

Analysis the Impact of Pesticide Maximum Residue Limit Standards on Agricultural Product Imports from China to Indonesia

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Abstract

Background: Maximum Residue Limit (MRLs) standards are one of non-tariff measures in the agricultural product international trade adopted by numerous countries. In traditional cognition, all kinds of standards including MRL of pesticides, will cost more to exporter country, which is considered as a trade barrier. In fact, in order to meet the international or foreign standards, in addition to the production cost of manufacturers, it will also provide consumers with useful information about product quality and increase consumers' information.

Material and methods: In order to analyze the trade-effect of MRLs, trade data regarding import value of Indonesian fruit from China in period 2008 to 2018 and data of MRLs for pesticide residues, are used. The empirical strategy used to examine the trade diversion effect of MRLs is based on the gravity model. This model is selected to account for the standard determinants of trade as MRLs will not be the only factor for altering fruit import. A typical gravity dataset from the Institute for Research on the International Economy (CEPII) is used. This data covers Gross Domestic Product (GDP), and distance between Indonesia and China. Furthermore, this study also considers population and exchange rate. Exchange rate is included because it estimated has impact on import value. population are considered to account for the supply and demand side in the global market.

Results: A study of Indonesia and China MRLs has shown that China's MRLs regulations are stricter than Indonesia and empirical results show that MRLs have a positive correlation with trade. It means increasing stringency of Indonesia's MRLs could impede fruit and vegetable import from China, vice versa, if China increases their stringency of MRLs regulation could impede fruit and vegetable import for Indonesia. In addition, Indonesia and China GDP, Indonesia, and China population and distance are statistically significant on fruit import, while on vegetable import China population is not statistically significant to affect vegetable import to Indonesia.

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I. Introduction

At present, the import trend of agricultural products in Indonesia is gradually shifting from bulk commodities to products such as fruits, vegetables, and other products. Fruit imports also play an important role in the import of agricultural products in Indonesia. Since CAFTA was signed in 2002, fruit and vegetable importation to the Indonesia from trade partners has nearly quadrupled. The primary drivers of Indonesia consumer demand include the desire to eat off-season and non-tropical fruit items, promotion of produce-rich diets, and lower prices available from other countries, particularly when supported by favorable terms in trade agreements.

Indonesia Ministry of Agriculture indicates that imported fruit and vegetable to Indonesia since 2015 has continued to increase. In 2015, the volume of import was recorded at 480.528,8 tons, up 9 percent from 2015 at 435.004,1 tons. In the following year, the volume of imported fruit shot up by 39 percent to 1.034.120,80 tons with a value of US \$ 1 billion. Up to 2018 the growth of imported fruit is consistently recorded an increase up to 1.567.547,40. This situation recorded during the last 10 years as the highest volume of fruit and vegetable imports to Indonesia. Indonesian Central Statistics Agency data recorded, the most imported fruit and vegetable comes from China, Australia, Thailand, the United States and Pakistan. Mostly the fruits are fresh longan, fresh orange, mandarin orange including tangerine and fresh and dried satsuma, fresh and dried lemon, pear, grape and apple and mostly the vegetable are broccoli, carrot, cauliflower, cabbage and celery.

On the other hand, increased fruit and vegetable imports are inversely proportional to Indonesian fruit exports. Since 2008, Indonesia's fruit and vegetable export volume are continuously decreased. Declining volume also causes the value of exports to sag. If comparing the realization of the value of exports and imports

of fruit and vegetable, it can be concluded that the trade balance of Indonesian fruit and vegetable commodities recorded a deficit or the value of imports is greater than the value of fruit exports. The value of the deficit is around US \$ 226 million.

One major challenge for Indonesia domestic fruit is to meet consumers demand, however fruit is nature produce so its up on seasonal only. In order to fill consumers demand Indonesian Government imported those fruit from other country. To protect imported fruits from any disease, Indonesia government set many kinds of food safety standards, including the most standard of pesticide and veterinary medicine in products, various food additives and their application, nutrition related labels, etc. Indonesia has applied Maximum Residue Level standards since 1996. The MRL standards apply to domestic vegetables as well as imported vegetables. In short, if vegetables do not meet the standards, they are not allowed to enter the market or cannot be imported in the first place.

II. Material and Methods

The pesticide maximum residue limit standard studied in this article is one of the food safety standards and is the most commonly used standard in food trade, especially agricultural trade. This study conducts a comparative analysis of the food safety standard systems of Indonesia and China, then analyzes the differences in the strictness of Indonesia and China's pesticide MRL standards by calculating the similarity index. Around 15.483 MRL list, 1669 total pesticide and 908 total crop were analyzed for similarity index.

The objective in this study was thus to measure the effect of pesticide residue standards and factors on trade-flows of agricultural product from China to Indonesia using gravity model. Based on the analysis of Indonesia-China fruit trade data and the availability of MRL, this article selects tangerine (080520), grape (080610), apple (080810), pear (080820), and peach (080930), also take 5 kind of vegetable such cauliflower (070410), cabbage (070511), lettuce (070519), carrot (070610), asparagus (070920) as the research object.

Annual data for the time 2008-2018 were used in the analysis. The dependent variable in the panel data is fruits and vegetables imported to Indonesia. The independent variable are similarity index, GDP, population, exchange rate and distance. STATA 15.1 is used to perform regression analysis of the gravity model. Ordinary Least Squares (OLS) and Poisson maximum likelihood (PPML) is used to analyze panel data to estimate how the similarity of MRL standards affects trade.

MRLs Similarity Index

Based on the data characteristics of the selected pesticide MRL standards, to examine Indonesia and china mrl similarity index, this study use Anirudh et al relatively stringent indexes formula:

$$S_{pkt-1}^M = \begin{cases} \frac{MRL_{IDN_{pkt}} - MRL_{CHN_{pkt}}}{MRL_{IDN_{pkt}} + MRL_{CHN_{pkt}}} & (1) \\ 0 \end{cases}$$

$$S_{pkt-1}^X = \begin{cases} \frac{abs(MRL_{IDN_{pkt}} - MRL_{CHN_{pkt}})}{MRL_{IDN_{pkt}} + MRL_{CHN_{pkt}}} & (2) \\ 0 \end{cases}$$

Where $MRL_{IDN_{pkt}}$ is the maximum residue level of pesticide k allowed by Indonesia to remain on product p in year t and $MRL_{CHN_{pkt}}$ is the maximum residue level of pesticide k allowed by China to remain on product p in year t. $S_{pkt-1}^M > 0$ means that for agricultural product p, pesticide k China has a stricter MRL than Indonesia, and $S_{pkt-1}^X > 0$ means that for agricultural product p, Indonesia pesticide k has a stricter MRL than China.

Then, the relative stringency for S_{pkt-1}^M and S_{pkt-1}^X are carry out a simple weighted average according to the types of pesticides specified in product p to obtain the corresponding difference index:

$$S_{pt-1}^M = \frac{1}{K} \sum_{k=1}^K S_{pkt-1}^M \quad (3)$$

$$S_{pt-1}^X = \frac{1}{K} \sum_{k=1}^K S_{pkt-1}^X \quad (4)$$

Among them, K is the total pesticide category specified for product p in MRLs, that is, the number of MRLs items for product p. S_{pt-1}^M and S_{pt-1}^X the value range is [0, 1]. The closer the value is to 1, it means that the Indonesia or China as a whole has stricter control over the MRLs of agricultural products p. Since the difference index uses the total pesticide types to averagely weight the relative strict index, it has a stable characteristic that does not change with the regulation intensity. Using the simple average calculation method avoids certain products from being given higher weights because of more pesticides.

Gravity Model

This study focuses on the impact of Indonesia’s food safety standards on Indonesia’s fruit import, hoping to explore whether Indonesia’s MRL plays a promoting or inhibiting role in Indonesia’s fruit import by using gravity model. This model is successful in estimating bilateral trade flow (Gomez-Herrera, 2013) as it can provide the most robust economic findings Chaney (2013).

Several papers have investigated the appropriate practical forms for the gravity model. Silva and Tenreyro (2006) took the log of dependent and independent variable in a gravity model to verify unbiased estimator under heteroscedasticity exists. Also, Carrère (2006) used a gravity model to find out the appropriate number of dummy variables to identify trade diversion effects. More studies have studied how to analyze panel data using the gravity models (Egger and Pfaffermayr, 2003; Serlenga and Shin, 2007). In addition, Xiong and Beghin (2012) adopted the gravity model to analyze how the MRL standards affect the bilateral food trade between the U.S. and Canada. They concluded that imports to the U.S. are negatively affected by the stringency of MRL standards. The specify gravity model in this study as follows:

$$\ln Y_{ijt} = \beta_0 + \beta_1 S_{pt-1}^M + \beta_2 S_{pt-1}^X + \beta_3 \ln(iGDPt) + \beta_4 \ln(iPOPt) + \beta_5 \ln(cGDPt) + \beta_6 \ln(cPOPt) + \beta_7 \ln(ExchangeRatet) + \beta_8 \ln(DISTic) + \epsilon_{ict} \tag{5}$$

Y_{ijt}: The import value of p product imported from china to Indonesia at time t

S_{pt-1}^M and *S_{pt-1}^X*: The similarity index ;

iGDPt: Indonesia Gross Domestic Product (GDP) at time t;

iPOPt: Indonesia population at time t;

cGDPt: China GDP at time t;

cPOPt: China population at time t;

Exchange Ratet: Exchange rate in USD at time t;

DISTic: Geographic distance between China and Indonesia;

ε_{ict}: Error term

The gravity equation were estimated using the Ordinary Least Square (OLS) and Poisson Pseudo Maximum Likelihood (PPML) for panel data.

III. Result

MRLs Similarity Index

To observe the effects of MRLs toward trade flow, it was necessary first to examine compliance data. Data of Indonesia MRL and China MRL is shown in table 1.

Table 1. Indonesia and China’s MRLs

Total	Indonesia	China
MRLs	5230	10. 253
Pesticide	556	1. 113
Product	333	575

Source: 2021 data processing

Around 15.483 MRL list, 1669 total pesticide and 908 total crop were analyzed for similarity index. As shown from graph all the total amount of china MRL regulation is more strict than Indonesia MRL regulation. It means to export agricultural product from Indonesia to China, Indonesia must pay close attention to china’s strict MRL standards. For Indonesia whose own countries’ MRL standards are not as strict as china’s such as Indonesia, meeting those standards means adding relatively high costs to their products.

In these cases, china’s strict MRL standards become technical barriers to trade for Indonesia. However, for china where the MRL standard already stricter than Indonesia, it means china can comply with Indonesia MRL standards with much lower costs. The lower compliance costs can help keep the price of agricultural product from china is lower than the agricultural product produced in Indonesia.

With the assumption quotation from Ferro et al., 2015 p.74 “if the MRL level is stricter in the exporter country than in the importer country, then the latter’s MRL standards should have no effect on its imports from the exporter country”. Also from Xiong and Beghin, 2014, p.1193 “exporters who have been subject to tougher MRLs in their domestic markets are less likely to experience trade disruption”. Following these quotation this study compares and analyzes the stringency of Indonesia and China standards by calculating the similarity index. The figure for Indonesia and China MRLs similarity index is shown in chart 1 and 2.

Chart 1. *S_{pt-1}^M* in fruits and vegetables

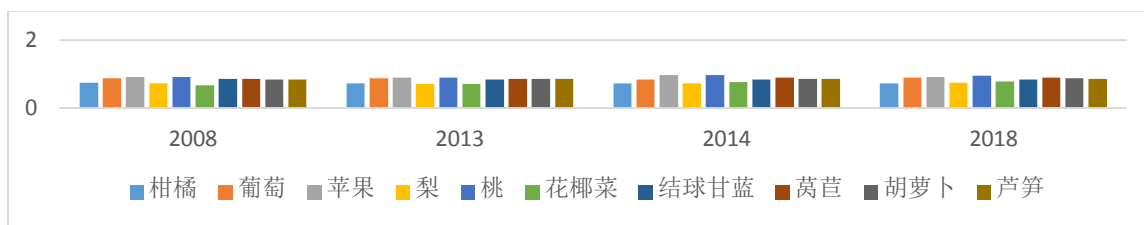
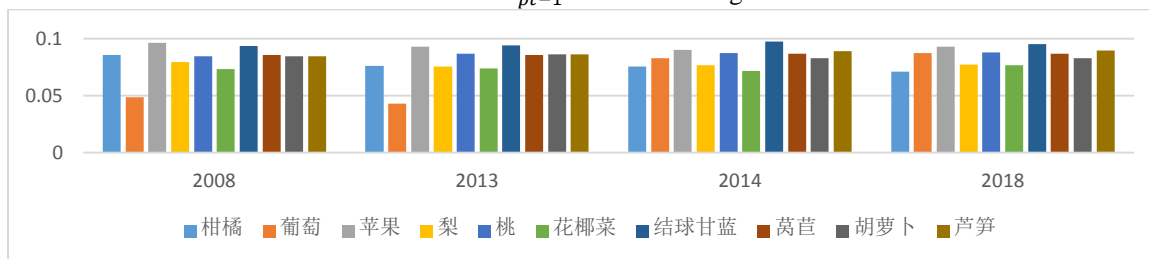


Chart 2. S^X_{pt-1} in fruits and vegetables



It can be seen from the above chart that from 2008 to 2018, There are obvious differences between S^M_{pt-1} and S^X_{pt-1} . The S^M_{pt-1} showed unobvious fluctuation and the value remained around following year. The product that showed an upward trend are grape, pear, and peach, cauliflower, cabbage, lettuce, and carrot, while tangerine, apple, and asparagus showed downward trend. Regarding the similarity index S^X_{pt-1} , except for tangerine and carrot which showed downward trend, the rest all have a fluctuating upward trend.

Gravity Model

Indonesia imports fruit trade from China

Results show seven independent variables, namely S^M_{pt-1} , S^X_{pt-1} , GDP Indonesia, GDP China, population Indonesia, Population China and distance have a statistically significant impact on fruit trade between Indonesia and China. However exchange rate are insignificant.

Table 2. Analysis results of imported fruit from China to Indonesia

Variable	OLS		PPML	
	Coefficient	t	Coefficient	z
S^M_{pt-1}	3.05	(3.32)**	0.0002	(5.46)**
S^X_{pt-1}	-20.59	(-2.28)**	-6.08	(-2.50)**
Indonesia GDP	17.62	(1.72)**	-0.02	(6.16)**
China GDP	3.62	(1.56)**	0.17	(6.10)**
Indonesia Population	5.07	(1.67)***	0.0006	(3.61)***
China Population	0.37	(2.35)***	0.0008	(1.53)**
Exchange Rate	-4.81	(-1.75)	(-0.002)	(-5.45)**
Distance	-13.53	(-2.64)**	-0.004	(-4.59)**
Constant	-25.59	(-1.53)**	-2.06	(-2.78)**
R^2	0.8844		0.8491	

t statistics in parentheses: * = $P < 0.10$; ** = $P < 0.05$; *** = $P < 0.01$

1. Under the OLS and PPML results indicate that the key variable, S^M_{pt-1} show positive sign and statistically significant at 5% significance level. S^M_{pt-1} formula is used when Indonesia's MRL regulation is less strict than China's, which means Indonesia's MRL regulation is higher than china MRL regulation. In this situation, when China's MRLs are stricter than Indonesia's MRLs, China would willingly export fruit to Indonesia's market because to export fruit to Indonesia, China no need pay close attention to Indonesia MRL standards because China's MRL standard are more strict than Indonesia's. For China whose own countries' MRL standards that higher than Indonesia's, meeting those standards means an opportunity to relatively lower costs to their products and could increase the profit margin. To prevent this, Indonesia need to lowered their MRL regulation, because lower MRLs could decrease china's fruit exports as lower MRLs reflect a higher level of stringency. This is because lower MRLs mean that less pesticide residue is allowed to remain in fruit. The coefficient is 3,05 in OLS and 0,0002 on PPML can be explained if Indonesia MRL regulation lowered by 1% means increased the level stringent, then fruit import decreases by 3,05% and 0,0002% based on the estimation

of OLS and PPML respectively. However, when the MRL standards are too strict, they may act as technical barriers to trade because governments may use the MRL standards to limit imports and protect the domestic food industry (Martinez and Thornsbury, 2010). These strict restrictions can generate considerable welfare losses for domestic consumers and merchandise losses for food exporters.

2 . The coefficient of S_{pt-1}^X is found negative and statistically significant at 5% significance level, S_{pt-1}^X formula is used when Indonesia's MRL regulation is more strict than China's, which means Indonesia's MRL regulation is lower than china MRL regulation. In this situation, to export fruit to Indonesia, China must pay close attention to Indonesia's strict MRL standards. For exporters whose own countries' MRL standards are not as strict as Indonesia's, meeting those standards means adding relatively high costs to their products. However, when the costs are too high, some exporters cannot afford to export their products to Indonesia because the profit margin is too narrow. In these cases, Indonesia's strict MRL standards become technical barriers to trade for China. To increase fruit export from China to Indonesia, China need to lower their MRL regulations.

3. The coefficients for Indonesia GDP were positive and highly statistically significant in both estimator at 1% significance level, reflecting the wealth effect of buyers. Suggesting that growth in Indonesia consumption power would be followed by increase in export from China. The coefficient can be interpreted that if Indonesia GDP is increase by 1% then fruit import increase by 17,62% and 0,02% based on the estimation of OLS and PPML respectively.

4. The coefficients for Indonesia population were also positive and statistically significant at 1% significance level in both OLS and PPML, the positive signs on the GDP and population coefficients indicate that a larger market size and higher purchasing power will significantly increase the demand for fresh fruit. The coefficient population have greater influence than GDP because market size can portray demand more accurately than purchasing power, the coefficient of population is 5,07 in OLS and 0,0006 on PPML which means if Indonesia Population increased by 1% then fruit import increase by 5,07% and 0,0006% based on the estimation of OLS and PPML respectively.

5. The coefficient of China GDP is positive and statistically significant at 5% significance level. This positive relationship between an increase in exporter country income and exports may be indicative of domestic economic growth stimulating both greater production to meet increased domestic demand and improved marketing infrastructures which can facilitate exporting.

6. Increased domestic demand and improved marketing infrastructures which can facilitate exporting can supported by the coefficients for population of exporting country, which were positive and statistically significant, it means larger countries being more self-sufficient, however, larger populations in exporting countries might also give rise to scale economies in production and hence with increased exports.

7. The coefficient of exchange rate show a negative sign and statistically un-significant means it is not important factors affecting fruit import.

8. The coefficients of geographic distance were negative and statistically significant is consistent with theoretical of gravity model explaining that greater distance between country tends to increase trade (transportation) costs which turn results in lower opportunities for trade.

Table 3. Analysis results of imported vegetable from China to Indonesia

Variable	OLS		PPML	
	Coefficient	t	Coefficient	z
S_{pt-1}^M	0.06	(5.76)***	0.0002	(12.54)***
S_{pt-1}^X	-2.23	(-3.21)***	-0.07	(-3.94)***
Indonesia GDP	27.38	(6.38)***	0.07	(11.15)***
China GDP	9.19	(3.61)***	0.02	(4.35)***
Indonesia Population	0.19	(3.11)***	0.0005	(5.74)***
China Population	0.02	(0.24)	0.00005	(0.55)
Exchange Rate	-1.65	(-4.07)	-0.004	(-6.17)
Distance	-4.65	(-8.85)***	-0.44	(-16.53)***
Indonesia GDP	-21.24	(-8.17)***	-2.83	(-14.23)***
R^2	0.9497		0.9512	

t statistics in parentheses: * = $P < 0.10$; ** = $P < 0.05$; *** = $P < 0.01$

1. The key explanatory variable S_{pt-1}^M for vegetable import shown the same sign as fruit import its positive sign as expected and statistically significant at 1% significance level. In this situation, when China's MRLs are stricter than Indonesia's MRLs, China would willingly export vegetable to Indonesia's market because to export vegetable to Indonesia, China no need pay close attention to Indonesia MRL standards because China's MRL standard are more strict than Indonesia's. To prevent this, Indonesia need to lowered their MRL regulation, because lower MRLs could decrease china's vegetable exports as lower MRLs reflect a higher level of stringency. This is because lower MRLs mean that less pesticide residue is allowed to remain in vegetable. The coefficient is 0,06 in OLS and 0,0002 on PPML can be explained if Indonesia MRL regulation lowered by 1% means increased the level stringent, then vegetable import decreases by 0,06% and 0,0002% based on the estimation of OLS and PPML respectively.
2. The other key explanatory variable is S_{pt-1}^X , it is also found negative and statistically more significant at 1% significance level. In this situation, to export vegetable to Indonesia, China must pay close attention to Indonesia's strict MRL standards. For exporters whose own countries' MRL standards are not as strict as Indonesia's, meeting those standards means adding relatively high costs to their products. However, when the costs are too high, some exporters cannot afford to export their products to Indonesia because the profit margin is too narrow. In these cases, Indonesia's strict MRL standards become technical barriers to trade for China. To increase fruit export from China to Indonesia, China need to lower their MRL regulations.
3. Results indicate that the signs for Indonesia GDP were positive and highly statistically significant in both estimator at 1% significance level, GDP represents the purchasing power of the importing country in this case its Indonesia and is positively related to vegetable imports from China. The coefficient can be interpreted that if Indonesia GDP is increase by 1% then vegetable import increase by 27,38% and 0,07% based on the estimation of OLS and PPML respectively.
4. Population indicates vegetable demand size for importing country in this case is Indonesia Population. Thus, a larger population raises import. This can be seen from the positive sign of the results in both OLS and PPML. Under OLS shows that a 1% increase in the population of Indonesia raises China's vegetable import by 0,19% with the significance level at 0.1%. Similarly, under PPML estimation shows that a 1% increase in the total population of Indonesia and China as importing countries raises exports by 0.0005%.
5. The sign of China GDP is positive and statistically significant at 1% significance level. This means that the larger the economic size of the exporting country, the stronger their domestic economic growth stimulating both greater production to meet increased domestic demand and improved marketing infrastructures which can facilitate exporting. Under OLS shows that a 1% increase in the GDP of China raises vegetable export by 9,19% with the significance level at 0.1%. Similarly, under PPML estimation shows that a 1% increase in the GDP of China can raises exports by 0.02%. with the significance level at 0,1%.
6. China population indicate the production ability of China as an exporting country. The estimation results of the OLS and PPML consistently show positive signs for this variable. However, it is not statistically significant. The positive sign means that a higher total population of China could increase domestic demand of vegetable. In this situation the national production is not enough to fulfill in domestic consumption with the result China as exporting country prefer to allocate their production for domestic market.
7. The coefficient of exchange rate also show a negative sign and statistically un-significant just like fruit imports.
8. Results indicate that the signs for distance are as usually expected in the gravity model explaining that distance reduces bilateral trade. In other words, the negative sign means the farther the distance the higher the trade cost, which in turn results in lower opportunities for trade. Distance show a significance level at 0.1% in the OLS and PPML.

IV. Conclusion

1. China food safety standard are stricter than Indonesia standards. The number of pesticides and the number of products involved in China pesticide maximum residue limit standards are far more than Indonesia. It can be seen from the comparison of China MRLs and Indonesia MRLs from 2008-2018 that China set more regulation than Indonesia.
2. The differences between china food safety standards and Indonesia standards will hinder the development of bilateral trade. Both the empirical analysis results of china and Indonesia fruit and vegetable trade show that the differences index of pesticide maximum residue limit standards are significantly affected both bilateral trade.
3. For fruit trade the other explanatory variable GDP, Population and distance are also significantly affected bilateral trade between Indonesia and china, while exchange rate is not significantly affected fruit trade. Same for vegetable trade other explanatory are also significantly affected, but surprisingly china

population is not significantly vegetable trade from china to Indonesia.

V. Suggestion

In order to avoid the adverse effect of excessed fruit and vegetable imported to Indonesia, this article has the following enlightenment:

1. Improve Indonesia's standardization level
Through empirical research, this article concludes that less strict the food safety standard means could attracting exporters whose own stricter regulation to export their products to that country because meeting those standards means an opportunity to relatively lower costs to their products and could increase the profit margin. In this situation policy makers should ensure compliance with MRLs according to exporting country regulations. To achieve this compliance, the government of Indonesia needs to actively participate in the WTO which facilitates the notification of new MRL regulations by its member countries. This action is important for building multilateral cooperation to enhance trade including negotiation and harmonization of MRLs. In addition, because most of the imported fruit and some vegetable production are low domestically especially fruit so mostly depend on imported product, the government should improve the national food safety management system so it can respond to the issues promptly.
2. Improve the national food safety standard system and enhance the industry standardization level
The findings of this paper show that china food safety standards are stricter than Indonesia standards. This means, raising the level of industry standards can not only help break trade barriers and promote domestic product exports, but also improve product quality and enhance international competitiveness. Strict standards on the one hand help to build consumer confidence and expand exports; on the other hand, it can also improve the international competitiveness of products and establish a good international image of safe products. In this regard, the industry should continue to strengthen technological innovation and demand itself with stricter standards. At the same time, it is necessary to strengthen industry supervision, formulate flexible and effective supervision policies, strengthen food safety supervision performance evaluation, and ensure that enterprises comply with strict standards for production.

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