutions of the home-school cooperation in rural schools[J]. Primary and Secondary School Principals, 2019(8): 3. (in Chinese).

[5] LUO X. On the construction of "soft environment" in universities and the innovation of moral education[J]. Journal of Hunan Agricultural University (Social Sciences), 2006, 7(6): 3. (in Chinese).

[6] TANTAI LL. On American homeschool and the inspirations on education in China[J]. State Academy of Forestry Administration Journal, 2008 (4): 4. (in Chinese).

[7] REN YZ. Research on the construction strategies of dynamic classroom in secondary vocational schools: From the perspective of classroom teaching management[J]. Vocational Education Research, 2018(5): 5. (in Chinese).

[8] MO FP. On moral education field strength and its conformity and optimization system[J]. Journal of Northwest Minzu University (Philosophy and Social Sciences), 2006(5): 135 - 140. (in Chinese).

[9] [Germany] KURT L. Topological psychology[M]. GAO JF (Translator). Beijing: Commercial Press, 2003. (in Chinese).

[10] WANG XD, XU SM, YUE NN. Situation change, practical difficulties and transcendence path of school moral education under the background of "double reduction" [J]. Contemporary Education Sciences, 2022 (8): 63 - 70. (in Chinese).

[11] WANG XD. The confusion, clarification and routes of practice on the cooperative education of compulsory education under the background of "double reduction" policy[J]. Journal of The Chinese Society of Education, 2022(2): 28 - 33. (in Chinese).

(From page 35)

tics of berries in China. In addition, the standard-setting should be open and transparent, follow scientific principles, and actively invite members of the World Trade Organization (WTO) to comment on the scientific nature of the standards. Further, it is required to actively follow up and participate in the formulation of international pesticide residue standards, and strive to make international standards consistent with the actual situation of the berry industry. This not only helps to protect the berry industry from the impact of foreign substandard products, but also builds a solid technical barrier for the sustainable development of China's berry industry[4].

3.2.4 Improving industrial support and promoting the development of berry industry. It is necessary to reinforce the protection of intellectual property rights, promote the declaration of achievements and combat infringement. Besides, it is recommended to optimize policy adaptability, implement the management policy of facility agricultural land, and reserve special land use indicators to support the development of the berry industry. Also, it is necessary to establish and improve the information transmission mechanism, use the big data platform to integrate resources, strengthen the communication between government and enterprises, guide growers to plant rationally, and widely publicize preferential policies. Guizhou Province should promote its berry brand, participate in exhibitions and conferences, improve brand awareness, expand influence with the help of e-commerce platform, and deeply integrate with tourism, culture and other fields. Finally, it is recommended to promote the development of eco-tourism, integrate natural resources, build industrial chains, promote the development of berry industry, and cultivate well-known enterprises.

References

[1] YU J. Analysis of berry industry in Heilongjiang Province by SWOT and its development countermeasures [D]. Harbin: Northeast Agricultural University, 2023. (in Chinese).

[2] WANG QP. Guizhou: Rapid development of blueberry industry[J]. China Fruit News, 2024, 41(3):54. (in Chinese).

[3] TANG LJ. Research on the integrated development model of blueberry industry in Majiang County, Guizhou Province [D]. Guizhou: Guizhou University, 2023. (in Chinese).

[4] WANG T, LIAO JF, ZHANG Y, *et al.* Comparative analysis of maximum pesticides residue limits in blueberry at home and abroad [J]. World Agriculture, 2015(10): 118 - 123,240. (in Chinese).

[5] REN YL, TIAN H, WANG T, *et al.* Investigation on insect pests and diseases on export base of blueberry[J]. Acta Agriculturae Zhejiangensis, 2016, 28(6): 1025 - 1029. (in Chinese).

[6] REN YL, ZHOU J, WANG T, *et al.* Status and development countermeasures of blueberry industry in Guizhou[J]. Guizhou Agricultural Sciences, 2016, 44(6): 172 - 175. (in Chinese).