

Chapter 2

China's Food Safety Regulation and Mass Spectrometry

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Abstract

Food safety is essential to people's health and people's livelihood. To ensure that food safety is an important current strategy of the governments, both regulation and standardization are important support for implementing this strategic initiative effectively. The status and prospects of China's food laws, regulations, and standards system are introduced. China now has established a complete law regime providing a sound foundation and good environment for keeping the health of people, maintaining the order of social economy and promoting the international trade of food. At the same time, it is undoubtedly important to strengthen standardization and improve the food safety standards system. In the administration of food safety, mass spectrometry is becoming more and more important and many analytical methods developed in China are based on its application.

Key words: Food safety, Law, Regulation, Standards, Mass spectrometry, China

1. Food Laws and Regulations of China

1.1. China's Legislative system

1.1.1. Legislative System

China's current legislative system is unitary, two-class, and multi-level. "Unitary" means according to the constitution thus China is a both a unified and multi-ethnic country. Therefore, there is but one unified legislative system. The so-called "two-class" system indicates that according to the constitution, the Chinese legislation system is divided into two levels containing central and local legislation. "Multi-level" as defined by the constitution, such that both central-level legislation and local-level legislation can be divided into several categories.

The state council is empowered to enact administrative regulations, issue decisions and orders, and change or repeal inappropriate decisions and orders of the local state administrative organs at all levels, under the provision of the constitution and other related laws and regulations.

The national people's congress and its standing committee of the provinces, autonomous regions, and municipalities can enact local rules and regulations according to the administrative area of the specific conditions and actual needs, under the premise that they do not conflict with the constitution, laws, and administrative rules.

The people's congress or its provincial and municipal standing committee or special economic zones located therein, can set the regulations in the scope of special economic zones, in accordance with the authorization of the national people's congress.

The national people's congress of the autonomous regions, autonomous prefectures and autonomous counties, also has the right to develop self-government regulations and separate regulations, laws, administrative regulations, and to modify the provisions, in accordance with local political, economic, and cultural charters.

The ministries and commissions under the state council and the people's bank of China, the audit commission and the departments with administrative functions, can develop regulations within the purview of their sector, according to the administrative rules and regulations, decisions, and orders of the state council.

1.1.2. Legislative Procedure

The law-making process refers to the procedures and methods, which the state organizations with legislative power must comply with during the enactment, amendment, supplements, and repeal of regulatory legal documents. In general, China's legislative procedure comprises proposal, pondering, voting, and publishing of a law.

1.2. The Status of China's Food Laws and Regulations (2, 3)

Food laws and regulations refer to the sum of legal norms, being conducted or authorized by national mandatory authority to strengthen the supervision and management of food, ensure food hygiene, protect people's health from food contamination and health hazards, and provide adequate nutrition. The Chinese food laws and regulations system are composed of the following normative documents at different legal levels, based on its sound form and legal effect-level.

1.2.1. Laws

On February 28, 2009, the Seventh session of the China's national people's congress (NPC) standing committee passed "the Food Safety Law of the People's Republic of China," replacing the food hygiene law. This has become the highest legal effect-level normative document in food safety and the health legal system, and the basis of formulating food safety regulations, rules, and other normative documents.

The relevant laws being issued and implemented in the field of food include the Product Quality Law, the Standardization Law, the law on the quality and safety of agricultural products, the law on import and export commodity inspection, the law on

Animal and Plant Entry and Exit Quarantine, the advertising law, the consumer rights and interests protection law, the unfair competition law, and the trademark law.

1.2.2. Administrative Regulations

The administrative regulations can be developed by the state or local governments, but its legal status is second to the constitution. Administrative regulations in the food industry refer to the law normative documents drawn up by departments of the state council, in accordance with the constitution. The administrative regulations are called regulations, provisions, and measures. The regulations comprise a comprehensive and systematic foundation for the administrative work, and the provisions provide a subset of rules on the administrative work. The measures make up specific rules based on the administrative work, for example: food hygiene management for the catering industry, hygiene management for food additives, and hygiene management for health food.

Local food administrative regulations refer to the normative documents formulated by the people's congress or its standing committee of provinces, autonomous regions, and municipalities according to the constitution. The local administrative regulations are valid only in its own territory, and cannot contravene the constitution, laws, and administrative regulations, such as detailed rules for the implementation of the measures for food hygiene of Hebei province.

1.2.3. The Departmental Rules

The departmental rules include the rules and regulations stipulated by the executive department of the state council and local governments. These encompass food measures for the hygiene administration of food additives, measures for the certification of organic food, and measures for hygiene management of genetically modified food.

1.2.4. Other Normative Documents

Normative documents don't belong to laws, administrative regulations, departmental rules, or standards. These include notifications issued by the state council or individual administrative departments, the management measures of food hygiene licensing developed by the relevant administrative departments of local government, and the management measures of the procurement of food and raw materials. These kind of normative documents are indispensable, and they are an important part of the legal system. An example is "the decision of state council on further strengthening the work of food safety," "hazard analysis and critical control point (HACCP) management system of food-producing enterprises."

1.3. The Introduction to China's Food Laws and Regulations

Based on many laws such as the food safety law, product quality law, and the law on import and export commodity inspection, the main body China's food safety regulatory system is set. This in turn sets the "standardization law" and the "import and export

commodity inspection law” as the basis for “food production and processing enterprise quality safety supervision and management measures,” “food labeling mark rule,” “food additive regulations,” as well as a large number of food safety requirements related to technical standards and other regulations as the main body. In addition, these are supplemented by food safety regulations of the provincial and local governments. In addition, China’s local governments have introduced a large number of local laws and regulations and local administrative regulations, which lay an important foundation for improving the level of food safety in China.

1.3.1. Food Safety Law

The Food Safety Law was implemented formally on June 1, 2009. The law provides an orderly solution to the current system of food safety and opens a new stage of China’s food safety supervision.

1.3.1.1. The Background and Motivation of the Food Safety Law

- The previous food hygiene law was no longer suited to the current socioeconomic situation.

At the inception of the food hygiene law, it played an important role in ensuring the quality of Chinese food hygiene and safety. However, the food hygiene law became unsuitable to the current food safety management with the economic development:

1. The division work of food regulatory authorities was not clear. There was too much crossover and blind spots between the management of different departments that caused disruption in the food market.
2. With the social and economic development, enforcement according to food hygiene law failed to exercise sufficient punishment to deter potential offenders causing the proliferation of fake and shoddy products within China. As examples, illegal ingredients such as Sudan dye and the melamine were used for food counterfeiting and forgery by unscrupulous traders.

- International trade calls for more scientific and effective laws to keep food safe.

The development of global economic integration enables countries to produce food for the world. China is a large agricultural country and its products are so cheap and fine that they sell very well abroad. For example, chicken breasts made in China are well received by the distributors of European countries, because of their automated production, complete and clean nature. However, it is often meets limit export because veterinary drug residues do not meet EU requirements.

Chinese foods restricted by developed countries also include vegetables and aquatic products. This phenomenon not only affects the development of food enterprises in China,

but also causes significant loss of its reputation. Therefore, the development of more scientific and effective laws to guarantee food safety is not only needed in the domestic market, but also to break through technical barriers and enter the international market.

1.3.1.2. The Major Focus of the Food Safety Law

1. The establishment of a food safety commission.

The food safety law provides that a food safety commission and its work responsibilities is established by the state council. Health administrative departments under the state council are responsible for integrated and coordinated work, risk assessment, standards establishment, and information disclosure of food safety. It also sets accreditation conditions and test specification development of the food inspection agency, the organization charged with investigating and dealing with major food safety incidents. In addition, the state council implements supervision and management of quality, industrial and commercial administration, and the state food and drug's supervision of food production, food distribution, and food service activities in accordance with the provisions of this law and the state department functions.

2. The unification of national food safety standards.

The Food Safety Law provides that enforcement food standards of the current food quality and safety standards for agricultural products, food hygiene standards, food quality standards, and industry standards should be integrated into the national standards for food safety. At the same time they do not establish mandatory food standards other than for food safety.

3. The establishment of a monitoring and evaluation system for risk assessment.

The Food Safety Law provides that food safety risk monitoring systems be built in China to address forborne diseases, food contamination, and harmful factors in food. Food safety risk assessment system was established in China for food additives and biological, chemical, and physical hazards.

4. The abolishment of the food exemption system.

The Food Safety Law clearly states that food safety supervision and management departments cannot implement an exemption for food. Quality supervision, business administration, food and drug supervision, and management departments above the county level shall carry out regular or irregular food sampling tests.

5. The implementation of a recall system for problem food.

Food safety law clearly states that: food recall system was built in China. Food producers should immediately stop

production, recall the sale food, notify the relevant production operators and consumers, and make a recording and notification of the recall if it is found that the production of food does not meet food safety standards. The law also stipulates if food business operators found the food does not meet food safety standards, it shall immediately cease operations, notify the production operators and consumers, and make a recording and notification of cessation of operations.

6. Ten times the compensation.

The new law serves as a deterrent as the compensation standard is greatly improved and the cost to illegal operators has significantly increased. In the event of food safety incidents, the responsibility of food companies may bear civil, administrative, and criminal action. If entrepreneurial capacity is limited, civil compensation must first be met, which reflects the protection of civil rights.

7. Food additives outside of the directory are banned.

Food additives are not only the essential raw material for production in the modern food industry, but also a double-edged sword. It will be counterproductive if they are used illegally. The approvals of food additive are being strictly managed in the present food safety law. If a food additive is not in the directory, even if there is initial proof of no hazard to the human body, it is still banned. In addition, the use of additives must be specifically labeled on the package and with how much. Legal action would be taken if the content was not labeled correctly.

1.3.2. Food Hygiene Law

The food hygiene law of People's Republic of China was adopted and promulgated on the 25th meeting of the fifth national people's congress standing committee on November 9, 1982, which marks the change of Chinese food health work from health administration to legal management. The food sanitation law of the People's Republic of China was adopted on the sixteenth meeting of the eighth national people's congress standing committee on October 30, 1995, which was promulgated as the presidential decree no. 59. However the food safety law of the People's Republic of China was adopted on the seventh meeting of the eleventh national people's congress standing committee on February 28, 2009, and the food sanitation law was revoked.

The food sanitation law was implemented by the national mandate for food hygiene in food production, supervision, and management. It was to address any state engaged in food production, business units or individuals, as well as food production, operators and consumers in the food safety and health management, and supervision of social relations especially for economic interests.

1.3.2.1. The Meaning of Developing and Implementing the Food Hygiene Law

The amendment and implementation of the food sanitation law is of great significance for promoting the healthy development of the food market economy and for food hygiene protecting the health of people. It addresses the need to protect people's lives. It establishes and improves the legal system for food hygiene. It also strengthens administrative law enforcement and increased law enforcement efforts and it is beneficial for the healthy development of China's food industry.

1.3.2.2. The Main Content of the Food Hygiene Law

The food hygiene law which consists of 9 chapters and 57 sections makes clear definitions for the applicable conditions, behavior patterns, and the legal consequences of food hygiene norms.

1. Chapter I: General Provisions

This provides the legislative purpose and legal range, for compliance with this law if engaging in food production and operation within the territory of the People's Republic of China. All food, food additives, food containers, packaging materials and food, tools, equipment, detergents, disinfectants are applicable to this law, as well as food production and business premises, facilities and the environment. It stipulates that the health administrative department of the state council is in charge of the national food hygiene supervision and management. In addition, state council departments are responsible for food hygiene management.

2. Chapter II: Food Hygiene

This provides for health requirements in the process of food production and operation and for production that is prohibited along with the management of food. It also provides that food should be non-toxic or harmless and nutritional and that food should be consistent with the corresponding color, smell, taste, and other sensory characteristics. In addition, it requires drugs are not added into food, while those that are both food and medicine in their raw state such as spices or traditional nutrient enhancers are accepted.

3. Chapter III: Health of Food Additives

This provides that production, operation, and use of food additives conform to the use of hygiene standards and health management.

4. Chapter IV: Sanitation of Food Containers, Packaging Materials, Food Processing Tools, and Equipment

5. Chapter V: Development of Food Hygiene Standards and Management Practices

This chapter provides the standards-setting bodies of national health standards, health management practices and inspection procedures, and local health standards.

6. Chapter VI: Food Hygiene Management

The main provisions are contained in a seven step health management system.

7. Chapter VII: Food Hygiene Supervision

This chapter contains the health monitoring system, food safety oversight responsibilities, establishment of food safety supervisors, health rights, and obligations of supervisors.

8. Chapter VIII: Legal Liability

The administrative, civil, and criminal responsibility for violation of the food sanitation laws are contained herein. Administrative consideration, administrative litigation and administrative relief measures are also provided.

9. Chapter IX: Supplementary Provisions

This chapter provides the interpretation of the food sanitation law. Food hygiene management for exporting is assigned by the state import and export commodities inspection department in conjunction with the state council, health administrative departments, and relevant administrative departments. Food hygiene management measures for the army special food and confession are assigned by the central military commission in accordance with this law, as well as the formal implementation date of this act.

1.3.3. *Law of the People's Republic of China on Product Quality*

On February 22, 1993, the seventh national people's congress standing committee 30th meeting adopted "law of the People's republic of China on product quality." This was amended according to the ninth national people's congress standing committee 16th meeting conference on July 8, 2000. Since September 1, 2000, the "law of product quality" was implemented. The "law of product quality" is the basic law and regulations of China's product quality, and important to standardize problems of product quality both comprehensively and systematically, and is the basic law containing supervision of product quality and the responsibility of product quality. The law consists of 6 chapters and 74 sections, including general principles, supervision of product quality, quality responsibilities and obligations of producers and sellers, damages, penalties provisions, and supplementary provisions.

1.3.4. *China's Food-Related Laws*

China's food-related laws promulgated and implemented also include the "standardization law," "measurement law," "trademark law," "patent law," "advertising law," "law of the People's Republic of China for countering unfair competition," "law of the Peoples Republic of China on the protection of consumer rights and interests," "foreign trade law," "law of the People's Republic of China on import and export commodity inspection," "law of the People's Republic of China on the entry and exit for animal and plant quarantine," "frontier health and quarantine law of the People's Republic of China," "animal epidemic prevention law of the

People's Republic of China," "radioactive pollution prevention and control law," "infectious disease prevention and control law," "agriculture law," "fisheries act," "wild animal protection law," "seed law," and the "agricultural product quality safety law."

1.3.5. Food Administrative Regulations, Departmental Rules and Regulations

1.3.5.1. Administrative Regulations

The current food administrative rules and regulations of China mainly include food distribution management regulations, the management rules of the agriculture genetically modified organisms safety, the regulations of the People's Republic of China on the import and export animal and plant quarantine, the policy of purchasing grain, regulations on pig slaughtering, edible salt monopoly regulation, regulations on edible salt iodization as a means to eliminate iodine deficiency disorders, and management regulations on veterinary drugs.

1.3.5.2. Normative Documents of the State Council

Normative documents of the state council mainly include decisions on further strengthening food safety, a circular on issuing the development of food and nutrition program, and a circular on the implementation of food and drug safety project.

1.3.5.3. Departmental Regulations

The current food regulations of China mainly include the measures of food additives health management approach, the management and supervision of the quality of food processing manufacturer, health registration regulations of the enterprises for the production of export commodities, order of the state environmental protection administration, and up to more than 50 other rules and regulations

1.3.5.4. Normative Documents of the Ministries

Normative documents of the ministries mainly include management system certification regulations for food manufacturers' hazard analyses and critical control point (HACCP), the management approach on applying for foreign registration of exporting food production enterprises, rule on import and export food labeling auditing operation and nearly more than 20 filings.

1.3.5.5. Regulations of Local Government

Regulations of local government include the management measures of Muslim food for the city of Guangzhou.

1.4. Key Issues and the Improvement of Laws and Regulations for Chinese Food Quality and Security

1.4.1. Key Issues of Laws and Regulations for Chinese Food Quality and Security

The key issues of China's current system for food safety is mainly focused on the following aspects: the food safety law is not complete; the food safety standards are not sound; there is poor internal coordination in the legal system; some of the current system is not entirely reasonable and does not operate well; there is some conflict between law regulations and the actual supervision and management system; The penalty system needs to be more strict.

1.4.2. The Improvement of Laws and Regulations for Chinese Food Quality and Security and Prospects (4)

For improvement of the laws and regulations of Chinese food quality and security, we must emphasize not only the integration of the existing system, but also the creation of a new system. The integration of the existing system would form a uniform scientific and effective regime based on massively different levels and a different emphasis simplifying the stipulations, adjusting the old measures, and solving significant conflicts. The foundation of the new system should streamline relationships while avoiding new conflicts between the laws, regulations, and rules during the time of its foundation. Meanwhile, consistent with the Chinese national situation, we should learn from our advanced foreign experience and focus on the innovations of management, including institutional innovation and system innovation. Therefore, during the reformation of present laws and regulations, we also should focus on improvement and development of the following systems.

1. Food security risk monitoring and risk assessment system.

Food safety risk monitoring and risk assessment is a comprehensive, interdisciplinary, cross-professional technical work, reflecting food safety supervision and management based on prevention. It provides the scientific basis for food security policy making and developing food safe supervision and management. It may help to improve government decision-making of food security and the management of scientific validation.

2. Early-warning system for food safety risk.

“Preventing accidents before they occur” is the best way to reduce the cost to society. The Food safety risk early warning system is different from what the food safety regulatory agencies have done in the past, warning after the accident, now with the intention to prevent the occurrence of adverse events. Through the early warning system, the openness and transparency of food safety management can be enhanced, while also enhancing public confidence in food safety management.

3. Special supervision and management system for new food resources.

The basic contents of the system should include, but not be limited to the following aspects: defining the concept of new food resources; appraisal system of new food resources applying the prerequisite and the examination of the main body of new resources entering the market; the labeling requirements of new food resources, namely, it must indicate clearly its nature and any danger to the consumer; the remedial measures of the new food resources predicted risk; the related legal liability stipulation of the new food resources safety.

4. For the operator of the food production and the management system for food risk classification.

5. The management system for food production commissioned the legal relationship involving marking, the label of food production commissioned, and the specific issues of the food quality safety responsibility burden-sharing, which affects the market supervision and claims approach of the consumer. General Administration of Quality Supervision Inspection "Food Production and Processing Enterprises Quality and Safety Supervision and Management Regulations (Trial)" contains the relevant stipulations, which are still at the testing stage, but also needs further standardization and confirmation in its legal form.
6. The food production and operation management system for traceability, as some countries and regions have already established and implemented a "food status coded identification system."
7. The food recall system is implemented for unsafe or defective food in a timely manner before markets are entered to avoid the occurrence of damaging public safety, thus providing the benefit of consumer protection. In addition, a special system is needed for flawed products. Because food sale is broad and single food product values are low, a universal recall is difficult, unlike large products such as automobiles. Therefore, there is a need for special recall rules including the conditions of food recall, the main body of a recall being unsafe food, the specific ways and methods of an unsafe food recall, recall procedures of unsafe food, and finally the relevant legal responsibilities.
8. Food security for the processing system and accident prevention. There is a need to establish an effective prevention system which is fast and highly effective containing a coordinated response and defined handling mechanism to address a processing accident because human health is directly related. Therefore, it is proposed to stipulate security for accident prevention and processing by the following: 1) the prevention system for accidents involving food safety; 2) an accident report and notification system for food safety; 3) a medical and responsibility investigation system for food security; 4) administrative control measures and a medical treatment system for food safety accidents.
9. Food safety information release system.
Through releasing of food safety information, this may encourage legitimate producers to fight against illegal trade and provide a reference for consumers that may reduce the substandard food production that causes harm.
A food safety information system includes the following: 1) determination of the performer of an issue; 2) determination scope and content of the issue; 3) determination of the

procedure for verification of the issue; 4) determination of legal liability of an omission or an unlawful act regarding the information process of the issue.

10. The quality of food production and its operation.

In view of the spread of counterfeit and shoddy food and other unsafe food forms, as well as frequently occurring food security accidents, the responsibility system and food safety supervising and management department's legal liability system should further strengthen the food security administration legal responsibility. The civil liability for food quality standards, simultaneously, should further consummate protection rights and interests of food cost for the consumer and provide a relief system.

2. Food Standard of China

2.1. The Development Process of the Chinese Food Safety Standard System

China's food safety standard system was constructed in the 1950s and has passed through five stages, a primary stage of establishment (1960s and 1970s), a developmental stage (1980s), one of adjustment (from late 1980s to middle 1990s), consolidation and further development (from mid-and late 1990s to 2001), and now an improvement stage (2001–present).

2.1.1. The Primary Stage

A rapid development of food standardization took place in this period. The Ministry of Light Industry issued 13 standards for milk and dairy products, 8 standards for egg products, and 3 standards for salt, all of which were published as a ministerial standard. The canned food industry had a larger scale of production and higher technical level. Strengthening standardization management was first carried out in the canned food industry in order to meet the needs of export. In 1964, 153 ministerial product standards for the main varieties of canned foods were formulated and published. At the same time, the corresponding process operational elements, detection methods, and canning factory health system were established, which became a milestone in the standardization of canned food. In 1976, 42 ministerial standards for varieties of canned food were formulated and published, and some provinces and municipalities also organized companies to develop enterprise standards. In 1977, the National Standards Administration approved and issued 54 national standards of food hygiene including meat, eggs, aquatic food, beverages, wine, and food additives. These were proposed, organized, and developed by the Ministry of Health. In 1978, the National Standards Administration approved and promulgated standards for white sugar, soft white sugar, wheat, soybeans, corn, rice, wheat flour, peanuts, fruit, peanut oil, soybean oil, rapeseed oil, refined rapeseed

which were presented and organized to be developed by the Department of Commerce and Ministry of Light Industry. In the same year, the Ministry of Commerce, Ministry of Health, Ministry of Light Industry and Supply and Marketing Cooperatives jointly formulated and issued food quality standards, testing methods, quality management regulations and health regulations of soy sauce, vinegar, bean paste, and flour paste.

2.1.2. The Development Stage

China's food standardization was developed in the 1980s. Much was done in this period. Not only did food standards increase greatly, but also a number of technical institutions were established, all to ensure food standardization specification and rapid organizational.

A total of 725 national standards of food were issued by The State General Bureau of Standardization, The State Bureau of Technology and the Ministry of Health successively in this 10-year period (1980–1990). These referred to food processing products, agricultural standards, food industry base and related standards, food testing method standards, food and hygiene standards for processed products, food packaging materials and container standards, and standards for food additives in which there were the “General Standard for Food Labeling.” Additionally, there were 12 categories of food businesses hygienic practices, a number of important national standards including 16 infant and young children food standards issued.

At the same time, a total of nine ministerial Food Standards were issued by the Ministry of Agriculture, Animal Husbandry and Fishery. A total of 15 ministerial Food Standards were issued by Ministry of Light Industry. A total of 245 ministerial food professional standards were issued by Ministry of Commerce.

2.1.3. The Adjustment Stage

A rapid development of China's food industry took place in the late 1980s to mid-1990s. Food standards no longer met the needs of the situation at that time and thus food standardization went into the adjustment stage.

During this period, the existing standards at all levels were regulated and a total of 232 food standards were rectified as mandatory national standards while the food hygiene standards remained the main body.

After rectification, there was 108 former national standards, which were adjusted to the food industry standards; there were 198 former food products mandatory ministerial standards, professional standards and industry standards approved and released by Department of Commerce, which were all adjusted to the recommended food industry; there were 174 original food mandatory ministerial standards, professional standards, and industry standards approved and released by the Ministry of Light Industry, which were all reduced to 23 mandatory industrial standards.

Subsequently, the Ministry of Health revised a total of 140 food hygiene standards and testing methods and the relevant authorities revised a total of 28 standards for food additives.

After the comprehensive rectification of standards, China built the food standardization system with Chinese characteristics in the 1990s. Then China's food standardized management accomplished the management model that is the harmonization of food standards program, centralized review of the draft standards, and coordinated release to administrative departments. The model further promotes China's food standards into a legal and uniform track.

2.1.4. The Consolidation of the Development Stage

The consolidation and enrichment of China's food standardization and integration with the global standards (from mid and late 1990s to 2001) is an important stage in which the national standardization organization (National Standardization Management Committee) was established. In this period, a number of laws and department regulations were successively promulgated, which further strengthen the foundational position of food standardization. Meanwhile, China's food standards were further improved, mainly by amending old and out-of-date food product standards and formulating ones that the market needed. The Ministry of Health revised a total of 140 standards and testing methods for food hygiene, and the relevant authorities revised a total of 28 standards for food additives. All relevant departments also revised a number of important food standards.

2.1.5. The Improvement Stage

According to the relevant provisions of State Council for strengthening food safety management, the National Standards Committee organized people to rectify the existing agricultural standards and food standards (including national standards and industry standards) in 2001–2005. This was the second major adjustment and improvement of China's food standardization since the founding of the People's Republic of China.

A total of 867 national food standards, 347 industry standards, 268 projects of national standards and 134 industry-standard projects were canceled after collation. There were a total of 259 national food standards that continue to be valid, 49 to be modified, 282 to be amended, 122 to be revised integrally, and 125 to be repealed, 17 mandatory standards to be turned into recommended standards, and 12 to be turned into industry standards. There were a total of 68 food industry standards that continue to be valid, 109 to be amended, 124 to be revised integrally and 47 to be repealed. There were a total of 120 national standards projects to be continued, 90 to be integrated, 32 to be canceled and 26 completed. There were a total of 78 industry-standard projects to be continued, 26 to be integrated, and 30 to be canceled. The verification for local food standards were accomplished and a total of 250 standards were collated.

After China's new "Food Safety Law" was implemented, current safety standards for agricultural products and food quality, food hygiene standards, food quality standards, and industry mandatory standards for food industry were integrated by the health administrative departments of the State Council, and turned into food safety national standards.

2.2. The Status of China's Food Safety Standard System

2.2.1. The Basic Components of Chinese Food Safety Standard System

After more than 50 years of development, China's food safety standardization has made great achievements, especially remarkable in recent years.

China established a food standards system that consists of the national standards, industry standards, local standards, and enterprise standards before the implementation of new Food Safety Law.

The National Standard issued by the standardization administrative department of the State Council is a technical requirement that needed to be unified nationwide. The Industry Standard is the technical standard that has no national standard but needs to be uniform throughout industry. The Industry Standard was established by the relevant administrative departments of the State Council and then put on record by the standardization administrative department. The local standard is the uniform standard for food safety, including sanitation requirements where there are no national standards and industry standards but where it is needed at the provincial, autonomous regions, and municipalities. The Local Standard is provided by the standardization administrative departments of the provinces, autonomous regions, and municipalities and put on record by the standardization administrative department and relative administrative department of the State Council. The Enterprise Standard is the technical requirements for enterprise-wide coordination and harmonization, management and work requirements, and is set the basis of production and business activities. National Standards, Industry Standards and Local Standards are divided into mandatory and recommended ones according to the binding nature of the laws. By 2005, there were a total of 3,680 standards including all kinds of food national standards, industry standards and local standards and a large number of enterprise standards. Among national standards, industry standards, there were a total of 484 food hygiene standards, 1,298 quality standards, 170 basic standards, 1,418 methods standards and 30 management standards referring to the basics of food safety standards, toxic and harmful substances in food limited standards, food contact materials hygiene standards, food safety management and control standards, food safety inspection and testing methodology standards, the label of food safety standards, and identifying a specific food product standards. These standards initially shaped our country's food standards system, and basically met the needs of China's food production and consumption requirements.

Existing standards will be integrated into the new Food Safety Law, and the scope of Food Safety standards is limited. The food safety standards should include the following: limited requirements of pathogenic microorganisms, pesticides residues, veterinary drug residues, heavy metals, pollutants, and other substances harmful to human health in food and food-related products. It also includes the varieties, use, and consumption of food additives, nutrient requirements of food specifically for infants and young children, and other specific groups, labeling, marking and specification requirements referring to food safety and nutrition, health requirements during food production and business processes, quality requirements related food safety, food inspection methods and procedures, and other needs to develop food safety related standards.

2.2.2. The Management System of China Food Safety Standards

1. Administration

Before implementation of the Food Safety Law, the State Standardization Administration carried out the nation's food standardization work that was authorized by the State Council. Ministries and commissions in charge of food-related industries such as National Development and Reform Commission, Ministry of Agriculture, Ministry of Commerce, Ministry of Health, State Administration of Grain manage the industry's food standardization in accordance with the work division. Local quality and technical supervision departments and relevant administrative departments carry out the food standardization management in the administrative regions with the principle of "unified management and division of labor."

2. Food Safety Standardization Organization

Before the implementation of the Food Safety Law, the food safety standardization organization consisted of the Food Standards Technical Committee of Standardization, standardization research institutions and relevant associations. The food-related National Standardization Technical Committee includes the National Food Industry Standardization Technical Committee, the National Standardization Technical Committee on Food Additives, the National Cereals, Oils & Standardization Technical Committee, and the National Fisheries Standardization Technical Committee. The food-related industries administration established industry standardization technical committees, such as the food hygiene standards Professional Committee of Hygiene Standards, the Technical Committee of the Ministry of Health, and the tropical crops and products Standardization Technical Committee of the Ministry of Agriculture all for meeting the developing needs of food standards. Standardization research institutions and food-related trade associations play active

roles in the food standards revision, the standards promotion, monitoring the implementation of standards, and advisory services. After the implementation of the new Food Safety Law, it was authorized that the formulation and publication work of national standards for food safety would be carried out by the health administrative departments of the State Council. The standardization executive branch of the State Council is responsible for providing national standard numbers. Pesticide and veterinary drug residues limits in food and the testing methods and procedures are provided by the health administration and agriculture administration of the State Council. The inspection procedures for slaughtering livestock and poultry are provided by the relevant administration in conjunction with the health administration of the State Council. National standards of the products involved in the provisions of food safety should be consistent with National standards of food safety.

2.2.3. The Features of Chinese Food Safety Standard System

Compared with the food safety standard system of the Codex Alimentarius Commission (CAC), the International Organization for Standardization (ISO) and other international organizations as well as the USA, the European Union, Japan, Australia, Canada, and other developed countries and regions, the features of the Chinese food safety standard system are mainly embodied in the following areas:

1. Standards at all levels complement each other and form a relatively complete standard system.
The food safety standard system of our country's compulsory standards combined with recommended standards, national standards matched with industry standards, local standards, and enterprise standards form a relatively complete set of criteria.
2. Meets the demand of food safety control and management.
The types of Chinese food safety standards are relatively complete and cover major food species, every link of the food chain, and toxic or hazardous pollution factors, and can realize the target for hazard control of the entire food chain.
3. Consistent with international standards.
Compared with the CAC, from a general point of view, our country's food safety standard system is basically consistent with the CAC, whether considering the standard system structure and composition the main standard index, or technical requirements.
4. Reflects the scientific principle of the WTO: SPS (World Trade Organization: Sanitary and Phytosanitary) agreement.
The development of our country's food safety standards has fully taken into account the principle of the "SPS Agreement,"

use of or change to international standards as far as possible. The food safety standards of our country, also take into account the unique geography of Chinese environmental factors, human factors, and other special requirements in order to relegate the “appropriate level of health protection” as the goal and principle, and take “risk assessment” as the scientific basis.

2.2.4. Issues of the Food Safety Standard System

As the food industry's development is improving people's living standards, food safety standardization is facing several challenges. Challenges include the overall level of standards still need to be improved, some standards have disparity with international standards, and some standards lack coordination, and cross functionality with other standards. Finally the national standards still have some deficiencies and the status of implementation of some standards need further strengthening in their administration.

2.2.5. China's International Food Safety Standards

In 2002, China led the draft of the CAC standard for production norms for the control of aflatoxin contamination in fruit trees. This marked the first time China effectively participated in the work of international standards. Since then, China has led the preface of standards for food additives, the food classification system for food additive, and the revision of fermented product standards. In the development of the work of Codex standards such as the chloropropanol limit in soy sauce, the limit of acid hydrolyzed vegetable protein, the limit of lead in aquatic products, microbiological risk management principles and guidelines, the International Code of Hygienic Practice, and the standards of fermented bean paste and chili sauce China actively participated in the formulation group and submitted monitoring data.

In addition, agricultural products to be tested for multi-residue pesticide, pyrethrum lipids, poultry organizations testing for dichloro-dimethyl pyridinoline, and methods for veterinary drug residues, developed by the chief researchers of AQSIQ (General Administration of Quality Supervision, Inspection, and Quarantine) (1) and with the research guidance of AOAC (International Association of official analytical chemists) Professor Pang Guofang, were approved as international AOAC standards by the International Association of official analytical chemists (AOAC). This was the first AOAC international standards study that was developed by Chinese scientists, and won honor for our country in the international analytical chemistry arena.

2.3. Measures and Prospects to Speed Up Construction of China's Food Safety Standard System

To address the concern of food safety, we should first grasp the source of agricultural standardization, the whole process from farm to table carrying out standardization of management; strengthening the food safety standard system construction through the culture, production, processing and distribution of

the whole process to form a complete standard system. Food safety standardization is a systematic project which should give complete attention to agriculture, health and other departments, and unified management effectively improving the food safety standards system.

Based on the situation faced by the food industry and developing trends, in order to continue building the technical base for food standardization, we should focus on the following areas.

2.3.1. Construct the Food Safety Standard System

The construction of the food safety standard system mainly includes:

1. The construction of a completed food safety standard system that covers all aspects “from farm to table.” National, industrial and local standards should accurately position and coordinate supporting legislation. The enterprise standard should not only be legally effective, but aimed more to improve the level of protection.
2. We need to accelerate standard revision process. To do this effective management is needed to streamline the entire process of standards revision, and to shorten the cycle-time of revisions by using information technology and other advanced means.
3. We need to improve the level of effectiveness of the standards. This requires strengthening the theoretical research and preliminary studies needed for food safety standards, including enhancing the scientific basis of standards with the use of risk assessment. The standards should be revised according to the principle that fair, open, transparent, and broad participation will ensure their applicability. Finally, we can ensure validity of the standards and continuous improvement by frequent review and information feedback.
4. The standardization level of food enterprise should be improved. Food enterprises are not only the main body of implementation of the food safety standards, but also the main force to formulate and revise those standards. We encourage enterprises to formulate and implement enterprise standards that are more stringent than the national or industry standards, thus improving the quality of food enterprises.
5. We need to improve the expertise required food safety standards so that a high level of technical support is available for standardization and revision.
6. Finally, we need to establish emergency mechanisms of food safety standardization that can provide warning, analysis, and treatment measures when food safety accidents occur.

2.3.2. Development of Important Food Standards

Enhanced research for food standards, advanced foreign standards, and emphasis on important standards is essential for independent intellectual property. In the next few years, food national standards and their revisions will focus on:

1. Food terms and classification-based standards are the key points of the construction and management of the food safety standards system. The drafting unit should learn from international standards in the revision process. At the same time, we need to take full account of the status of development and management needs of our country's food industry, to ensure the effectiveness of the standards.
2. Limit standards for pesticide residues should be based on the investigation and study of pesticide residues and pollutants making full use of risk analysis, to supplement and perfect the relevant standards in a timely manner.
3. Standards for food additives should be revised using sanitation methods to perfect the relevant methods and standards of food additives products, and to ensure stable and effective implementation of the standards in a timely manner.
4. The relevant standards of detection methods should be a gradual rationalization of existing detection methods of food standard system. It should be the goal to improve the generality and applicability of detection standards. There should be a focus on improving the accuracy of inspection standards, and shorten testing cycles through the research of advanced detection technology.

2.3.3. Emphasize the Application of the Principles and Methods of Risk Analysis on the Development of Food Standards

Food safety risk analysis is the principle that the WTO/SPS agreement clearly stipulates that member states must comply. It is also widely recognized in the international community as a strengthening measure of food safety management and in resolving trade disputes. Food safety standards formulated by the principles and methods of risk analysis are based on scientific data to ensure the standards are both technically correct and reasonable. Therefore, the study and the application of the food safety risk analysis, is currently a cornerstone of the production of food safety standards.

2.3.4. Development of the Basic Scientific Research for Food Standardization

Basic research on food safety standards is needed to limit poisonous and harmful material in food, the migration of harmful material in packing materials, and the safety assessment and inspection methods of genetically modified food. In addition, in accordance with international and domestic food market development, the research on food labeling should be developed to regulate the normal operation of food circulation so that conditions for the safety of consumer are created. Standard measures should be actively pursued to protect domestic food markets and to break foreign technical barriers which will improve the competitiveness of the Chinese food enterprise.

2.3.5. Value the Implementation and Supervision of Food Standards

The implementation of the food standard is the key to food standardization activities, and will make it effective and achieve its intended goals. Comprehensive utilization of the means that propagate, training execution, and certification will provide market access and monitoring to ensure the effective implementation of food standards. At the same time, the establishment of a feedback mechanism for the further amendments and improve the standard system is important. That mechanism must include scientifically sound and powerful monitoring programs that provide accurate assessment of how enterprises meet the standards and where the standards do not address ever changing issues. It is chromatographic techniques combined with mass spectrometry that provides this in the area of safe residue requirements.

3. Application of Mass Spectrometry to Food Safety of China

Mass spectrometry has become a powerful tool for the analysis of complex samples such as food. During recent decades, scientists in China have made significant achievements with the application of mass spectrometry on the determination of chemical contaminants in foods. Some rapid, simple, sensitive, and accurate analysis methods based on the mass spectrometry have been applied.

Regulatory analysis of pesticides, veterinary drugs, and additives frequently encounter compounds, which cannot be readily identified by chromatography alone on two or more stationary phases. Fortunately, mass spectrometry with its powerful ability of structure identification can easily resolve this problem. In addition, mass spectrometry provides high sensitivity and good quantitation of chemical contaminants in foods.

For example, gas chromatography coupled to triple quadrupole mass spectrometry (GC-MS/MS) was applied for the first time in the determination of trace food-derived hazardous compounds (2). The sensitive method developed for 13 heterocyclic amines provided both confirmation and quantitation. The method includes a solid-phase extraction procedure with a polystyrene copolymer cartridge (LiChrolut EN), followed by a derivatization reaction with *N,N*-dimethylformamide di-*tert*-butylacetal. Analyses were performed by gas chromatography with triple quadrupole mass spectrometry in electron ionization mode. The MS/MS fragmentation pathway of derived heterocyclic amines was studied and the differences of fragmentation characteristics were used successively to distinguish the isomers in absence of chemical standards. The excellent selectivity and sensitivity was achieved using multiple reaction monitoring mode (MRM). The limits of quantitation of the method for these compounds ranged from 0.12 to 0.48 ng/g of sample. The method developed was applied to the analysis of Chinese cooked foods and the results

demonstrated the power of GC-MS/MS for the analysis of trace food-derived hazardous compounds in complex food matrices such as meat samples.

3.1. Analysis of Pesticides Using Mass Spectrometry

Pesticides are found in plants and soil and the amount of residues and their toxic metabolites must be determined. Many methods based on mass spectrometry have been developed by Chinese scientists to determine these pesticide residues.

Wang (3) has developed a gas chromatography-mass spectrometry method for the determination of 11 herbicide residues (alachlor, acetochlor, butachlor, pretilachlor, metolachlor, dimethenamid, propachlor, napropamide, propanil, atrazine, and metribuzin) in rice and soybeans. The sample was extracted with acetone–water, defatted by liquid–liquid partition, and purified through solid-phase extraction with Florisil. Experiments on five fortification concentrations were carried out, and the limit of determination is 0.02 mg/kg. The average recoveries of soybean samples ranged from 63.3 to 96.0% and the relative standard deviations were from 2.14 to 11.2%. The average recoveries of rice samples ranged from 76.8 to 102% and the relative standard deviations are from 2.2 to 9.08%. The results indicated that the method was fast, accurate, and easy to perform. It also demonstrated that the method met the requirements of simultaneous determination of 11 herbicides in rice and soybeans. Zhang (4) developed a rapid multi-residue method for the determination of 16 herbicides in onion. The onion samples, which had been pre-treated were extracted with acetonitrile followed with solid-phase extraction (SPE) clean-up. The herbicide residues in onion were detected by gas chromatography/mass spectrometry with selected ion monitoring. The limit of quantitation (LOQ) ranged from 0.003 to 0.015 mg/kg. Xu (5) developed an effective method for the trace analysis of indoxacarb residue in foodstuffs of both plant and animal origin (grapefruit, ginger, fresh soyabean, bamboo shoot, chicken, fish, and pork) using gas chromatography (GC-ECD) and liquid chromatography tandem mass spectrometry (LC-MS/MS). Samples were extracted using acetone and n-hexane mixed solvent (1:2, v/v) and then purified using SPE. The extracts were analyzed using GC-ECD and LC-MS/MS. The MS/MS used MRM with transitions of each of the precursor ions with two product ions in which one product ion for identification was m/z 529 > 293 and the another for quantification was m/z 529 > 249. The detection limits (LODs) of the methods were 0.0015 and 0.0006 mg kg⁻¹, and the quantification limits (LOQs) were 0.005 and 0.002 mg/kg for GC-ECD and LC-MS/MS, respectively. The relative standard deviations (RSDs) of recovery for indoxacarb were lower than 15% in 10 types of agro-products. Ten repetitive determinations of recovery achieved good reproducibility for indoxacarb and the recovery ranged

from 72.08 to 113.74%. The proposed procedure was applied to the analysis of several real samples of different origin from Fujian Province, China, and 299 samples were screened for indoxacarb residue of which five positive samples were found.

The improvement of throughput of the analysis method is very important for food safety and many efforts on this type of method development were made in China. An efficient and sensitive method was established and validated by Yang (6) for the simultaneous determination of 118 pesticide residues in teas. This multi-residue method involved extraction with ethyl acetate-hexane, clean-up using gel permeation chromatography (GPC) and solid-phase extraction (SPE), and subsequent identification and quantification of the 118 pesticides in the extract by gas chromatography-mass spectrometry (GC-MS). For most of the target analytes, the optimized sample preparation led to no significant interference with the analysis of sample matrix for the determination of the 118 compounds was achieved in about 60 min. The limits of detection for the method were 0.00030–0.36 mg/kg, depending on each pesticide. A new approach for the extraction of nine kinds of organochlorine pesticides (OCPs) from vegetable samples coupling single-drop micro-extraction with gas chromatography-mass spectrometry was presented by Zhang (7). A novel mixed liquid of *p*-xylene and acetone was selected as an organic extraction solvent. Experimental parameters such as the extraction solvent composition, solvent volume, drop size, stirring speed, and the extraction time were optimized. The results indicated that the proposed approach is feasible for the fast determination of organochlorine pesticides in vegetable samples. Chen (8) investigated a simple and fast method for the simultaneous analysis of thiobencarb, deltamethrin and 19 organochlorine pesticide residues in fish by gas chromatography-mass spectrometry. Most of the lipids in the extract were eliminated by low-temperature cleanup (freeze out), prior to solid-phase extraction cleanup. The lipids extracted from the fish samples were easily removed without any significant losses of the pesticides. The newly developed method was demonstrated to give efficient recoveries and LODs for detecting pesticide multi-residues in fish.

In addition, the methods for determination pesticide residues in the biological samples have been developed in China. Zhou (9) developed a new method, headspace solid-phase microextraction (HS-SPME), with in situ derivatization and gas chromatography-mass spectrometry (GC-MS), which was used for the determination of trace amount of pentachlorophenol (PCP) in human plasma. The conditions for the analysis of PCP in human blood plasma using headspace SPME with situ-derivatization coupling with GC-MS was optimized with chemometrics. By using headspace SPME, the sample preparation procedure was simplified and the used quantity of organic solvents decreased

substantially, meaning less associated costs and low environmental impact. The proposed method attained a detection limit (0.02 ng/mL) lower than previously described methods for detection of PCP level in human plasma samples. Moreover, only 0.5 mL of plasma sample was needed for the analysis. Therefore, the proposed method could be considered as an attractive alternative to the currently used analytical methods. Jin (10) developed a novel analytical method for the determination of 14 trace chlorophenols in clam tissues by ion chromatography (IC) coupled with atmospheric pressure chemical ionization mass spectrometry (APCI-MS) in negative mode. The method comprised a fast ultrasound-assisted extraction using a mixture of methanol/water (4:1 v/v) containing 5% triethylamine (TEA) as extraction solvent. Solid-phase extraction with an Oasis HLB cartridge was followed by ion chromatography with a gradient separation using KOH/acetonitrile at a flow rate of 1.0 mL/min on an IonPac AG11 guard column (50 mm × 4.0 mm I.D.) and an IonPac AS11 analytical column (250 mm × 4.0 mm I.D.). The deprotonated molecular ions were selected for quantification in the selected ion monitoring (SIM) mode for monochlorophenols (MCPs), dichlorophenols (DCPs), trichlorophenols (TCPs), and pentachlorophenol (PCP).

3.2. Analysis of Veterinary Medicines Using Mass Spectrometry

Jia et al. (11) reported an ultra-performance liquid chromatography coupled with tandem mass spectrometric (MS/MS) method for the simultaneous quantitation of multiclass veterinary drugs in egg. The analysis of target compounds, including seven tetracyclines and four types of quinolones, may be accomplished in total run time of 15 min. The egg was extracted with ethylenediamine tetraacetic acid–McIlvaine buffer solution and further purified using a polymer-based Oasis HLB solid-phase extraction cartridge. A C18 column was used to separate the analytes followed by MS/MS using an electrospray ion source. The overall average recoveries of the analytes based on matrix-fortified calibration ranged from 71 to 112% with acceptable relative standard deviations of <20% for six trials. For all of the target compounds, the limits of quantitation ranged between 0.02 and 4.29 µg/kg. The proposed method is sufficiently sensitive and highly selective.

Tang et al. (12) demonstrate a high-throughput screening method using LC/MS/MS with on-line extraction cartridge cleanup for measuring drug residues in animal muscle. The rapid qualitative method was developed and validated for screening 13 target veterinary drugs: four macrolides – erythromycin A, josamycin (leucomycin A3), kitasamycin (leucomycin A5), and tylosin A; six (fluoro)quinolones–ciprofloxacin, danofloxacin, enrofloxacin, flumequine, oxolinic acid, and sarafloxacin; and lincomycin, virginiamycin M1, and trimethoprim in different animal muscles. Clindamycin, norfloxacin, nalidixic acid, oleandomycin,

ormetoprim, and roxithromycin were used as the internal standards. After simple deproteination and analyte extraction of muscle samples using acetonitrile, the supernatant was subjected to on-line cleanup and direct analysis by LC/MS/MS. On-line cleanup with an extraction cartridge packed with hydrophilic-hydrophobic polymer sorbent followed by fast LC using a short C18 column resulted in a total analysis cycle of 6 min for 19 drugs. This screening method considerably reduced the time and the cost for the quantitative and confirmatory analyses. The application of a control point approach was also introduced and explained.

3.3. Analysis of Additives Using Mass Spectrometry

Food additives have been defined by the Joint WHO/FAO Committee in 1955 as substances “which are added intentionally to food, generally in small quantities, to improve its appearance, flavor, texture, or storage properties” (13). This definition excludes substances, which find their way into foods, but have not been deliberately added, and are usually classed as contaminants. Here we mainly introduced the application of mass spectrometry in the analysis of original food additives. Some prevalent contaminants analyzed by mass spectrometry are briefly introduced.

There are various types of food additives used in China, including antioxidants and preservatives, colors, sweeteners, flavors, emulsifiers, bread and flour additives, and nutritional additives. Here we introduce some methods for analyzing food additives in foods by mass spectrometry.

First we present recent work done in China for quantitative or qualitative analysis of antioxidants and preservatives by mass spectrometry. Hao et al. (14) developed a method of liquid chromatography/ion trap mass spectrometry (LC/ITMS) to quantify the synthetic phenolic antioxidant, tertiary butyl hydroquinone (TBHQ), in 2005. The liner calibration curves were obtained in the concentration range of 61.8–4,542.5 $\mu\text{g/L}$ ($R^2=0.9999$), the detection limit was 48 $\mu\text{g/L}$, and the recoveries of TBHQ from ten samples were 81.9–109.6%. This method has been used for determination of TBHQ in edible vegetable oil and the RSD was less than 5.3% ($n=10$). Zhang et al. (15) developed a method for determining TBHQ content in edible oils using ultra performance liquid chromatography-tandem triple quadrupole mass spectrometer (UPLC-QQQ) in 2009. The detection used selected reaction monitoring (SRM) mode and calibration by external standard. The detection limit of TBHQ was 0.10 mg/kg. The correlation coefficient of linear calibration curve was over 0.999 in the range of 0.05–2.5 $\mu\text{g/ml}$ and the recovery rate was 83–115%.

TBHQ could also be detected by GC-MS. For example, The TBHQ in XO sauce was detected by Yue et al. (16) using gas chromatography-mass spectrometry (full scan mode) in 2004. Feng et al. (17) developed a GC-MS method for simultaneous determination of butylated hydroxyanisole (BHA), butylated

hydroxytoluene (BHT) and TBHQ in foods (instant rice, instant noodles, preserved ham, apple pie, and shortening). Besides antioxidants, preservatives have also been determined by MS. For instance, Wang et al. (18) developed a method for determination of four paraben preservatives including methylparaben (MP), ethylparaben (EP), propylparaben (PP) and butylparaben (BP) in dairy products by high-performance liquid chromatography mass spectrometry (HPLC-MS).

A trend for determination of preservatives and antioxidants in food is simultaneous analysis and some marked progress has been made in this field. Li et al. (19) developed a method for determination of preservatives and antioxidants in cake by GC-MS-SIM. The method could simultaneously determine seven preservatives (sorbic acid, benzoic acid, dehydroacetic acid, methyl paraben, ethyl paraben, propyl paraben, and butyl paraben) and three antioxidants (TBHQ, BHA, and BHT) in cakes. The detection limits of the 10 additives were 0.02–0.10 mg/kg. Zhan et al. (20) developed a method for the simultaneous determination of methylparaben, ethylparaben, propylparaben, butylparaben, BHA, BHT and TBHQ in food with complex matrices, by gas chromatography with mass chromatography (GC/MS). The detection limits were 0.05–0.5 mg/kg for all compounds based on a 5.0 g sample. Xiang et al. (21) developed a method for determination of four preservatives (methyl-*p*-hydroxybenzoate, ethyl-*p*-hydroxybenzoate, propyl-*p*-hydroxybenzoate, butyl-*p*-hydroxybenzoate) and three antioxidants (butylated hydroxy anisol, *tert*-butylhydroquinone, and 2, 6-di-*tert*-butyl-4-methylphenol) in food was developed by GC-IT/MS combined with hollow-fibre membrane liquid-phase microextraction (HF-LPME). The linear range for the method was 0.4–80 mg/kg, and the detection limits (LOD) were between 0.002 and 8.0 µg/kg.

Colorants are also a large class of food additives. Some analysis methods to determine them using mass spectrometry have also been developed. Chen et al. (22) developed a method for determination of five pigments (Tartrazine, Amaranth, Ponceau 4R, Sunset Yellow FCF, Brilliant Blue FCF) in drinks by reverse phase liquid chromatography tandem mass spectrometry under selected ion monitoring (SIM) mode via negative electrospray ionization. This method has been applied in the determination of these colorants in drinks.

Besides water-soluble colorants, fat-soluble colorants have also been detected by mass spectrometry. Sun et al. (23) developed a method for simultaneous determination of banned 10 azo-dyes (Sudan (I-IV), Sudan Orange G, Sudan Red B, Sudan Red G, Sudan Red 7B, Butter Yellow, and Para Red) in hot chili products by gel permeation chromatography-LC-MS/MS. The LOD and LOQ for the investigated dyes were in the ranges of 0.1–1.8 and 0.4–5.0 µg/kg respectively, depending on the matrices.

This method has been applied successfully for the determination of the studied ten banned dyes in hot chili products. Ning et al. (24) developed a method for determination of Para-red in food by UPLC-ESI-MS/MS. The detection limit of the method was $0.26 \mu\text{g/kg}$ ($S/N=3$), and the limited of quantitation was $0.85 \mu\text{g/kg}$ ($S/N=10$). The author also developed a method for simultaneous determination of Para-red and Sudan I–IV in food by UPLC-ESI-MS/MS with isotopic internal standard (Sudan I-D5 and Sudan IV-D6) (25).

GC-MS has also been applied in colorants detection. For instance, Huang et al. (26) developed a method for determining Sudan I–IV in food by GC-MS/SIM. The linear range of the determination Sudan I and II were $0.01\text{--}10 \text{ mg/L}$ with a detection limit of $1 \mu\text{g/kg}$. The linear range of the determination of Sudan III and IV was $0.1\text{--}10 \text{ mg/L}$ with a detection limit of 5 and $10 \mu\text{g/kg}$. The method has also been applied to the determination of Sudan I–IV in foods such as hot chili products with satisfactory results.

Ma et al. (27) developed a method of simultaneous determination of water-soluble (Tartrazine, Amaranth, Ponceau 4R, and Sunset Yellow FCF) and fat-soluble (Sudan (I–IV)) synthetic colorants in foodstuff by high-performance liquid chromatography-diode array detection-electrospray mass spectrometry. This method uses dimethylsulfoxide (DMSO) as the extraction solvent in the sample preparation process. Detection and quantitation limits of the investigated dyes were in the ranges of $0.01\text{--}4$ and $0.03\text{--}11.2 \text{ ng}$ respectively. The recoveries of the eight synthetic colorants in four matrices ranged from 93.2 to 108.3% and the RSDs were less than 8.2%. Although this method has been applied successfully in the determination of synthetic colorants in four matrices (soft drink, delicious ginger, chilli powders, and chilli spices), the mass spectral data had to be acquired under positive/negative mode requiring a separate injection for each. New-style ESI-MS systems now offer operation simultaneously under positive and negative ion mode. Therefore, the method for simultaneous determination of water-soluble and fat-soluble synthetic colorants may be a development trend for screening and quantitation of colorants in foodstuff by HPLC-ESI-MS.

Cai et al. (28) developed a method for rapid identification of betacyanins from *Amaranthus tricolor*, *Gomphrena globosa*, and *Hylocereus polyrhizus*, by matrix-assisted laser desorption/ionization quadrupole ion trap time-of-flight mass spectrometry (MALDI-QIT-TOF MS). Based on this method, 14 free and acylated betacyanins, belonging to amaranthin-type, betanin-type, and gomphrenin-type betacyanins, respectively, were identified. However, the related isomers could not be differentiated for the lack of LC separation.

Artificial sweeteners are also a type of food additive that needs sensitive detection for determining their identity and concentrations in foods. Yang et al. (29) developed a method of simultaneous determination of seven artificial (aspartame, saccharin, acesulfame-K, neotame, sucralose, cyclamate, and alitame) and one natural sweetener (stevioside) in foods by HPLC/ESI-MS. The correlation coefficient of the calibration curve was better than 0.998 ($n=6$). The limits of detection (LODs) were below 0.10 $\mu\text{g}/\text{ml}$, whereas the limits of quantification (LOQs) were below 0.30 $\mu\text{g}/\text{ml}$.

Huang et al. (30) developed a highly sensitive method for the determination of cyclamate in foods (such as prepared dried fruit of *Areca catechu* L and tanned fruits) by ion-pair high-performance liquid chromatography-electrospray ionization mass spectrometry. The quantitation of the target compound was completed using a selected ion monitoring (SIM) at m/z 178 obtained from ESI-mode. Tiopronin was used as internal standard for the quantitation of cyclamate. The correlation coefficient of the calibration curve was better than 0.996 in the range of 50–5,000 ng/mL . The limits of detection and quantitation were 5 ng/ml and 20 ng/ml , respectively.

Lin et al. (31) developed a method for determination of sodium cyclamate in vitamin C effervescent tablets by gas chromatography-mass spectrum with selected ion monitoring (GC-MS/SIM). Sodium cyclamate was quantified using a single ion. The linear range was 0.05–10 mg/L with a detection limit of 0.6 mg/kg . The recovery range was 90.5–96.9% with a RSD of less than 4.4%.

The merits of high sensitivity and accuracy in mass spectrometry analysis have also been applied in flavors detection. For example, Han et al. (32) developed a method for isolation and identification aromatic components in milk by GC/MS. Using this method, 17 compounds were identified. The main flavor components in milk were: piperonal (16.210%), vanillin (16.838%), ethyl vanillin (9.817%), δ -undecalactone (32.657%), τ -octalactone (6.050%), and the ethyl ester (5.163%). The author (33) also developed a method for determination of vanillin in milk by GC-MS. The result shows that this method could eliminate interferences with complex material conveniently, quickly, and accurately.

There are some other studies applying MS analysis in food additives and contaminants. For example, Zhu et al. (34) developed a method for simultaneous separation and determination of eight kinds of drugs in dietary supplements with solid phase extraction and high performance liquid chromatography-mass spectrometry. The average recoveries for the eight drugs were 60.4–93.1% with relative standard deviations of 1.13–9.82% and the limits of detection were 0.5–3.0 mg/L respectively. Xu et al. (35)

developed a method of simultaneous separation and determination of chloropropanols (1, 3-DCP, 2, 3-DCP, 3-MCPD, and 2-MCPD) in soy sauce and other flavoring with gas chromatography-mass spectrometry in negative chemical and electron ionization modes. The author used D (5)-3-MCPD and D(5)-1,3-DCP as the deuterium isotopic labeled internal standards. Shao et al. (36) developed a method of analysis of nonylphenol(NP), octylphenol(OP), and bisphenol A (BPA) in animal tissues by liquid chromatography-tandem mass spectrometry with accelerated solvent extraction. Sample concentration and purification were performed using an Oasis NH₂ solid extraction cartridge. The detection limits of the method under multiple reaction monitoring mode were 0.3, 0.05 and 0.1 µg/kg for BPA, NP, and OP respectively. Zhang et al. (37, 38) developed a LC-MS/MS method to determine the concentration of acrylamide in fried bread sticks and chicken wings. The authors found that both bamboo leaves (AOB) and extracts of green tea (EGT) have two natural antioxidants that could reduce acrylamide levels significantly in fried bread sticks. The present study indicated that both AOB and EGT could significantly reduce the acrylamide content generated in fried bread sticks while maintaining the original flavor and crispness of the fried bread sticks. This study could be regarded as an important contribution to the studies on the reduction of acrylamide by natural antioxidants.

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