

Article

# Barriers to Sustainable Food Trade: China's Exports Food Rejected by the U.S. Food and Drug Administration 2011–2017

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**Abstract:** Food export rejection can be a harmful barrier to sustainable international food trade. To understand China's export food rejected by FDA (Food and Drug Administration) of the United States, we analyzed 4047 cases of rejection from February 2011 to July 2017. Although the number of rejected food exported from China to the United States has been declining, and the quality has been improving, there is still space for improvement. Of the 4047 cases of rejection, the Guangdong, Fujian and Shandong provinces were the top three with the largest number of rejected food (1253 (31%), 520 (12.8%), and 508 (12.6%), respectively) (being rejected mainly in New York and Los Angeles). The top four types of rejected food involved fruits and vegetables, fishery and seafood products, bakery products, grain and related processed products. More importantly, the major reasons for rejection can be attributed to problems in maintaining food safety, namely: (1) the food contained filth, decay, decomposition or other substances; (2), the food contained toxic and harmful substances (e.g., suspected melamine, chemical insecticides, or lead); and (3) the food contained agricultural and veterinary drugs. The results are of great implications for the United States to regulate the imported food from China, and for China to improve the quality and safety of export food.

**Keywords:** sustainable food trade; food safety; export rejection; China; U.S. FDA

## 1. Introduction

The food trade of China has developed rapidly since China joined the World Trade Organization (WTO) in 2001. The United Nation (UN) Comtrade Database shows that China's food export trade volume increased from \$14.210 billion to \$66.132 billion in 2001 to 2016. China has become one of the major food exporters in the world. However, a series of food safety incidents occurred with the development of China's economy and the transformation of society. There were 99,487 illnesses and 870 deaths found in 2387 incidents of acute foodborne illness which published in various professional Chinese journals from 1999 to early 2010 [1]. Food safety incidents not only threaten the health and life safety of the all people but also damage the image of a nation in the food export trade severely.

The United States (U.S.), the European Union, and Japan are the major trading countries and regions of China's export food. According to the report of the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, the United States, the European Union, and Japan have made 340, 228, and 119 Technical Barriers to Trade (TBT) notifications, 184, 245, and 109 sanitary and phytosanitary measure (SPS) notifications, respectively since 2001. An important reason why China's export food has been frequently rejected is the strict food safety standards in developed countries [2–6]). However, food safety standards are also a good

opportunity for developing countries to improve their export food quality, market maturity, trade competitiveness, and export performance [7,8]. Some scholars analyzed the obstacles to China's food export to different countries. Yamada and Sui identified the causes associated with the rejection of Chinese frozen vegetables [9]. Mori et al. analyzed the underlying reasons for port rejections of live and processed eels imported from China to Japan by using publicly available data [10]. Using the information on rejections with Chinese firm-level export data, Beestermöller et al. examined the impact of European borders inspections on agri-food exports [11]. Some scholars also analyzed the import refusal data of the U.S. [12,13], but there are relatively few studies aimed at the Chinese export food rejection from the United States, especially long-term studies involving large volumes of data. By comparing the data of rejection for China's food exporting to the U.S., European Union, Japan, South Korea, and others, the most frequent cases occurred in the United States [14]. Therefore, it is necessary to make a systematic study to analyze the data of rejected food which export from China to the U.S.

Food and Drug Administration (FDA) of the United States is the highest authority responsible for the safety of most domestic and imported food. Eighty percent of the U.S. food is supervised by it, and all food export to the United States must be notified specifically to FDA before entering the country [15]. Public Health Security and Bio-terrorism Preparedness and Responses Act of 2002 provides that all imported products must be registered in FDA and reported to FDA and customs. The main regulatory responsibilities of FDA involves the following aspects: to analyze the food composition, to test for the agricultural residues, microorganisms and various toxins, to check the packaging and label identification, to confirm whether the canned food and carbonated drinks with special requirements have the Food Canning Establishment (FCE) and Submission Identifier (SID), etc. Once the food fails to meet the requirements of FDA, it will be rejected.

With such practical importance, a comprehensive analysis of China's exports food rejected by the U.S. FDA is needed, in order to illuminate the systemic trends and situation of rejection. Note that the toxic (or the like) problems also come from other parts of the whole food system. This study, as usual studies do, focuses only on a specific and meaningful part (i.e., export) of those parts. The remaining sections of this paper are arranged as follows: Section 2 introduces the data source and method. Section 3 shows the research results and discussions. Sections 4 and 5 demonstrate the further discussions and conclusions.

## 2. Materials and Methods

### 2.1. Data Source

We collected data on the largest website of China's food industry named "Foodmate" (<http://www.foodmate.net/>). This website is equipped with an import and export information query system under the professional food safety database module, the system discloses and updates all kinds of import and export food safety data of China. It contains more than 6000 detailed cases about FDA of the U.S. rejecting imported food from China since January 2007. The data on Foodmate comes from the U.S. FDA (<https://www.accessdata.fda.gov/scripts/importrefusals/>) and all the data we collected and used are consistent with the data released by FDA. Due to missing data during the period from January 2007 to January 2011, it is difficult for us to achieve a coherent and effective sample. Therefore, this paper mainly analyzes the data from February 2011 to July 2017. We obtained a total of 4047 valid cases, excluding medicines, nonfood, pet food and unidentified food. The sample has a large size and a long-time span, and also involves a wide range of food categories.

### 2.2. Method

The method used in this paper is content analysis. Content analysis is a scientific method for an objective, systematic, and quantitative description of the manifest content to communication [16]. Furthermore, it was extended to analyze the content of empirical documentation and widely used in

social science [17–19]. First, we used coding to classify the key features of these cases systematically, Table 1 is the coding table. Second, we formed a dataset by extracting information corresponding to the following categories from each individual case-year and month, export provinces of China, jurisdiction area of the U.S. FDA, food categories and reason for rejection. Third, we used the Excel and Tableau software [20] to analyze the coded cases in the dataset.

**Table 1.** Coding Table of Rejected Cases.

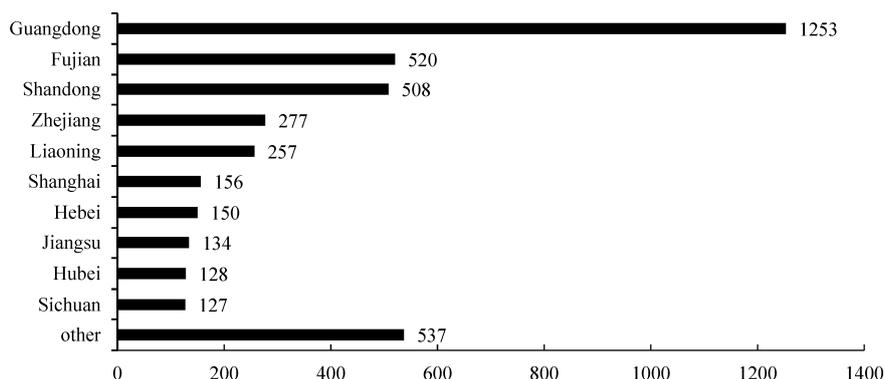
Categories	Classification
Time frame	February 2011–July 2017
Export provinces of China	23 provinces, 4 province-level municipalities, 5 autonomous regions and 2 special administrative regions in China
Jurisdiction area of the U.S FDA	New York, Los Angeles, San Francisco, Seattle, Chicago, Baltimore, New Orleans, Atlanta, Detroit, Philadelphia, Minneapolis, Cincinnati and other cities
Food categories	Fruits and vegetables, Fishery and seafood products, Bakery products, Grain and grain products, Flavorings, Candy/sweeteners/cocoa/chocolate/chocolate products, Frozen drinks/beverages/ liquor, Meat and meat products, Milk and dairy products and other
Reason for rejection	The food contained filth, decay, decomposition or other substances; The food contained toxic and harmful substances; The food contained agricultural and veterinary drugs; the food contained unsafe additives; Food label problems; Unfiled production and processing technology; Not providing information in accordance with the provisions; Unregistered; Hygienic problem; Bacteria exceed thresholds; Food adulteration; The food contained antibiotic; Other

### 3. Results and Discussions

#### 3.1. Spatial Distribution

##### 3.1.1. Export Provinces of China

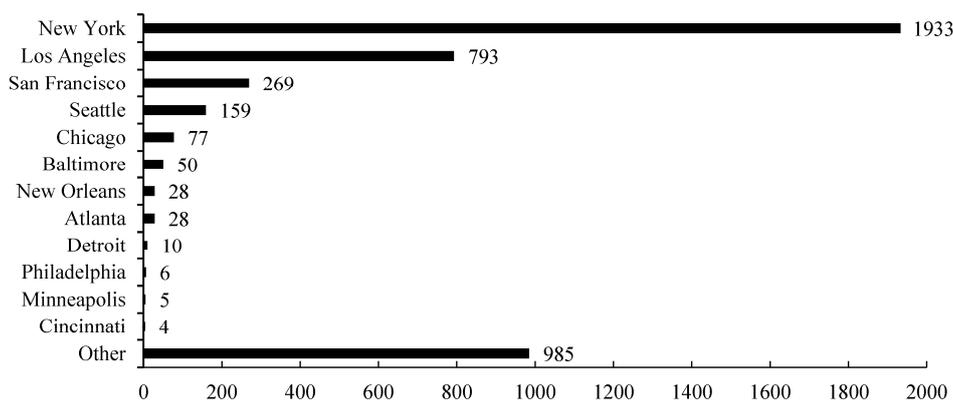
The 29 provinces (autonomous regions and province-level municipalities) of China are the main origin of the export food rejected by the FDA of the U.S. Figure 1 shows that eight of the top ten rejected provinces are distributed in economically developed coastal areas of southeast China and rejected number accounts for more than 80 percent of the total sample. Further, the rejected number of Guangdong, Fujian, and Shandong provinces are the top three (2281 cases), accounting for 56.36% of the total, especially Guangdong province which occupied 30.96% of the total rejected number. It is worth noting that Shandong has been the main food exporting province for many years in China, but the rejected number is relatively low comparing with Guangdong and Fujian provinces. This is presumably due to the factory inspection and quarantine officer system that has been implemented by Shandong province in key food export enterprises. (Factory inspection and quarantine officer system: food inspection and quarantine personnel should visit the frontline of food export enterprises, production bases, and processing sites. They implement the full supervision to food enterprises with every stage of food production and processing and timely find out and solve problems in the regulatory process. It is quite different from the past which only supervises and inspect the final production of export enterprises.) Through this system, the related enterprises might improve the ability to deal with foreign trade technical barriers and to reduce the risk of food rejection [14].



**Figure 1.** The main origin of the Chinese export food rejected by Food and Drug Administration of the United States (FDA of the U.S.).

### 3.1.2. Jurisdiction Area of the U.S. FDA

As jurisdiction area of FDA coding of a few refusal cases in the original dataset are missing, unidentifiable and fuzzy, we analyzed the refusal data that can be identified the city name of the U.S. and classified the rest to “other” group. Figure 2 shows that China’s food exported to the U.S. were mainly rejected in New York and Los Angeles and the total refusal number of these two cities was 2726 (67.36%), New York ranked the first in terms of the refusal number.



**Figure 2.** The main refusal jurisdiction area of FDA in the U.S.

### 3.2. Refused Food Categories

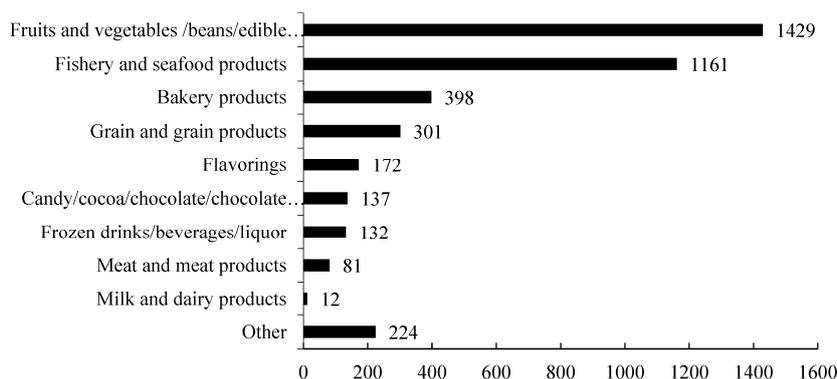
On the basis of the China food classification system (GB2760-2011), the food is divided into sixteen categories: milk and dairy products, oil/fat/fat products, frozen drinks, fruits and vegetables/beans/edible fungi/algae/nuts and seeds/candy/cocoa/chocolate/chocolate products, grain and grain products, bakery products, meat and meat products, fishery and seafood products, eggs and egg products, sweeteners(including honey), flavorings, special nutritional supplements, beverages, liquor, and other. According to statistical results of the sample and the approximation of food classification, we eventually adopted 11 categories, including three new ones (Figure 3). Among the new categories, we mix frozen drinks, beverages, liquor together, and mix candy/cocoa/chocolate/chocolate products, sweeteners (including honey) together, and mix oil/fat/fat products, special nutritional supplements and other together, and get rid of eggs and egg products (Special statement: FSIS (Food Safety and Inspection Service) and APHIS (Animal and Plant Health Inspection Service) of USDA (United States Department of Agriculture) are in charge of the meat and poultry, eggs and egg products supervision. Therefore, the classifications of Chinese export food refused in U.S. FDA do not include eggs and egg products.). After reclassification, we can see

that the top four groups of Chinese refusal food involved fruits and vegetables (1429 cases (35.3%)), fishery and seafood products (1161 cases (28.7%)), bakery products (398 cases (9.8%)), and grain and grain products (301 cases (7.4%)). These four types of food form over 81 percent of all refusal cases. The further analyses and statistical results about the top four types of refusal food are shown in Table 2.

Table 2 illustrates the top four types of refusal food in detail. Of these, the most of refused food were the fruits and vegetables (including beans, edible fungi, algae, and nuts and seeds) (1429(35.3%)). As for vegetables, the total refusal number achieves 497 times, 72 were spinach and its products, 58 were agaric, others were pepper and its products, bamboo shoots, leaf mustard, radish and its products, and so on. As for fruits, the total refusal number achieves 399 times, 92 were jujube and its products, and others were oranges, pear, raisins, strawberry and its products, and so on. In addition, the refusal number of edible fungi, bean products, and nuts and seeds were 388, 101, and 44. The second largest number of refused foods were fishery and seafood products. Out of 1161 (28.7%) refusal cases, 592 were fresh aquatic products, 347 were frozen aquatic products, 135 were pre & cooked aquatic products, 30 were canned aquatic product, and 57 were other aquatic products, the refusal frequency of tilapia and frozen tilapia were much higher. The third and fourth largest number of refused food were bakery products and grain and grain products.

**Table 2.** Top four types of refusal food statistical results.

Classification	Subdivision	Food with the Highest Refusal Frequency	Origins/Provinces	Jurisdiction Area of FDA
Fruits and vegetables (1429(35.3%))	Vegetables(497)	Spinach and its products(72), Agaric(58), Pepper and its products(55), Bamboo shoots(32), Leaf mustard(29), Radish and its products(29)	Shandong(109) Guangdong(106) Fujian(56)	New York(243) Los Angeles(115)
	Fruits(399)	Jujube and its products(92), Oranges(31), Pear(31), Raisins(27), Strawberry and its products(27)	Guangdong(124) Shandong(65) Hebei(49)	New York(185) Los Angeles(77) San Francisco(47)
	Edible fungi(388)	Mushrooms and its products(311)	Fujian(106) Zhejiang(66) Guangdong(50)	New York(170) Los Angeles(65)
	Bean products(101)	—	Guangdong(39)	New York(73)
	Nuts and seeds(44)	Peanuts(21)	—	New York(32)
Fishery and seafood products (1161(28.7%))	Fresh aquatic products(592)	Tilapia(131), Shrimp(81), Squid(64), Pectinid(45), Yellow croaker(28), Catfish(28)	Guangdong(128) Liaoning(102) Shandong(88)	New York(159) Los Angeles(129)
	Frozen aquatic products(347)	Frozen tilapia (film)(66),Frozen Punetaus (film)(39), Frozen bread shrimp(22)	Guangdong(78) Liaoning(62) Fujian(53)	Los Angeles(99) New York(74)
	Pre & cooked aquatic products(135)	(Imitation) crab meat and its products(27)	Guangdong(42)	New York(56)
	Canned aquatic products(30)	Mackerel can(12)	Shandong(17)	—
	Other aquatic products(57)	—	—	—
Bakery products (398(9.8%))	Bread(26)	—	Guangdong(14)	New York(25)
	Pastry(60)	Cake(31)	Guangdong(45)	New York(55)
	Biscuits(277)	—	Guangdong(207)	New York(240)
	Other bakery products(35)	—	—	—
Grain and grain products (301(7.4%))	—	Noodles(57), Rice flour(40)	Guangdong(102)	New York(205)



**Figure 3.** Classifications of Chinese refusal food (Meat and meat products in Figure 3 do not include poultry and poultry products and meat and meat products which defined in “Federal Meat Inspection Act” and “Federal Poultry Products Inspection Act”. According to the acts above, meat refers to cattle, sheep, pigs, goats, horses, mules, or other equine animals. Meat products refer to all or part of the products that are available for human use from the meat of cattle, sheep, pig, goat, or other carcasses, except for special cases. Poultry refers to live or dead domesticated poultry or birds. Poultry products refer to any food made from poultry carcasses or its partitions, whole or part of poultry carcasses, except for special cases.).

We also made a further analysis of detailed food categories of refused cases for the top three origins/provinces, just as shown in Table 3.

**Table 3.** Detailed food categories of refused cases for the top three origins/provinces.

Origins/Provinces	Classification	Subdivision	Food with the Highest Refusal Frequency
Guangdong (1253(31%))	1. Fruits and vegetables (including beans, edible fungi, algae, nuts and seeds)(329)	Fruits(124)	Jujube and its products(34), Plums and products(13), Oranges and products(10)
		Vegetables(106)	Agaricand products(20)
		Edible fungi(50)	Mushrooms and its products(43)
		Bean products(39)	Tofu and related products(28)
		Nuts and seeds(10)	—
	2. Bakery products(285)	—	Biscuits(207)
		Fresh aquatic products(128)	Tilapia(50), Shrimp(29)
	3. Fishery and seafood products(266)	Frozen aquatic products(78)	Frozen tilapia (film)(33)
		Pre & cooked aquatic products(42)	—
		Canned aquatic products(2)	—
Other aquatic products(16)		—	
Edible fungi(106)		Mushrooms and its products(86)	
Fujian 520 (12.8%)	1. Fruits and vegetables (including beans, edible fungi, algae, nuts and seeds)(212)	Vegetables(56)	—
		Fruits(26)	—
		Bean products(17)	Tofu and related products(10)
		Nuts and seeds(7)	—
		Frozen aquatic products(53)	Frozen tilapia (film)(10), Frozen Eel(10)
	2. Fishery and seafood products(142)	Fresh aquatic products(50)	Yellow croaker(14)
		Pre & cooked aquatic products(17)	—
		Canned aquatic products(8)	—
		Other aquatic products(14)	—
		3. Grain and grain products(55)	—

Table 3. Cont.

Origins/Provinces	Classification	Subdivision	Food with the Highest Refusal Frequency
Shandong 508 (12.6%)	1. Fruits and vegetables (including beans, edible fungi, algae, nuts and seeds)(223)	Vegetables(109)	Spinach and its products(37), Ginger and its products(19), Pepper and its products(18)
		Fruits(65)	Strawberry and its products(21)
		Edible fungi(36)	—
		Bean products(6)	—
		Nuts and seeds(6)	—
	2. Fishery and seafood products(179)	Fresh aquatic products(88)	Squid(29)
		Frozen aquatic products(45)	—
		Pre & cooked aquatic products(27)	(Imitation) crab meat and its products(9)
		Canned aquatic products(17)	—
		Other aquatic products(2)	—

It can be seen that fruits and vegetables, fishery and seafood products, bakery products, and grain and grain products account for the largest number of refusals. Of these four types of food, the vegetables from Shandong, Guangdong, and Fujian province, the fruits from Guangdong, Shandong, and Hebei province, the fresh aquatic products and frozen aquatic products from Fujian, Zhejiang, and Guangdong province, the bakery product and grain and its products from Guangdong province were the food with the highest refusal frequency. Most of these were rejected in New York and Los Angeles.

### 3.3. Food Safety Factors of Rejection

By analyzing the direct causes of Chinese export food rejected by FDA, we refined the 13 food safety risk factors of the refusal food and made a cross-analysis of the top four groups of Chinese refusal food and the top five refusal reasons. As shown in Figure 4 (The total number of safety factors in this part was more than 4047, because one refusal case may be caused by more than one risk factor.) and Table 4, food contained filth, decay, decomposition, or other substances was the most common risk factor which leads to 1117 refusal cases (27.6%), and there were 491 fishery and seafood products cases and 455 fruits and vegetables (including 188 edible fungi and 110 vegetables) cases caused by it. The food contained toxic and harmful substances (including suspected melamine, chemical insecticides, lead, and so on) was the second most common risk factor, and there were 1097 related refusal cases (27.1%). There were 473 bakery products, especially biscuits cases, that had suspected melamine or other toxic and harmful substances, 144 cases of fruits and vegetables had chemical pesticides and vegetables. The food contained agricultural and veterinary drugs was the third most common risk factor and resulted in 826 refusal cases (20.4%) (We have combined the risk factor of containing pesticides (including illegal pesticides) and containing veterinary drugs (including illegal veterinary drugs) into the food contained agricultural and veterinary.), of these cases, 378 rejection cases occurred in fishery and seafood products with veterinary drugs or illegal veterinary drugs, 312 rejection cases occurred in fruits and vegetables with pesticides or illegal pesticides. The food contained unsafe additives was the fourth most common risk factor, and the related refusal cases frequently occurred in fruits and vegetables especially fruits, fishery and seafood products especially frozen aquatic products and fresh aquatic products. Food label problems, such as incomplete label information, incorrect label information, and so on, were the fifth most common risk factor which occurred in all kinds of refusal food.

In addition, the risk factors of unfiled production and processing technology, not providing information in accordance with the provisions, hygienic problem, and bacteria exceed the standard (salmonella and listeria), food adulteration, the food contained antibiotic or other brought about 902 refusal cases, accounting for 22.29% of the total sample.

**Table 4.** The results of cross-analysis of the top four groups of Chinese refusal food and the top five refusal reasons.

	The Food Contained Filth, Decay, Decomposition or Other Substances (1117(27.6%))	The Food Contained Toxic and Harmful Substances (1097(27.1%))				The Food Contained Agricultural and Veterinary Drugs (826(20.4%))	The Food Contained Unsafe Additives (563(13.9%))	Food Label Problems (523(12.9%))
		Suspected Melamine (454)	Chemical Insecticides (178)	Lead (11)	other (454)			
Fruits and vegetables	455 (Edible fungi 188, Vegetables 110)	7	144 (Vegetables 64)	11	37	312 (Edible fungi 109, Vegetables 103, Fruits 95)	200 (Fruits 155)	145 (Vegetables 75)
Fishery and seafood products	491 (Fresh aquatic products 267, Frozen aquatic and products 163)	—	1	—	25	378 (Fresh aquatic products 235)	166 (Frozen aquatic and products 74, Fresh aquatic products 48)	55
Bakery Products	10	267 (biscuits 193)	7	—	206 (biscuits 155)	—	38	59
Grain and grain products	84	84	3	—	56	23	31	59

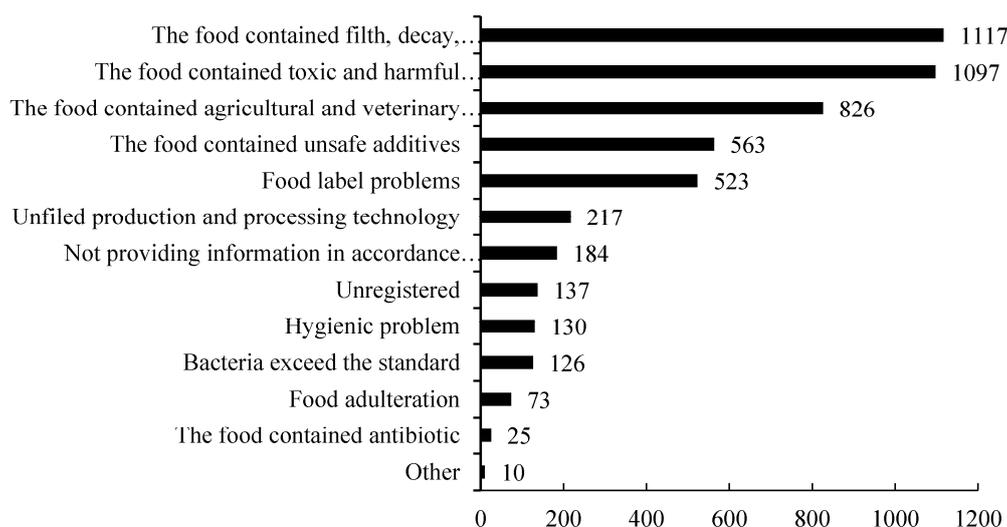


Figure 4. Risk factors for refusal food.

The statistics show that the food contained filth, decay, decomposition or other substances, the food contained suspected melamine, chemical pesticides, lead, and other toxic and harmful substances, the food contained agricultural and veterinary drugs, the food contained unsafe additives, and food label problems were the five common risk factors which caused Chinese exports food rejected by FDA. In fruits and vegetables and fishery and seafood products, there were always risk factors of filth, decay, decomposition or other substances, chemical pesticides and unsafe additives. In bakery products (especially cookies), there were always risk factors of suspected melamine or other toxic and harmful substances. Label problems were the common risk factor for all types of food.

Beyond the general reasons such as unclear or mismatched labeling, one critical reason for rejection of the bakery and grain processing products is Melamine. Melamine may usually be contained in milk products like cream, cheese, condensed milk, etc., all of which are important elements of bakery foods (the grains too). Further information has revealed that Melamine is suspected to be added in those rejected cookies, breads, cakes, etc. Such 'suspicion' (which may not be true) may actually be a technical trade barrier, because the trust in such and related foods has been decreased seriously since the famous event of the 'poison milk'. Recently, European countries and Japan have lifted restrictions on these foods from China, while the U.S. has not. Specifically, Guangdong province is among the largest that export bakery and grain products. Hence, it is more likely that such products from Guangdong were rejected.

So far, Melamine is a necessary item in the list of food quality examination in China. However, current regulation has less clear descriptions about what methods is best to implement a high-quality check for Melamine and lower related risks. We suggest that there should be more comprehensive scientific project and research on the quality checking methods/technologies for Melamine. Also, think tanks, research projects, and practice improvements on regulations for Melamine and similar food issues should be granted with emphasis, in order to provide constant upgrading for food safety related knowledge bases that facilitates successful international food trade.

#### 4. Discussions

Through the analysis of the previous section, we can see that the food safety factors constitute the main reason for China's exports food rejection by the U.S. FDA. We suggest that the food safety issue might mostly come from the imperfection of the Chinese food processing system. From China's angle, the factors leading to food safety concerns are:

- (1) The understanding of US food safety standards by Chinese food export enterprises is insufficient. Many of the Chinese food export enterprises did not fully and duly understand the U.S. laws and regulations, standards, or detailed processes of imported food.
- (2) The quality/safety assurance ability of Chinese food export enterprises is insufficient [21]. Some corporate-level limitations such as financial stress, poor production and processing technology, imperfect inspection and inspection technology, poor hygienic environment, backward equipment and lack of related talents on food safety, etc., may lead to less qualified export food.
- (3) Inadequate government supervision of food safety. On the one hand, there are still many loopholes in China's current export food safety law and regulation system such as: lack of systematization and coordination, and inadequacy of crime deterrent punishment. On the other hand, the food safety regulation system has been segmented before 2013, causing regulatory overlap, vulnerability, and vagueness of the responsibilities in the supervised items of foods.
- (4) The food standard system in China is not perfect. Firstly, the overall level of food standards is relatively low and the coverage is narrow. Secondly, the unity and the coordination of the standard is relatively poor, so there are some problems with the standards, such as duplication, overlapping, contradiction and so on. Thirdly, the food safety standard formulation is time-consuming, and the update and upgrade speed is slow.

For the U.S. side, the following situation may enlarge the gap between China and the U.S. food systems and affect the trading between them:

- (1) The food laws and regulations of the United States are becoming more strict. The U.S. has an efficient legal system of food safety and the seamless supervision of food supply chain from farmland to dining table. The U.S. has formulated and revised at least 30 laws and regulations to safeguard their own domestic food safety since the promulgation of the "Food and Drug Law" and "Meat Inspection Act" in 1906 and 1907. There are seven laws directly related to food safety and also the core of food safety law of America: "Federal Food Drug and Cosmetic Act", "Public Health Service Act", "Federal Meat Inspection Act", "Federal Poultry Products Inspection Act", "Federal Egg Products Inspection Act", "Federal Insecticide, Fungicide, and Rodenticide Act", and "Food Quality Protection Act".
- (2) The food standard system of the United States is becoming more and more stringent. "Federal Food Drug and Cosmetic Act" and relevant laws stipulate that all imported foods must meet the same standard in the United States. The food standards in the U.S. are divided into national standard, industry standard, and enterprise standard. In general, the food safety standards of the U.S. has wide coverage, detailed scope, short cycle of renewal, and very close combination with technical regulations.

Note that future studies are encouraged to look deeper into detailed categories of refused cases for the top three origins/provinces to further investigate if there were any differences in food categories among the top three provinces/origins. Nonetheless, this must be done with a meaningful and integrative guiding framework that incorporate suitable research questions, going beyond the scope of this currently present one. It would also be interesting to see the spatial distribution (i.e., by provinces) of the top refused food categories in order to see issues like perishable productions.

Furthermore, it would be interesting for future studies to link this and similar datasets to the food safety incidence in China to see how food safety incidences may affect the rejection rates of China food export before and after the incidence. The effect of non-tariff barriers including both Technical Barriers to Trade (TBT) and sanitary and phytosanitary measures (SPS) is controversial in international trade. Advocates of non-tariff barriers often emphasize that these standards could reduce the potential health risk of consumers in the importing countries and thus enhance their welfare, which inevitably increase hurdles to export countries, mostly developing countries. This present paper has offered hints about

food safety incidence damaging the image of China in the food export trade. Future studies can follow this path and extend the work to make systematic contribution together.

## 5. Conclusions

1. Sustainable food system involves concerns in both economic and environmental dimensions [22]. China should further improve its food safety laws, regulations, and standard system, in order to match and work well with its partner countries for international trade (e.g., [23]). On the one hand, the advanced experiences of the United States are worth learning and combining with the national conditions of China. On the basis of the newly revised Food safety law of the People's Republic of China, formulating special laws for various classifications of food is necessary. Furthermore, Chinese food export enterprises should be supervised according to classification. Among the Chinese export food rejected by the U.S. FDA, there are differences in different types of food in terms of rejection frequency, export provinces, and degree of food risk. Faced with the contradiction between limited regulatory resources and large regulatory objects, we suggest that the relevant regulatory departments should determine the priority of regulation object and allocate regulatory resources effectively. It can improve the accuracy of supervision by setting reasonable regulatory focus and regulation frequency of food export enterprises to different industries and different regions.
2. Specific laws and regulations system for better governance of the whole food supply chain system is even more critical. Institutions should integrate the existing legal resources, clarify the responsibilities of the legal subjects and increase the punishment for the illegal and criminal behavior of food safety. On the other hand, China should keep track with the food safety standards of developed countries, increase the standard adoption ratio and shorten the standard update cycle. China also should make a thorough investigation of the lagging and missing standards, then formulate a reasonable repair plan and establish a unified standard system as soon as possible. The quality and safety standards and requirements for imported food should be thoroughly understood by Chinese food export enterprises. A large part of China's export food rejected by the U.S. FDA is due to the facts that Chinese food safety standards were not in line with international standards or Chinese food export enterprises did not make a timely adjustment when the food safety standards of the importers were changed. This requires that exporters should make a detailed and careful study of the laws, regulations, food safety standards and other requirements of importers in order to avoid the risk of food export as much as possible.
3. Risk analysis for sound food safety supervision should be strengthened. Risk analysis system is one of the effective governance methods to formulate scientific food safety regulatory measures as it can help improve the safety of food supply chain and reduce the incidence of foodborne disease. Most developed countries have established a perfect food safety risk analysis system. In order to meet the requirements of quality and safety of imported food in developed countries, China should develop more scientific and systematic risk identification, risk management, and risk communication activities of food safety. Specifically, information asymmetry and incomplete early-warning systems restrict the export of Chinese food. So it is necessary to establish and improve China's export food information network communication platform. We can make efforts to minimize the safety risk of export food by collecting, evaluating, publishing, tracking, and feedback on export food safety information.

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