

# Main Problems and Countermeasures of Chinese Chive Quality and Safety in China

Pingyang SHAN<sup>1,2,3#</sup>, Haoshuang DONG<sup>1,2,3#</sup>, Lei WANG<sup>1,2,3</sup>, Zhe MENG<sup>1,2,3</sup>, Jianhua WANG<sup>1,2,3</sup>, Jinlu LI<sup>1,2,3\*</sup>, Yue HUANG<sup>1,2,3\*</sup>

1. Tangshan Food and Drug Comprehensive Testing Center, Tangshan 063000, China; 2. Hebei Agricultural Products quality and safety testing Innovation Center, Tangshan 063000, China; 3. Tangshan Institute of Industrial Technology for functional agricultural products, Tangshan 063000, China

**Abstract** In recent years, the problem of pesticide residues in Chinese chives has attracted widespread attention from society. This paper comprehensively analyzed the production and planting situation, quality and safety status and changes in pesticide standards of Chinese chives, and deeply discussed the main quality and safety problems of Chinese chives and their causes. On this basis, it was proposed to improve the quality and safety level of Chinese chives from three aspects: improving limit standards, promoting green production prevention and control techniques, and strengthening supervision on input products.

**Key words** Chinese chive; Quality and safety; Pesticide residue; Supervision

**DOI:**10.19759/j.cnki.2164-4993.2023.06.012

Chinese chives are one of the important special vegetables that Chinese residents like. However, it has been frequently exposed by the media that "prohibited organophosphorus pesticides" have been detected in Chinese chives everywhere<sup>[1-2]</sup>, which has aroused widespread concern and concern of the public media and consumers about the quality and safety of Chinese chives. The Baidu index shows that "Chinese chive" has significantly higher media attention than other vegetable varieties. China attaches great importance to this issue. On May 31, 2021, the seven ministries and commissions including the Ministry of Agriculture and Rural Affairs jointly launched the three-year action of "controlling illegal drug residues and promoting improvement" for edible agricultural products<sup>[3]</sup>, focusing on solving the problem of excessive pesticide residues in "three vegetables" (cowpea, Chinese chive and celery), and proposing to strive to basically solve outstanding problems and hidden dangers such as the use of prohibited and restricted drugs in about three years. This paper systematically analyzed the quality and safety problems and main reasons of Chinese chives in China from the technical point of view, and put forward corresponding countermeasures.

## General Situation of Chinese Chive Planting in China

According to the data published in *China Agricultural Industry*

Received: August 6, 2023 Accepted: October 8, 2023

Supported by The Fourth Batch of High-end Talent Project in Hebei Province; Hebei Provincial Science and Technology Innovation Leading Talents (21130243A); Special Project of the Central Government in Guidance of Local Science and Technology Development (226Z5504G); Tangshan Talent Project (A202202005).

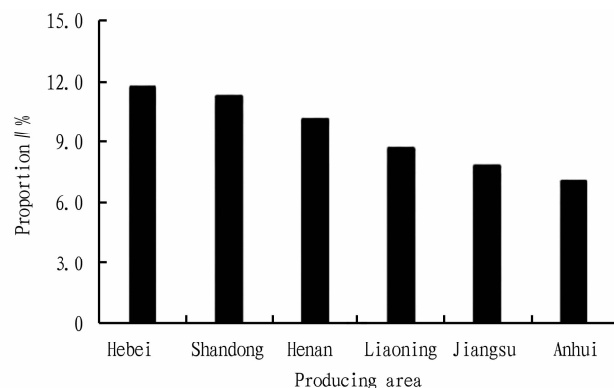
Pingyang SHAN (1988 -), female, P. R. China, engineer, devoted to research about food detection and analysis.

Haoshuang DONG (1994 -), female, P. R. China, engineer, master, devoted to research about food detection and analysis.

#These authors contributed equally to this work.

\* Corresponding author.

*Technology Development Report 2020*<sup>[4]</sup>, the national planting area of Chinese chives was 435 000 hm<sup>2</sup> in 2020, with an output of 2.8 million t. The relatively concentrated Chinese chive producing areas are mainly distributed in Hebei, Shandong, Henan, Liaoning and other provinces. The planting areas of Chinese chives in Hebei, Shandong and Henan are stable at about 40 000 hm<sup>2</sup> all the year round, with an annual output of about 2 million t<sup>[5]</sup>. According to the investigation and statistical results of the national characteristic vegetable industry technology system, the distribution of major producing provinces with planting areas exceeding 5% of the total planting area of Chinese chives is shown in Fig. 1.



**Fig. 1** Proportions of Chinese chive planting areas in main producing areas to the total planting area of Chinese chives in China

The cultivation modes of Chinese chives mainly include open field cultivation, small arch shed cultivation, solar greenhouse and multi-layer mulching cultivation. Due to different climates in different producing areas, the annual harvest time and harvest situation are also different. Taking Shandong Province as an example, 5–7 crops are harvested in open field cultivation every year, with a yield of 30–33 t/hm<sup>2</sup> per crop, and the harvest time is from March to November; and 1–2 crops are harvested per year in

small arch shed cultivation, with a yield of 22.5–30.0 t/hm<sup>2</sup> per crop, and the harvest time is from February to March and December; and in solar greenhouse and multi-layer mulching cultivation, three crops are harvested every year, with a yield of 30.0–37.5 t/hm<sup>2</sup> per crop, and the harvest time is from December to March of the following year. According to field investigation, the production organization mode in main Chinese chive producing provinces such as Shandong, Henan and Liaoning is mainly farmers' families, and the organization form of "farmers + cooperatives" is widespread.

## Analysis on Quality and Safety Status of Chinese Chives

While bringing economic benefits to farmers, the quality and safety problems brought by the annual planting mode of Chinese chives cannot be ignored. Judging from the monitoring and sampling inspection of agricultural and rural departments and market supervision departments, the main problem in the quality and safety of Chinese chives is that pesticide residues exceed the standards.

The quality and safety risk monitoring data of Chinese chives from 2018 to 2021 showed that there were 128 unqualified products of Chinese chives, and the overall qualified rate was 92.7%, which was lower than the monitored qualified rate of vegetable products and agricultural products over the years<sup>[6]</sup> (Fig. 2). According to the unqualified parameters (multiple parameters exceeded the standards in one unqualified sample), procymidone was the main reason for unqualified Chinese chives (Fig. 3), accounting for 46.9% of the total unqualified samples, followed by chlorpyrifos, iprodione and carbofuran, accounting for 12.5%, 11.7% and 8.6% of the total unqualified samples, respectively. Among them, chlorpyrifos and carbofuran are prohibited pesticides used in vegetables.

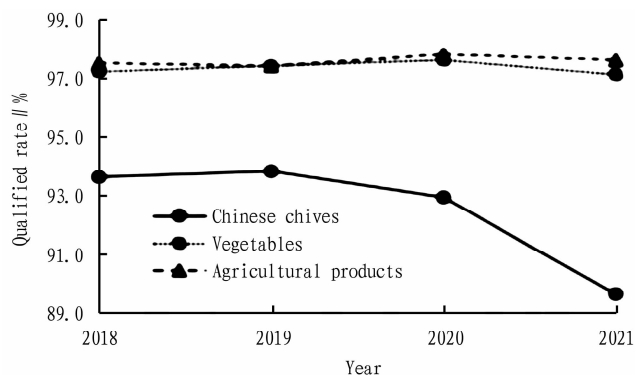


Fig. 2 Trends in monitored qualified rates of Chinese chives, vegetable products and agricultural products from 2018 to 2021

According to the results of 52 reports on unqualified foods in sampling inspection issued by the official website of State Administration of Market Regulation in 2020–2021, Chinese chives have been frequently reported by the regulatory authorities because of excessive residue of procymidone<sup>[7–8]</sup>, and have become one of the edible agricultural products with high unqualified frequency in recent years. In the 52 reports, 32 batches of Chinese chives were

involved, accounting for 6.74% of the total batches of unqualified edible agricultural products. According to the unqualified parameters, procymidone exceeded the standard the most times, accounting for as high as 60%. According to links, most of the locations where unqualified Chinese chives were detected were wholesale markets or retailers. According to regional distribution, Sichuan Province was the most unqualified place for Chinese chive sampling, accounting for 22% of the total number of unqualified Chinese chive batches, followed by Anhui Province, accounting for 13% of the total number of unqualified Chinese chive batches.

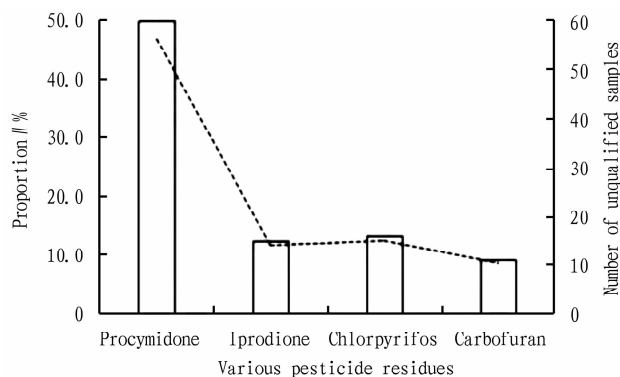


Fig. 3 Monitoring of unqualified parameters for Chinese chives

## Analysis on Present Situation of Pesticide Residue Limit Standards in Chinese Chives

China's current GB 2763-2021 *National food safety standard—Maximum residue limits for pesticides in food*<sup>[9]</sup> was officially implemented in September 2021. On the basis of GB 2763-2019<sup>[10]</sup>, GB 2763-2021 revised categories and maximum residue limits of pesticides used in production of Chinese chives. By comparing and analyzing the pesticides used in Chinese chive production in GB2763-2019 and GB 2763-2021, it was found that there are 112 pesticides used in Chinese chive production in the current standards, including 25 related pesticides classified as "Chinese chive" in the food category and 87 related pesticides classified as "bulb vegetables" in the food category (excluding pesticides with "excluding Chinese chives" in product category). Compared with corresponding pesticide types involved in the production of Chinese chives in GB 2763-2019, there are 46, 7 and 39 types more, respectively.

According to the main uses of agrochemicals, there are 72 pesticides, 11 fungicides, 16 herbicides, one molluscicide, five acaricides, one fumigant, one nematicide, one acaricide and fungicide, one insecticide and acaricide, one insecticide and herbicide, and two insecticides/acaricides involved in the production of Chinese chives in GB 2763-2021, while in GB 2763-2019, there are 55 pesticides, six fungicides, two herbicides, one molluscicide, one insecticide/acaricide and one nematicide used in the production of Chinese chives. Specifically, GB 2763-2021 stops using three pesticides for Chinese chives, namely dimethoate, chlorpyrifos and carbosulfan; five new pesticides are added, namely acetamiprid, lufenuron, hexaflumuron, dinotefuran and thiamethoxam; five new fungicides are added, namely boscalid,

dimethomorph, iprodione, fluazinam and cyazofamid; and seven agrochemicals related to bulb vegetables have been clearly defined for their use, namely azoxystrobin, methomyl, ethoprophos, systox, chlordimeform, fenitrothion and methidathion.

From the adjustment of maximum residue limits, except for adjusting the maximum residue limit of acephate to 0.02 mg/kg, the maximum residue limits of agrochemicals related to bulb vegetables in GB 2763-2021 have not been changed in numerical terms. Moreover, GB 2763-2021 further clarifies the maximum residue limits of monocrotophos, phosphamidon, phosfolan, fenitrothion and toxaphene, and changes the maximum residue limit of terbufos in GB 2763-2019 to a temporary limit.

## Quality and Safety Problems of Chinese Chives and Their Causes

### Gray mold is prone to frequent occurrence, and procymidone easily leads to excessive pesticide residue in Chinese chives

Chinese chives are prone to gray mold. Compared with other diseases, the problem of gray mold is more prominent in Chinese chive production. It is easy for gray mold to occur in Chinese chives in open field in spring and the alternating period of autumn and winter<sup>[11]</sup>, and the disease highly occurs at the temperature of 20–25 °C and the relative humidity over 90%. Compared with Chinese chives in open field, Chinese chives in protected field are more prone to occurrence of gray mold. Once gray mold occurs in Chinese chives, it usually causes the leaves of Chinese chives to die or rot, which affects the quality and yield of Chinese chives and reduces farmers' economic income<sup>[12]</sup>. As a registered drug for controlling gray mold, procymidone is widely used in Chinese chive cultivation, especially in greenhouse, because of its low cost and good efficacy.

### Over-range drug application in Chinese chive production is common

Because Chinese chive growers don't know enough about the standards for safe use of pesticides and the guidelines for rational use of pesticides, it is common to use drugs beyond the ranges in Chinese chive production. It was found that Chinese chive growers used iprodione, carbendazim, paclobutrazol, chlorothalonil, metalaxyl, mancozeb and other fungicides in the control of gray mold, and these agrochemicals were out of the scope. And through monitoring results in the past 4 years, it has been shown that agrochemicals such as carbendazim, carbendazim, and paclobutrazol have been detected more frequently and there has been a phenomenon of pesticide residues exceeding the standards.

### There are hidden additions in compound drugs and fertilizers, and there are some empty spaces in supervision

According to the research results of the main production areas of Chinese chives, there is still a problem of implicit addition in the current market sales of mixed agrochemicals, composite drugs, foliar fertilizers, and integrated products of drugs and fertilizers. Some agrochemical manufacturers have added highly-toxic hidden ingredients to agrochemicals to meet the demand of planters for good and quick efficacy, but the actual agrochemical ingredients are not indicated on the labels. However, most Chinese chive

growers only pursue medicinal effects and use drugs with hidden additives without complete understanding, resulting in the detection of prohibited drugs.

## Policy Measures for Improving the Quality and Safety Level of Chinese Chives

### Perfecting the limit standards of pesticide residues related to Chinese chives

In response to the issue of unreasonable limit standard for procymidone in Chinese chive production, it is recommended to re-evaluate the limit standard for procymidone in Chinese chives and adjust and improve it as soon as possible, based on the residual level of procymidone in Chinese chive production and the results of field experiments, combined with the dietary characteristics of Chinese residents. In response to the issue of some drugs having good effects in preventing and controlling pests and diseases, but lacking limit standards, it is recommended to carry out tracking and evaluation of maximum residue limits based on the current production situation of Chinese chives. Based on the risk assessment results, new or revised maximum residue limits should be established or improved.

### Strengthening the promotion and training of prevention and control techniques for green production of Chinese chives

It is recommended to strengthen the promotion and training of green production prevention and control techniques for Chinese chives, in response to issues such as excessive use of drugs in Chinese chive production. The first is to develop more reasonable regulations for planting, production, and use, so as to guide farmers to use drugs safely according to "suitable categories, appropriate amounts, good time and appropriate ways" from aspects such as pest control methods, types of drugs, drug application methods, and precautions. The second is to actively carry out the research and development and verification of highly-toxic agrochemical substitutes, screen effective, low-toxic and low-residue control agents, and promote and encourage the screening, registration and alternative use of green and low-residue agrochemicals through input subsidies. For example, precise agrochemical subsidies can be implemented for production entities, to guide farmers to use registered low-toxicity pesticides and biopesticides; and subsidies will be provided for the drug registration test fees of voluntary application enterprises to encourage pesticide production enterprises to register on small crops such as Chinese chives, so as to meet the needs of disease and pest control. The third is to vigorously promote practical and effective green prevention and control techniques such as the "sun exposure and high-temperature film covering method", strengthen training for Chinese chive growers, and effectively prevent and control the main diseases and pests of Chinese chives through comprehensive use of green prevention and control measures such as agricultural control, biological control, and physical and chemical induction.

### Strengthening the supervision on input products of Chinese chives

The quality and safety of Chinese chives are created by both

production and management. In terms of "management", it is recommended to strengthen the supervision of input products of Chinese chives. The first is to strengthen the inspection of input product production and operation. It is necessary to intensify inspections on Chinese chive pesticide production enterprises, business units and online platforms, and strictly investigate and deal with illegal production and business activities that occur to ensure the quality and safety of Chinese chive input products. The second is to strengthen the traceability management of restricted agrochemicals in Chinese chives. For restricted agrochemicals in Chinese chives, fixed-point management and real-name purchase of restricted agrochemicals should be further implemented, and the traceability management system of agrochemicals should be improved to prevent prohibited input products from entering the circulation link. The third is to strengthen inspections, spot checks and inspections, especially during the peak application period of agrochemicals in Chinese chives in winter and spring and the centralized marketing period in spring and autumn, and increase the inspection intensity and sampling frequency for the use of banned agrochemicals, the failure to implement safety intervals for conventional pesticides and the expansion of dosage, so as to find hidden problems in time.

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Editor: Yingzhi GUANG

Proofreader: Xinxiu ZHU

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