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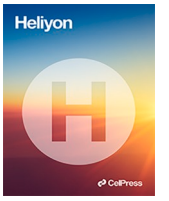

Review article

Historical evolution of basic characteristics, underlying causes, and management tools of food fraud in China: 1949–2022

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ABSTRACT

The emergence and development of food fraud are closely related to a country's economic system and social development. It has distinct characteristics in different historical stages, and an inherent historical logic links different historical stages. Following the thread of "what", "why", and "what to do", this study uses a broad perspective and comparative historical approach to examine the evolution of the basic characteristics, underlying causes, and management tools of food fraud in China at different historical stages over 70 years from 1949 to 2022. This study argues that the historical evolution of food fraud in China has characteristics unique to China as well as features similar to those in other countries. It provides a window for academics to understand the historical evolution of food fraud in China. It also provides valuable insights for other countries, especially developing countries, for objectively understanding the evolution of food fraud during their economic development process, and how to address it.

1. Introduction

Food fraud is a serious issue of global concern [1–4]. It is recognized as the second largest public health hazard after drugs, and thus has attracted great attention from academics [5]. Numerous studies have been performed on food fraud in terms of vulnerability assessment tools, mitigation strategies, and international collaboration, among others [6–14]. These studies are undoubtedly valuable. However, most previous studies take a static snapshot of food fraud in the real world. Meanwhile, the historical evolution of food fraud has not been fully understood due to the lack of dynamic research based on history. Food fraud is not an isolated social problem. From the perspective of historical evolution, the basic characteristics and underlying causes of food fraud in a country are closely related to and change with its socioeconomic development [15]. Moreover, the evolution of management tools is path-dependent. Therefore, research on food fraud management not only needs to be based on the present situation, but must also unravel the historical trajectory and uncover the inherent dynamics and governing factors.

Food fraud typically involves misrepresentation (e.g. counterfeiting), adulteration, and, in some definitions, theft, tampering, diversion, tax evasion, grey market activities, and overruns [16]. In the present study, we will focus solely on the aspects of food fraud related to adulteration, which aligns with the commonly used working definitions of food fraud in the United States Pharmacopeial Convention (USP) [17]. According to USP, food fraud can be defined as the fraudulent addition of non-authentic substances or the removal or replacement of authentic substances without the purchaser's knowledge for the economic gain of the seller. In this context,

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"adulterant" is defined as "the undesirable substance" or "fraudulently added material" in a fraudulent food product [18]. Adulteration can be divided into physical adulteration, caused by adding natural substances, or chemical adulteration, caused by adding chemical substances [19,20].

The marginal contribution of this study is to investigate food fraud in China from the perspective of historical evolution using a comparative historical approach (CHA). It provides a panoramic view of the basic characteristics, main causes, and management tools of food fraud between 1949 and 2022 in China, and clarifies the basic underling dynamics of the evolution of food fraud. China has developed from early industrialization to post-industrialization since 1949, transforming from an underdeveloped country into an economy that currently ranks second in the world in total GDP. During this industrialization period, the same types of food fraud incidents that occurred in Western countries have been repeated in China, and will happen in other developing countries in the future. Therefore, studying the evolution of food fraud in China will provide a glimpse of the entire evolution of food fraud during its journey from an underdeveloped country to initial modernization, and also provides useful guidance to China and other developing countries about proper management of food fraud in the future.

2. Methodology and logic

CHA is an effective method to identify the cause, process, and result of institutional change by analyzing a specific major social issue in a country through in-depth analysis and through comparisons in both time and process dimensions from a macro perspective based on rich and real historical data and cases [21]. CHA stems from the belief that the emergence and persistence of a major social issue is always rooted in history, and that practical solutions can only be found by revealing the evolution and inherent universal dynamics from a historical perspective [22,23]. The analytical framework of this study is shown in Fig. 1. Specifically, this study divides China's development into four stages, namely, planned economy, economic transition, market economy, and new era, using the country's three major economic reforms as critical junctures. Following the thread of "what", "why", and "what to do", it takes a broad perspective to describe the basic characteristics, causes, and management tools of food fraud in different historical stages, clarifies its entire evolution, and reveals its inherent underlying dynamics through vertical and horizontal comparisons.

2.1. Critical junctures: institutional arrangements that have a lasting impact on evolution

In CHA, critical junctures serve as entry points for examining the social issue under study [24]. Because institutions are difficult to change once they are on track, choices made at key historical junctures and relevant institutional arrangements will have a relatively lasting impact on the future [21]. Since 1949, China has implemented three major economic reforms. The first one is the reform and opening up since 1978, which broke the highly centralized planned economy; the second is the comprehensive establishment of a socialist market economy since 1992; and the third is the shift of the market from a basic to a decisive role in resource allocation since 2013. At present, the development of the food safety regulation system of China is mainly divided by these three reforms [25,26]. Based on the above studies, the development of China is thus divided into four periods by the critical junctures of 1978, 1992, and 2013: 1949–1978 is the period of highly centralized planned economy; 1979–1992 is the period of economic transition from "planned economy" to "planned economy supplemented by commodity economy"; 1993–2012 is the period of comprehensively constructing a socialist market economy; and 2013 marks the start of a new era of comprehensively deepening reforms.

2.2. Basic characteristics: what food fraud is

Historically, even within a single country, food fraud has different basic characteristics in different periods. Describing the basic characteristics of food fraud in different periods helps to comprehensively understand the overall situation of food fraud in each period. Referring to the existing literature [27], this study describes the food fraud situation in China in different historical periods across

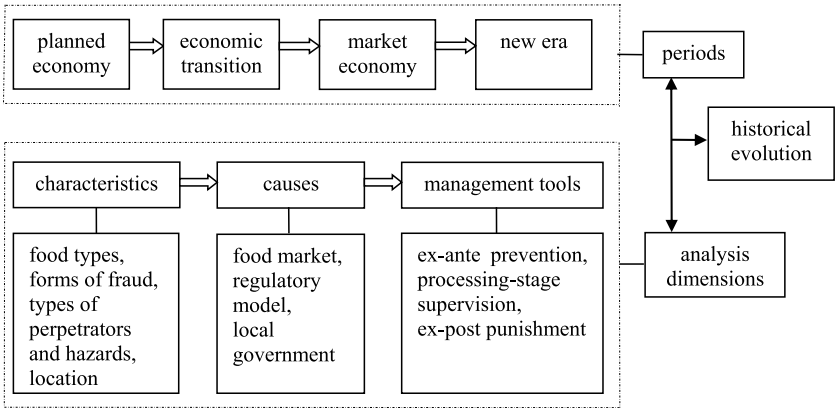

Fig. 1. Analytical framework of the historical evolution of food fraud.

multiple dimensions, such as food types involved, forms of fraud, types of perpetrators and hazards, and changes in location. Since 1949, academic literature, media reports, and statistical yearbooks, and so on have documented a large number of food fraud incidents in different historical periods in China from different angles, providing rich historical data and typical cases for this study.

2.3. Causes: why food fraud occurs and continues to evolve

This study explains the causes of the emergence and evolution of food fraud in China in three dimensions: food market, regulatory model, and local government. First, China has transformed from a highly centralized planned economy to a market economy in the 70-plus years since 1949. The drastic improvement in its socioeconomic development has been proven to have close links to the gradual establishment of a market economy. Food fraud is a product of the market. Indeed, food fraud cannot completely be eliminated as long as the market economy exists [28]. With the continuous development and changes in the market, new methods of food fraud may emerge. Therefore, there is a close relationship between the types of food fraud and market dynamics. Therefore, investigating the changes in the Chinese food market since 1949 allows for identifying the inherent logic of why food fraud occurred and evolved in China. Second, food safety regulation models often lag behind the need to combat food fraud whether historically or currently, whether in China or in other countries. This is an important institutional cause of food fraud. Third, local governments have overall responsibility for food safety in China. Therefore, the actions of local governments are also important variables influencing food fraud management.

2.4. Management tools: what has been done to combat food fraud and how effective it has been

Historically, as soon as health hazards were recognized, governments responded by using various tools to manage food fraud. Currently, developed Western countries in North America and Europe have established a system of management tools for "ex-ante prevention + processing-stage supervision + ex-post punishment" that covers the entire food supply chain. Ex-ante prevention refers to taking actions in advance to prevent the occurrence of food fraud in the first place and minimize the flow of counterfeit food into the market. This is the first firewall against food fraud. Processing-stage supervision refers to detecting counterfeit food entering the market through various methods, such as supervision and inspection. Once ex-ante prevention fails, processing-stage supervision will act as a second barrier. Ex-post punishment refers to the punishment of food fraud once discovered to force food companies to operate with integrity. Since the 21st century, by learning from the experience of Western countries, China has gradually established a system of tools to manage food fraud that uses all three of these approaches to cover the entire supply chain, and has made considerable achievements.

3. Food fraud during the planned economy period (1949–1978)

Following the founding of New China in 1949, the government adopted the model used by the Soviet Union, which prioritized the development of heavy industry and did not pay much attention to the food industry [29]. This period can be divided into two stages: The first stage was from 1949 to 1956, during which the food market was chaotic and food fraud was common. The second stage lasted from 1956 to 1978, during which the government established a highly centralized planned economy and banned the food market, thus almost eliminating food fraud [30].

3.1. Basic characteristics

In the 1949–1956 period, food fraud in China had the following basic characteristics. First, the form of fraud was mainly physical adulteration of luxury or special-purpose foods. During this period, most Chinese people did not have enough food to eat [31]. Main food items were primary agricultural products [32]. Processed foods, such as biscuits and canned foods, were luxury foods for ordinary people and were only available to a small number of wealthy people or special groups, such as the military. Food fraud primarily involves the physical adulteration of products to pass off inferior raw materials as high-quality ones. Examples include using moldy flour in cookies, adding lime powder to flour, adding sugar or brown sugar to soil, and mixing rotten horse meat with canned beef. A typical case occurred in 1952, where a few unscrupulous businessmen added large amounts of rotten and horse meat to beef to produce canned beef sold to the military [33]. Moreover, the addition of sand to rice and pickled vegetables has also been a significant issue. In some large cities, milk has also been found to be mixed with water.

Second, perpetrators were limited to a small number of criminals. China's modern food industry began with the flour processing industry established with imported machinery in the late Qing Dynasty (1840–1912) [34]. In the early years of New China, the food industry had a weak foundation [29]. Most of the food was produced by traditional manual operations or workshops [35]. There were only a few food processing factories in some big cities along the coast, giving little scope for widespread involvement in food fraud.

Third, the types of fraud committed posed great health hazards. Rotten and spoiled raw materials, which are very harmful to health, were used in food fraud during this period. For example, consumption of canned food made from rotten meat may cause severe food poisoning and damage the nervous system, liver, and kidneys. Consumption of moldy flour may cause acute or chronic poisoning and even cancer.

Fourth, food fraud mainly occurred in urban areas. As noted earlier in this section, processed foods were luxury goods that only wealthy families in urban areas could afford. Therefore, counterfeit food was predominantly found in urban areas during this period, whereas food fraud in rural areas was relatively rare [32]. In the early years of New China, farmers accounted for 88 % of the total

population. The rural society at that time was a typical self-sufficient small-scale peasant economy, which had minimal demand for industrial products, including processed food. However, there were also instances in rural areas where farmers diluted or short-weighted their products.

3.2. Underlying causes

In the 1949–1956 period, local governments did not have a remit to oversee food hygiene. A chaotic market and ineffective regulation were the main causes of food fraud.

Regarding the highly chaotic market, in 1949–1956, government regulation of food safety was almost absent because China was fighting a civil war, resisting US aggression, and aiding Korea [25]. Food was extremely scarce in this period. High speculation in private industry and commerce, soaring prices, and fictitious transactions meant the food market was highly volatile and uncertain, with little traceability, accountability, or standardization. Against this chaotic environment, food fraud where inferior raw materials were used to replace high-quality ones was carried out. Obviously, the chaotic food market was an important cause of food fraud during this period.

Second, the regulatory model of the time focused on hygiene management. Due to the country's specific historical background, the Chinese government at that time paid far more attention to food security than quality and safety. Moreover, in terms of food safety, the government paid more attention to foodborne diseases rather than food fraud [36]. Food safety was equated with food hygiene management and poisoning prevention. In addition, learning from the Soviet Union, China's national health department established health and epidemic prevention stations at all levels across the country to issue health licenses and deal with food-borne diseases and food poisoning. This hygiene management model focusing on food poisoning was not suitable for managing intentional food fraud [25].

3.3. Management tools

In response to the soaring prices, fictitious transactions, and speculation experienced in 1949–1956, the government did not aim to regulate the market, but rather implement its ideology by eliminating the market and establishing a highly centralized and unified planned economy. Although the government did not design tools specifically to combat food fraud, in 1956–1978, food fraud was almost eliminated following the establishment of a highly centralized planned economy, mainly because private food companies and self-employed food stall owners were outlawed [37]. Almost all food production and distribution activities were arranged uniformly by the government [25]. Food companies had neither independent decision-making power nor the motivation to pursue economic interests. Moreover, the people in charge of food companies were directly appointed by the government, and their behavior was oriented toward political promotion rather than economic gain [25], making them relatively honest.[1] Therefore, many studies have indicated that food fraud was almost non-existent during this period [30], and there were no management tools in place to address it.

4. Food fraud during the economic transition period (1979–1992)

The 1979–1992 period is significant because it marks China's transformation from a "planned economy" to a "planned economy supplemented by a commodity economy". With the re-emergence of the food market and rapid development of the food industry, the average annual growth rate of total output value was as high as 15.71 %. Meanwhile, food fraud became increasingly prevalent. This is similar to the food fraud situation in other countries, such as the United Kingdom and France, in the early stage of the establishment of a market economy [38](Collins, 1993).

4.1. Basic characteristics

First, the main form of food fraud in this period was chemical adulteration of daily-consumed food products. Unlike during the 1949–1956 period, food fraud during this period began to shift from physical to chemical adulteration due to the development of the chemical industry [39]. For example, ammonium nitrate and fertilizers were added to milk powder, industrial waste salt was added to edible salt, industrial alcohol was mixed with drinking alcohol, sulfur dioxide was added to edible oil, and formaldehyde was added to flour, among other fraudulent practices. The types of food involved also expanded significantly.

Overall, adulteration with industrial alcohol was the most prominent type of food fraud. For example, in the six months from May to December 1991, 45 (86.54 %) out of the 52 batches of famous liquors sent from all over the country to Zhejiang Province for testing were found to be counterfeit [40]. At the 1991 National Liquor Appraisal Conference, nearly 50 % of the 16 participating liquors were counterfeit [41]. The emergence of a large number of counterfeit alcohols in China confirms the conclusion of an empirical study in developing countries, such as India and Indonesia, that the problem of counterfeit alcohol tends to be more serious in countries with relatively low economic development [42].

[1] Between 1956 and 1978, China operated under a planned economy, and officials did not pursue economic interests, resulting in minimal corruption. It was not until the reform and opening-up in 1978 that corruption became a serious issue in China. Consequently, in 1979, the Central Committee of the CPC decided to establish discipline inspection committees in Party committees at all levels nationwide. Additionally, in 1983 and 1986, the Chinese government established the National Audit Office and the Ministry of Supervision.

Second, perpetrators became more diverse. With the food industry's rapid development, food fraud at this stage gradually evolved from an isolated phenomenon involving only a few criminals to a relatively common social phenomenon involving a wide range of enterprises. Businesses with all types of ownership, from individual and private businesses to collectively owned and state-owned enterprises, were involved in food fraud to varying degrees [43]. Incredibly, collectively owned and state-owned enterprises were frequent culprits in major food fraud cases. For example, 78 collectively owned and state-owned enterprises were involved in a major case of producing and selling 10,000 bottles of counterfeit Moutai and Dongjiu liquor in Shaoxing, Zhejiang Province in 1989.

Third, food fraud in this stage posed great and mainly direct hazards. Due to low levels of hygiene knowledge and production technology, food producers and distributors at that time lacked understanding of the health hazards of illegal additives, and they added non-edible substances that were directly and highly harmful to human health to food, resulting in the emergence of many serious criminal cases. For example, the use of methanol solvent or industrial alcohol with a high concentration of methanol in the production of drinkable alcohol in Jilin, Sichuan, Henan and other provinces in 1987 caused a total of 4988 people to be poisoned, 38 of whom were blinded, and 129 died [39].

Fourth, urban areas were the hardest hit. In 1979–1992, the living conditions of both urban and rural residents in China underwent significant changes, with an increase in per capita disposable income from 405.0 to 160.2 yuan to 2026.6 and 784 yuan, respectively. According to the exchange rate of that year, the per capita disposable income of urban and rural residents in 1992 was only 375.73 US dollars and 145.40 US dollars, respectively. Rural society remained a self-sufficient small-scale peasant economy. Rural residents mainly consumed primary agricultural products and had little demand for processed foods. In contrast, urban residents had relatively high incomes and consumed more processed foods. Moreover, with the rapid development of industry and commerce, the food market gradually emerged in urban areas. Therefore, most counterfeit food entered the urban food market. Urban areas were thus still the hardest hit by food fraud.

4.2. Underlying causes

The first cause is the re-emergence of the food market. In 1956–1978, the food market and food fraud were basically eliminated by the planned economy. However, at the end of 1978, China launched an economic reform, an important part of which was the reconstruction of the food market. Driven by economic interests, food and related industries developed rapidly in China [44]. A large number of private food companies and self-employed food stall owners emerged, breaking the pattern maintained in 1956–1978 in which collectively owned and state-owned enterprises dominated food production and distribution. Moreover, collectively owned and state-owned enterprises began to gain autonomy in food production and distribution. Food companies with different ownership structures were increasingly motivated to pursue commercial profits, causing opportunistic behavior to profiteer through food fraud.

The second cause relates to the regulatory model focusing on hygiene management. With the transition from a planned economy to a market economy, the previous food hygiene law enforcement system was unable to adapt to the emerging food market. In 1982, the Chinese government promulgated the *Food Hygiene Law (Trial)* and established a team of tens of thousands of food hygiene inspectors. However, like the previous period, the understanding of food safety was still limited to hygiene management [45]. The main task was to encourage and/or force enterprises to strengthen hygiene management during food production and distribution so as to reduce food-borne diseases and food poisoning. However, food fraud is a deliberate illegal act. A regulatory model focusing on hygiene management could not effectively combat the food fraud that sought to capitalize on the new market [25].

The third cause is the emergence of local protectionism. Before the reform and opening up in 1978, local governments were subordinate organs of the central government and had no independent local interests. The central government began to decentralize power in 1980. Only then did local governments begin to have their own interests, such as local tax revenue [46]. However, there is a conflict between the policy goals of economic development and food hygiene. Some local government leaders believed that the implementation of the *Food Hygiene Law (Trial)* would hinder the food industry's revitalization. Not only did they not properly fulfill their obligations in food hygiene management, but they also obstructed the food hygiene department's enforcement activities. In particular, due to the huge profits and high tax contribution of counterfeit alcohol, almost all local governments provided local protection for the counterfeit alcohol industry. This is also an important cause of the rampant alcohol counterfeiting during this period.

4.3. Management tools

During the period of economic transition, food fraud accompanying the food marketization reform caused strong public dissatisfaction, which in turn prompted the government to explore management tools compatible with a market economy [25]. However, only a small number of management tools were available during this period, and the enforcement system was embryonic.

First, administrative orders and ideological education originating from the planned economy period remained important ex-ante prevention tools in this period. Meanwhile, a relatively strict enterprise registration system began to be implemented to understand the situation of food producers and distributors and eliminate unqualified ones. Food producers, distributors, and sellers were required to obtain a health license before applying to the industrial and commercial administration department for registration or change of registration. The enterprise registration system was an important prevention tool against food fraud.

Second, processing-stage supervision tools began to be developed. Before 1978, food was produced according to directive plans issued by government industry authorities. Operational autonomy was essentially non-existent in all firms along the food supply chain [25]. Moreover, no government agency held specific responsibility for food safety regulation. With the continuous deepening of reform and opening up, the food market developed rapidly. Government agencies, such as those overseeing industry and commerce and quality inspection, began to conduct surprise inspections and investigations into the food circulating in the market to discover and

eliminate counterfeit food [30]. Processing-stage supervision tools, mainly surprise inspections, began to emerge.

Third, during this period, China was at the beginning of re-establishing a market economy, and food fraud was regarded as an act that disrupted the market. For the purpose of maintaining market order, the government explored ex-post administrative and criminal punishment tools to force enterprises to stop committing food fraud. The main measures were to impose administrative penalties, including suspension of production and operations, confiscation of illegal income, fines, and even revocation of production and health licenses, on food enterprises engaging in adulteration. A law was also enacted in 1985 to include food fraud as a "speculation crime" [47].

5. Food fraud during the market economy period (1993–2012)

The 1993–2012 period was critical in China's efforts to establish a socialist market economy with Chinese characteristics. The total output value of the food industry increased from 342.866 billion yuan (66.79 billion US dollars) in 1993 to 8955.184 billion yuan (1418.63 billion US dollars) in 2012, with an average annual growth rate of 19.87 %. However, the food industry at this stage developed extensively, and food fraud became more severe than in 1979–1992 with the development of the market economy. This is basically consistent with the food fraud situation in Western countries during the extensive development stage of the food industry [48]. Especially during this period, one of the most notorious food fraud cases worldwide was the discovery in 2008 of the illegal addition of melamine, an industrial raw material, to infant milk powder in China. This incident had a severe impact, harming 300,000 infants, six of whom died [49,50].

5.1. Basic characteristics

First, as in 1979–1992, food fraud in this period mainly involved daily-consumed food products, such as meat, soy products, dairy products, sauces, and candies. A series of incidents with devastating consequences, such as Fuyang milk powder, melamine-tainted milk powder, dyed steamed buns, red-yolk duck eggs, poisonous ginger, and essence-added steamed buns, occurred [51]. Chemical adulteration, such as intentional abuse of food additives and illegal addition of non-edible chemical substances, remained the main form of food fraud [43]. For example, Xu and Wang (2008) reported that 165 (49.7 %) out of 332 food safety incidents that occurred across the country in 2006 were caused by chemical adulteration [52].

Second, perpetrators now tended to be large-scale and group-based. From 1993 to 2005, small and micro enterprises had been the main perpetrators of food fraud in China. Although there were also numerous small or local frauds involving gutter oil and dog meat, after 2005, some large food enterprises known for producing high-quality well-known products exempt from inspection also engaged in food fraud [53]. For example, a number of large dairy product manufacturers with such qualification were involved in the melamine-tainted milk powder incident in 2008. Meanwhile, food fraud was no longer the preserve of individual enterprises, but increasingly became a common group speculative behavior in the industry [54]. Most food safety incidents that occurred between 2006 and 2011 were caused by food fraud and involved a large number of enterprises and even the entire industry [54].

Third, the main form of health hazards shifted from immediate to potential hazards. Food fraud incidents that directly resulted in serious physical injury occurred frequently in 1979–1992. However, the main form of health hazards from food fraud changed from direct apparent hazards to potential hidden hazards in 1993–2012, especially since the 21st century [51]. There are many such cases on record. For example, the practice of producing "leather milk" by adding protein derived by hydrolysis from leather waste or animal hair to dairy products was exposed in 2009. Short-term consumption of small amounts of this leather hydrolyzed protein containing excessive heavy metals does not pose obvious hazards to health. However, long-term consumption of large amounts will result in accumulation of heavy metal ions in bones, which may cause health hazards such as loose and swollen joints.

Fourth, rural areas became the areas hardest hit by food fraud. With the rapid development of the rural economy, the per capita disposable income of China's rural residents increased from 921.62 yuan (159.95 US dollars) in 1993 to 8389 yuan (1328.95 US dollars) in 2012. Hence, farmers increasingly came to consume processed and packaged foods. However, unlike urban areas, most rural areas did not have specialized food safety regulatory agencies at that time. As a result, illegal factories, workshops, and dens were ubiquitous in rural areas. Rural food markets were flooded with counterfeit, poor-quality, and expired food [55,56].

5.2. Underlying causes

The first cause for these changes in food fraud behavior is the intensifying competition in the food market. Since the 1990s, competition in the food market had been increasingly strong due to the increasingly high overcapacity, and shrinking profit margins became a normal situation due to the decreased prices and increased costs. As a result, food fraud became increasingly prevalent. For example, China's annual milk production increased from 8 million tons in 2000 to 36 million tons in 2008, a nearly fivefold increase and an average annual growth rate of more than 20 % [49]. With the growth of milk supply capacity, profit margins were severely impacted by decreases market prices and continuously increasing farming costs. In this case, dairy farmers sought to increase profits by adding water to milk [57]. In order for this watered-down milk to meet the protein standards, they added melamine to the milk, which eventually led to the melamine-tainted milk powder incident, which impacted 300,000 infants, six of whom died [49].

The second cause lies in the model of segmented regulation by multiple agencies [58,59]. With the food industry's rapid development, a complete food industry chain was formed in China [60]. The hygiene management led by the health department that was implemented in 1979–1992 could no longer meet the regulatory needs of this increasingly extended food industry chain. In 2004, the Chinese government established a multi-agency segmented regulation system. Specifically, the departments of agriculture, quality

inspection and quarantine, industry and commerce, health, and customs were responsible for regulating the production of primary agricultural products (raw materials), food production and processing, food distribution and retailing, food safety in restaurants, and international trade, respectively. However, this joint regulation by multiple agencies led to the fragmentation of regulation in which the agencies were isolated from each other and operated in their own ways [61]. This is one of the main reasons for the low efficiency of government regulation in China during this period [62]. It is also an important institutional cause of food fraud.

The third cause is increasing local protectionism. The local protectionism that began to emerge in 1979–1992 did not decrease in 1993–2012, but increased instead. The reason is that local governments were anxious to develop the food industry with the aim to promote regional economic growth. However, the policy goals of economic development conflict with those of food safety. Therefore, local governments protected the development of local food enterprises at the expense of food safety [63]. Food fraud incidents that occurred in 1993–2012 were more or less related to local protectionism. For example, in the melamine-tainted milk powder incident, the local governments not only shirked their regulatory duties, but helped the enterprises involved conceal the truth after the incident was exposed, and even tried to help them escape punishment.

5.3. Management tools

First, ex-ante prevention tools remained in use. From 1993 to 2001, the enterprise registration system established in 1979–1992 continued to be the main ex-ante prevention measure. By the beginning of the 21st century, small family-run food production enterprises with fewer than 10 employees accounted for 79.4 % of China's food production enterprises. The enterprise registration system could no longer meet practical needs. In 2002, the Chinese government created a market access system for food products such as wheat flour, rice, edible vegetable oil, soy sauce, and vinegar. Since then, almost all processed foods have been included, thereby establishing a food market access system based on production licenses, compulsory inspections, and market access labels. The main tool for ex-ante prevention changed to a food market access system with "licenses" as the core [26].

Second, in 1979–1992, a few government agencies, such as industry and commerce and quality inspection, began to inspect food products circulating in the market. However, the inspections during this period were only surprise inspections without effective testing methods. In 1993–2012, special rectifications and spot checks with wider coverage and more standardized procedures were implemented [64]. In the 1990s and early 2000s, these special rectifications often occurred after serious food fraud incidents. In other words, it was an ex-post measure. After 2004, special rectifications against food fraud were performed every year. The Food Hygiene Law promulgated in 1995 established the health department's leading role in food hygiene regulation. The health department implemented a food sampling inspection system to fulfill regulatory responsibilities. Since then, several reforms have been implemented, thereby establishing a relatively complete food sampling inspection system.

Third, administrative penalties did not change much from 1979 to 1992 to 1993–2012, although the severity of penalties increased [63]. For example, the 2009 *Food Safety Law* increased the maximum fine from 5 times to 20 times the value of the goods. In contrast, criminal penalties changed greatly. In 1979–1992, food fraud was unreasonably classified as a "speculation crime" as an act that disrupted the market. In 1997, food fraud was recategorized and was included in the *Criminal Law*. The "crime of producing and selling toxic or harmful food" was split into the "crime of adulterating food produced and sold with toxic or harmful non-food raw materials" and the "crime of knowingly selling food adulterated with toxic or harmful non-food raw materials". In 2011, the *Criminal Law Amendment (VIII)* revised the "crime of producing and selling food that does not meet hygienic standards" to the "crime of producing and selling food that does not meet safety standards". In 2011 and 2012, the number of completed criminal cases nationwide of "producing and selling food that does not meet safety standards" and that of "producing and selling toxic or harmful food" increased by 179.83 % and 224.62 %, respectively, year on year. Criminal penalties became an important tool for deterring food fraud.

6. Food fraud in the new era (2013–2022)

After 2013, the development of China's food industry shifted from high-speed growth to medium-high-speed growth [29]. The period of extensive development came to an end, and the food industry embarked upon a new era of high-quality development. As two reforms of the food safety regulation system were implemented across the country in 2013 and 2018, the governance system and its capabilities were gradually improved, and in response, some new characteristics of food fraud emerged.

6.1. Basic characteristics

First, the main target of food fraud remained daily-consumed food products such as edible oil, meat, and honey, just like in 1993–2012 [65]. For example, around 2016, overall 20 % of beef and mutton and their products sold in the market in Guangdong Province were adulterated [66]. However, physical adulteration replaced chemical adulteration to once again become the primary form of food fraud [65], just like in the economic transition period of 1949–1956. Many incidents with devastating consequences, such as the fake duck blood incident of Little Sheep and the fox meat incident of Walmart, occurred in this period.

Second, more advanced methods were used in food fraud. Before 2013, relatively simple methods, such as adding water to milk, were often used in food fraud. After 2013, more covert and advanced methods were used [45]. For example, in the previous period, honey, which is a triose, was adulterated with tetrose, such as starch syrup, sucrose, and corn syrup. Therefore, the authenticity of honey could be identified by C4 testing. In recent years, however, honey has been adulterated with fructose, which is also a triose [67]. As a result, the authenticity of honey cannot be identified even using the testing method of national technical standards [68].

Third, the health hazards are relatively controllable. Unlike the adulteration with harmful chemical substances in 1993–2012, the

adulterants used in this stage were mainly natural substances, which were used in small quantities and caused less harm to human health. This is similar to the fact that food adulteration in Western countries often does not cause obvious health hazards [69]. In a few cases, physical adulteration may be accompanied by abuse of food additives or illegal use of chemical substances. For example, pig blood can be passed off as duck blood, and industrial pigments and formaldehyde may be illegally added to improve the toughness, preservation, and similarity of the fake duck blood.

Fourth, food fraud became increasingly cross-regional. Since 2013, the differences in food fraud between urban and rural areas reduced greatly, but cross-regional characteristics have become increasingly obvious [70]. On the one hand, 19 urban agglomerations, including the Beijing-Tianjin-Hebei Region and the Yangtze River Delta, supported 75 % of the national population with 25 % of the national land area and contributed 88 % of the national GDP. Within these urban agglomerations, food production, distribution, and consumption, as well as food fraud, have obvious cross-regional characteristics. On the other hand, the online food delivery market of China exceeded 200 billion yuan (29.62 billion US dollars) as early as 2017, with more than 300 million users. "Internet Plus" has enabled food fraud to move from offline to online, showing an obvious cross-regional trend [71].

6.2. Underlying causes

First, the food consumption market was sluggish. Global economic development has been in a downturn since 2008, which has stimulated food fraud to some extent. For example, the EU reported 376 items of food fraud information, involving 24 food categories, through the Rapid Alert System for Food and Feed in 2008–2012 [72]. Since 2013, China's food industry has seen continued declining economic growth, while the cost of production factors has been increasing. In this context, the irrational pursuit of economic interests has greatly stimulated food fraud. Moreover, COVID-19 has seriously distorted the food market since 2020 [73], resulting in increasing incidence of food fraud [4,14,74].

Second, China's new reforms are not yet complete. Since 2013, the Chinese government has intensified its reform of the food safety risk management system [75]. Specifically, government agencies have been merged to reduce the fragmentation inherent in multi-agency regulation and address the coexistence of overlap and gaps in regulation [51]. Efforts have also been made to promote and deepen the market reform and improve the supporting mechanism for interim and ex-post regulation. The need for approval and issuance of licenses for food production and distribution were cancelled, and a notification and commitment system for market access was implemented instead. Moreover, a regulatory model of "double randomization + public disclosure" has been fully implemented, in which both the inspection targets and inspectors are randomly selected, and the inspection and investigation results are disclosed to the public in a timely manner. However, these reforms are not yet mature or complete, which may be an institutional cause of food fraud during this period.

Third, local governments faced a contradiction between cross-regional food fraud and fragmented management. Local protectionism was once an important cause of food fraud. In 1992–2012, the central government delegated all responsibilities for combating food fraud to local governments and implemented local food safety management in 1993–2012. Although this is conducive to the fulfillment of local government responsibilities, it inevitably leads to the differences and isolation of regulatory policies, tools, and law enforcement standards among local governments. Such isolation results in the spatial fragmentation of food fraud management and the inability to effectively address food fraud across administrative regional boundaries [76]. Since 2015, the implementation of the "double randomization + public disclosure" regulatory model has curbed local protectionism to some extent.

6.3. Management tools

First, prior to 2013, the Chinese government had paid more attention to processing-stage supervision and ex-post punishment, and had few tools for ex-ante prevention [77]. A large number of ex-ante prevention and management tools emerged after 2013. For example, registration and filing systems were implemented for small food production and processing workshops, small food stores, and food stalls. Food industry clusters have been established to promote the clustered development and regulation of enterprises. Food fraud vulnerability assessments have been encouraged for the food industry.

Second, new processing-stage supervision tools continued to emerge after 2013. Since 2015, the "double randomization" regulatory model has been fully implemented to circumvent the issue that special rectification movements and regular sampling inspections may interfere with the normal production and operation of enterprises [78]. The implementation of unannounced inspections and system inspections began to be explored in March 2016 on the basis of improving the daily supervision and inspection of corporate food production and distribution activities. The consumer reporting system has been established and improved, thus expanding the sources of information for government regulation. As of the end of 2016, all provinces, autonomous regions, and municipalities directly under the central government in mainland China had launched a reward-based reporting system for food safety violations and a personal confidentiality system. In 2017, the construction of the national 12,315 Internet platform was officially launched, which has greatly facilitated public reporting. Moreover, a food traceability system has been established that integrates ex-ante prevention, processing-stage supervision, and ex-post punishment functions. Despite its limitations, traceability still plays a crucial role in addressing food fraud [79].

Third, prior to 2012, ex-post punishment of food fraud in China was limited to penalties imposed by the government. In 2013, an interconnected information disclosure system for food safety regulation and sampling inspection was established. In this way, an institutional system was formed that integrates the production, classification, disclosure, dissemination and feedback of food safety information throughout the supply chain, thereby improving the reputation mechanism of the food market [80].

7. Discussion

The terms "comparative" and "historical" mean that CHA must be based on at least two dimensions [22,23]. First, in the time dimension, CHA is used to investigate social problems that occurred in the past and may be ongoing, as well as solve current social problems through historical comparisons. Second, in the spatial dimension, CHA can be used to determine the differences and similarities in the occurrence and development of social problems by comparative analysis of the same social problems in different countries or regions. Table 1 summarizes the characteristics, causes, and management tools of food fraud in China at different stages, thus revealing the evolution of food fraud in the time dimension. Considering the evolution of food fraud in Western countries in the spatial dimension, the following conclusions are drawn.

7.1. Similarities in food fraud between China and Western countries

Similarities and differences in food fraud between China and Western countries are also analyzed from the three perspectives of basic characteristics, causes, and management tools.

7.1.1. Similarities in the basic characteristics of food fraud

Firstly, the level of food fraud increased with the development of the food market. In both China and Western countries, although food fraud has long existed, it occurred in small numbers and on a small scale for a long time. However, with the rapid development of the market economy and increasingly fierce competition in the food market, instances of food fraud have become more prevalent [81]. Secondly, the primary form of food fraud has shifted from physical adulteration to chemical adulteration, although physical

Table 1
Characteristics, causes, and management tools of food fraud at different stages.

		1949–1978		1979–1992	1993–2012	2013–2022
		1949–1956	1957–1978			
Characteristics	Food types	Luxury or special-purpose foods	Rare occurrence of food fraud	Daily-consumed food products	Daily-consumed food products	Daily-consumed food products
	Forms of fraud	Mainly physical adulteration	–	Mainly chemical adulteration	Mainly chemical adulteration	Mainly physical adulteration
	Perpetrators	A small number of criminals	–	Individual and private businesses and collectively-owned and state-owned enterprises	Large-scale and group-based perpetrators	More covert and advanced methods used for food fraud
	Hazards	Great	–	Great and mainly direct hazards	Mainly potential hazards	Relatively controllable health hazards
	Location	Occurring almost exclusively in urban areas	–	Mainly in urban areas	Mainly in rural areas	Small differences between urban and rural areas and cross-regional characteristics
Causes	Food market	Highly chaotic food market	Food market being banned	Rebuilding the food market	Intensifying competition in the food market	Sluggish food consumption market
	Regulatory model	Regulatory model focusing on hygiene management	–	Regulatory model focusing on hygiene management	Fragmented model of segmented regulation by multiple agencies	New reforms not yet complete
	Local government	–	–	Emergence of local protectionism	Increasing local protectionism	Spatial fragmentation under management by local government
Management tools	Ex-ante prevention	–	–	Ideological education, enterprise registration	Raising barriers to market entry	Registration and filing systems, clustered development of the food industry, vulnerability assessment tools
	Processing-stage supervision	–	–	Surprise inspections	Special rectification movements and regular sampling inspections	Double-random sampling inspection, system inspection, unannounced inspection, traceability system, and public reporting, etc.
	Ex-post punishment"	–	–	Start exploring administrative and criminal penalties	Increased severity of administrative penalties and improvement of criminal penalty regulations	Adhere to administrative and criminal penalties while improving the reputation penalty mechanism

adulteration still occurs occasionally. Correspondingly, health hazards were small, then great, and then small again. The reason for this change is that when the chemical industry was underdeveloped, food fraud mainly occurred in the form of physical adulteration, which posed relatively small health hazards. Subsequently, chemical adulteration, which is more harmful, began to increase with the development of the food chemical industry and the emergence of a large number of industrial chemicals. Later, with the increase in management efforts, especially the improvement of testing methods and systems, food fraud shifted again from chemical adulteration to physical adulteration as the latter once again became easier than the former, with the unintentional side effect of food fraud shifting from causing more health harm to less harm. Third and lastly, economic development often started in urban areas, then extended to rural areas, and finally achieved urban and rural integration. In this process, food fraud was almost spatially synchronized with regional economic development, showing a shift from urban to rural and to both rural and urban areas.

7.1.2. Similarities in the causes of food fraud

Food fraud arises with the development of a market economy and evolves with market changes [32]. The market origin explains not only why food fraud begins to increase during the establishment of market economies, but also why food fraud tends to increase during economic downturns. In addition, every country has an inherent and urgent need to ensure food safety, and has to constantly adjust and improve its food safety regulation model according to the latest situation of food fraud. However, the reform and improvement of the food safety regulation model often lag behind changes of fraudulent actors. This is a common cause of the persistence of food fraud worldwide.

7.1.3. Similarities in food fraud management tools

In both China and Western countries, legal, inspection, and testing tools are important in combating food fraud. Western countries were committed to combating food fraud through legal means as early as in ancient Greece and Rome [82]. During the period of free capitalism from 1760 to 1850, the UK believed that the market would naturally eliminate perpetrators of food fraud. However, the market failed to punish such perpetrators, but instead enabled them to commit greater and more widespread fraud. The UK government finally returned to using legal means to combat food fraud. The UK introduced the *Preventing the Adulteration of Articles of Food or Drink Act* in 1860, and it was revised by the *Adulteration of Food and Drugs Act 1872* [6].

In the context of China, the rule of law was weak in 1949–1978. Only in 1997 was the rule of law finally established as the basic strategy for governing the country. Nevertheless, China then also embarked on the path of combating food fraud by legislation. For example, in 1985, the Supreme People's Court and the Supreme People's Procuratorate had classified food fraud as a "speculation crime" that disrupted the market Since then, the Chinese government has gradually improved the classification of the crime of food fraud to make it a serious offence in its own right.

In addition, Western countries attach great importance to food inspection and testing. In almost every period, Western countries were the first to apply the most advanced testing techniques to detect food fraud. China also regards inspection and testing as an important tool in combating food fraud. Specifically, a system of food safety inspection and testing agencies has been established at the central, provincial, municipal, and county levels. A complete sampling inspection system has also been constructed.

7.2. Differences in food fraud between China and Western countries

Because of the great differences in dietary habits and cultures between China and Western countries, there are obvious differences in the types of foods involved in fraud. The food fraud discussed in this study mainly refers to food adulteration aimed at pursuing economic benefits, also known as economically motivated adulteration. In modern Western countries, the economic operation system has always been a market economy. Therefore, objectively, there has always been a micro-foundation for enterprises to commit fraud in pursuit of economic interests. However, a planned economy was implemented in China from 1956 to 1978. Under the planned economy, enterprises no longer pursue economic benefits. There was no market and therefore almost no food fraud during this historical period. After 1979, with the development of the commodity economy and the gradual establishment and improvement of a market economy, food fraud reappeared in China and showed an evolutionary pattern similar to that of Western countries.

In addition, similarities exist in the regulatory models between China and Western countries. For example, both initially had fragmented approaches to food safety regulation [83,84]. However, some obvious differences also exist due to different national conditions. For example, in terms of the division of regulatory powers between the central and local governments, Western countries mainly use vertical regulation by the central government. In contrast, management by local governments has been implemented in China. This has led to differences in law enforcement awareness and capabilities among China's local governments, and some of them even adopted protectionism for food fraud, thus creating a breeding ground for food fraud. This is not an issue in Western countries. In terms of management tools, Western countries have attached great importance to food fraud vulnerability assessment tools in recent years. Meanwhile, China has innovatively developed many tools with Chinese characteristics, such as double-random inspections, unannounced inspections, and system inspections. However, China has also been actively exploring the application of food fraud vulnerability assessment tools in recent years. Oversight has generally improved with time, resulting in fewer major incidents but more frequent small incidents.

8. Conclusion

Research has revealed that as long as a market economy exists, food fraud cannot be completely eliminated unless China adopts a planned economy as it did from 1956 to 1978. Moreover, with the development of the economy and society, patterns in the types,

hazards, and geographic spread of food fraud have emerged. At the same time, governance tools for food fraud are continually being refined and improved, with policy and technology playing pivotal roles. These findings suggest that food fraud has persisted in almost every country at any given time, albeit with varying intensity. The future evolution and development of food fraud are predictable, and new tools for controlling food fraud will continue to emerge in the future. History does not simply repeat itself, but rather, it informs the future. Therefore, we recommend that countries worldwide examine the evolution of their own food fraud history and the governance tools used to combat it, thereby drawing lessons from historical experiences. It is also crucial to learn from the past experiences of other countries.

This study not only provides valuable historical insights for future food fraud management in China, but also provides a reference Chinese approach for other developing countries in understanding and addressing food fraud. However, there are obvious limitations in this study. For example, due to the lack of data, it is impossible to fully describe all characteristics and underlying causes of food fraud in China at different historical stages. It is also impossible to fully capture the common features of food fraud between China and Western countries due to the different food consumption cultures and different types and forms of food fraud. In addition, the causes of food fraud are highly complex. However, this study only focused on the market, regulatory model, and local government, and may have missed other important causes.

Data availability statement

No data was used for the research described in the article.

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CRediT authorship contribution statement

Liangyun Niu: Writing – review & editing, Writing – original draft, Conceptualization. **Di Sha:** Writing – review & editing. **Ke Qin:** Writing – review & editing. **Linhai Wu:** Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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