RESEARCH ON THE APPROPRIATE RESTRICTION OF HAZARDOUS ELEMENT IN TOYS AND RISK ANALYSIS OF CHEMICAL HAZARDS BASED ON THE CASE OF EU CHILDREN'S GOODS RECALLED

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Abstract

It was explained how the trade issue related to China's export of toys to the EU worked. In this paper, the risk factors for human health associated with unqualified products in terms of chemical hazards were investigated. The recall characteristics of China's toys by the EU "Safety Gate" in terms of recall frequency, notified countries, taken measures, and reasons for recall were analysed. Phthalate, boron, plumbum, and cadmium were discovered to be the primary causes. A risk assessment for boron in toys was done. It is advised to keep the boron element in slime under control; for children aged 3 to 6 years, the limit for boron migration in slime toys should be less than 704 mg/kg, and for children aged 7 to 12 years, it should be less than 1268 mg/kg.

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1. Introduction

The worldwide commerce in toys has been severely impacted by the Brexit, the intensification of the US-China trade war, and the Covid-19 outbreak. Yet because to an increase in exports from developing nations and those included in the Belt and Road Initiative, China is seeing rapid growth in the export of toys. The European Commission routinely introduces Technical Barriers to Trade (TBT) relating to toys to warn, withdraw, recall, and detain noncompliant items as concern for the safety, health, and environmental protection of toys has grown around the world. This paper examined the reasonable threshold of the harmful element boron in order to provide a useful reference for the high-quality development of the toy industry, which has positive significance for the export trade of toy products, using the analysis of the EU recall of China's toy products and chemical risk factors.

2. . The Chinese toy industry's export to Europe

China's toy exports to the EU trade in 2018 varied considerably, and the growth rate slowed down as a result of rising global trade tensions and factors including Brexit. The overall export trade for toys was $5.679 billion, or 22.66% of the total international commerce in toys. The total export trade of China's toy products in 2019 amounted to $7.729 billion, a year-over-year increase of 36.08%, thanks to favourable factors like the EU's economic recovery and the rise in per capita disposable income of residents, as well as buyers ordering earlier shipments out of concern for increased economic frictions and some enterprises shifting to the EU market with outstanding consumption power after the turmoil in the U.S. market. However, as a result of Covid-19, China's toy exports dropped to $5.67 billion in 2020. The Covid-19 continues to be rife in numerous significant EU nations and will have a significant negative influence on China's toy shipments to Europe (de Azevedo et al., 2021).

3. EU safety Gate's analysis of the recall of toy products in China

3.1. Recall Frequency

The EU "Safety Gate" figures state that between 2011 and 2020, a total of 22,120 batches of imported consumer goods were recalled (detained), making up 55.47% of the 12,271 batches of Chinese products that were recalled (detained). Toys account for the most (26.19%) of these recalls (detentions), with a total of 5793 batches. The batches of Chinese toy items that the EU "Safety Gate" recalls (and holds) between 2011 and 2020 demonstrate a shifting, undulating flattening tendency. The number of recalls announced and the number of follow-up actions taken by member states have a tendency to steadily fall over the previous three years in the event that the volume of export commerce of toys from China is gradually reduced (Li et al., 2019).

3.2. Recall Reasons

Three areas of chemical safety, mechanical and physical safety, and combustion safety are the primary causes for the recall of Chinese toys in the EU in 2020 (Rashad & Essa, 2020). The same product is likely to have several risk factors. For instance, a little part of the battery in electric toys, which can cause choking and suffocation as well as other mechanical and physical risks, may harm children's gastrointestinal tracts if placed in their mouths and eaten (Cheng et al., 2014). Chemical leaks from damaged or leaking batteries might provide a risk to human health; plastic components like battery covers may contain phthalates and other chemicals that are hazardous to human health (Podgórska et al., 2021). Soldering materials may include plumbum, cadmium, and other heavy metals that pose a risk from chemical reactions. Children may also be continuously at risk for burn injuries from batteries owing to overheating (Chang et al., 2004). Moreover, the polyimide film used to package electric toys was far too thin, creating choking concerns if it encountered a child's mouth or nose (Wang et al., 2019).

4. Chemical hazard risk factors analysis

Due to chemical safety concerns, the European Union recalled toys made in China 236 times in 2020. These recalls were primarily due to overproof phthalate and other organic dangerous compounds including boron, plumbum, cadmium, and so forth.

4.1. Phthalate

The biggest number of batches—117 batches, or 49.57% of all batches—were recalled because of overproof phthalate. The value of phthalate in plastic components of stuffed toys and plastic toys like DEHP, DBP, DINP, and DIBP significantly exceeds the limit, which may be harmful to infants' and children's genital systems and is in violation of the REACH Regulation, guidelines for toy safety, and EU standard EN 71-1. The EU's phthalate restriction has been getting more and stricter over the years. The EU published (EU) 2018/2005 rule at the end of 2018, increasing the number of limits from three to four (DIBP was added), more stringently limiting to less than 0.1%, and broadening the control area.

4.2. Boron (B)

Slime, for example, has far more boron than is permitted. 74 batches, or 31.36% of all batches, were recalled (detained). Excess Boron breaches the EU's EN71-3 rule and the instructions for toy safety since it can impair children's genitalia and endocrine systems. According to EN71-3, the maximum amount of boron that may migrate through liquid or fluid toys is 300 mg/kg. The detected Boron in the recalled slime toys from China significantly exceeds the limit, which is 1497 mg/kg on average and is around 5 times that of the EU, according to data in the "Safety Gate" warning. As much as 6960 mg/kg of boron migration has been recorded (Vickers, 2017).

4.3. Plumbum (Pb) and cadmium (Cd)

Certain electronic toys' welding materials include excessive amounts of substances that pose a risk to the environment, such as plumbum and cadmium. Plumbum and cadmium may be harmful to the environment and contravene RoHS 2.0 guidelines. 80 batches in all, or 33.90% of all recalled (detained) batches, were recalled or detained. The maximum permitted amount of lead (Pb) and cadmium (Cd) is 0.1% (1000 ppm) and 0.01% (100 ppm), respectively, according to the RoHS 2.0 guideline. The average measured value of plumbum in the recalled electronic toys from China was as high as 63.75%, which is 637 times the permitted limit of plumbum under RoHS 2.0, according to data in the "Safety Gate" notification.

5. Comprehensive Study of Limitations for boron in toys

Due to the significant safe danger posed by boron in slime, ISO/TC181 has begun researching how to set boron limits in slime in the first half of 2020 and is getting ready to update ISO 8124-3 accordingly. The EU has previously set a limit for boron. As the world's largest producer and exporter of toys, China has not imposed any restrictions on the boron content of pertinent materials in GB6675.4. As a result, there is no basis for monitoring the import and export of pertinent toys into and out of China, which makes it difficult to monitor the risks associated with toys. According to the EU RIVM report 320003001/2008 General Method for Safety Evaluation of Chemicals in Toys (hereinafter referred to as the "RIVM Report") and the Manual of Exposure Parameters for Chinese People (Children's Volume) (Hussain, 2009; Van Engelen et al., 2009), the limits of boron in Slime are set to provide a technical basis for market supervision, port supervision, and regularity enforcement.

Exposure dose per day

By using slime, children run the risk of ingesting boron. Moreover, the EU RIVM Report establishes the product age range for viscous material (also known as slime in EU standards) as (Duan, 2015). Nevertheless, according to studies for domestic major manufacturers, domestic Slime is typically given to children beyond the age of 3, thus that age range should be specified for this product.

According to the RIVM report and the Manual of Exposure Parameters for Chinese People (Children's Volume) , Table 1 displays the daily exposure dose for toys that children over the age of three can put in their mouths.

5.2. Limit Setting

1) Formula for calculating limits

The following formula is used to determine the limits of chemicals in the EU RIVM Report 320003001/2008 Generic Procedure for Safety Assessment of Chemicals in Toys (Duan, 2015):

$$10\%\, TDI \times \frac{child\ s\ weight\ (kg)}{daily\ exposure\ dose} = \ elemental\ limit$$

Table 1: Toy items should be exposed to children over the age of 3 daily

Material type	All toy materials
Oral and/or dermal exposure resulting in daily exposure dose/mg/day	400

Table 2: Setting of boron risk ceilings in Chemical goods

applicable product's age	Risk cap in milligrammes per kilogramme (mg/kg)
3 - 6 years old	704
7 - 12 years old	1268

Because kids will consume substances from food, drink, and other sources in addition to toys (Renwick, 1998), the TDI is the Tolerable Daily Intake (TDI) for kids. The WHO also utilises a

technique that multiplies the tolerated concentration of elements in drinking water by a safety factor of 10%, which is typically used to compute compound limits and evaluate the tolerable concentration of components in drinking water (Organization et al., 2004; Sayre, 1988).

2) The concept of placing limits

The typical kid weighs 17.6 kg, the TDI for boron is 0.16 mg/kg/day, and the daily exposure dosage for class II liquid or viscous substance is 400 mg/day. Children range in age from 3 to 6 years. To determine the limit of the boron element, the following data are added to the formula:

$$10\% \times 0.16\, mg\ kg\ \times 17.6\, kg\ \times 0.4g = 0.704\, mg\ g\ =\ 704\, mg\ kg$$

The maximum amount of boron when the youngsters are 7 to 12 years old and their average weight is 31.7 kg is:

$$10\% \times 0.16\, mg\ kg \times 31.7kg\ \times\ 0.4g = 1.268\, mg\ g\ = 1268\, mg\ kg$$

It should be mentioned that the EU determines that toys composed of viscous materials like Slime (i.e., "class II materials") are acceptable for children under the age of three and that the typical kid weighs 7.5 kg. As a result, 300 mg/kg of boron is the maximum allowed in EN71-3. Nevertheless, considering how Slime is made both domestically and internationally, the boron component originates from borax, which is today one of the essential raw components in Slime products. With a limit of 300 mg/kg, most slime products are difficult to manufacture or may not function properly, increasing challenges for Chinese businesses.

Application areas for Chinese toy standard GB 6675.4-2014 Section 4 of the safety of toys: Regardless of age or the appropriate age mark, migration of Particular Components includes perceptible liquid, paste, and gel (such as liquid paint, styling solution). Consequently, the following limit model may be used for risk assessment and combined with China's national circumstances.

For children aged three to six, boron migration in Slime that measured lower than 704 mg/kg can be considered a tolerable risk. For children aged 7 to 12 who tested negative for boron migration in slime, a risk of up to 1268 mg/kg can be considered acceptable (see Table 2 for details).

6. Conclusion

Toys from China were recalled (detained) by the EU 236 times due to chemical safety issues, mostly due to the presence of over-proof phthalate and other organic dangerous compounds including boron, plumbum, cadmium, and so on. Limiting the amount of the boron element in Silme that is exempt from China's toy requirements is advised in light of the industry's affordability: Boron migration in slime toys for children aged 3 to 6 must be kept to a minimum of 704 mg/kg, and for children aged 7 to 12 it must be kept to a minimum of 1268 mg/kg.

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