Food Control 72 (2017) 145–152

Contents lists available at ScienceDirect

Food Control

journal homepage: www.elsevier.com/locate/foodcont

Incidents of major food adulteration in Taiwan between 2011 and 2015

Guan-Jhih Peng, Mei-Hua Chang, Mingchih Fang, Chia-Ding Liao*, Chia-Fen Tsai, Su-Hsiang Tseng, Ya-Min Kao, Hsiu-Kuan Chou, Hwei-Fang Cheng

Food and Drug Administration, Ministry of Health and Welfare, Executive Yuan, 161-2, Kunyang St., Nangang District, Taipei City 11561, Taiwan

ARTICLE INFO

Article history:
Received 24 May 2016
Received in revised form
11 July 2016
Accepted 29 July 2016
Available online 31 July 2016

Keywords:
Adulteration
Plasticizer
Maleic anhydride
Starch maleate
Copper chlorophyll
Dimethyl yellow

ABSTRACT

Global availability and accessibility of food ingredients and the desire to produce food products at lower costs by industry have led to an increase in the incidents of fraud around the world, and Taiwan is no exception. This review outlines the major cases of food adulteration that occurred in Taiwan between 2011 and 2015, including the adulteration of food additives with plasticizers, starch products with maleic anhydride, olive oil with copper chlorophyll, lard with recycled cooking oil, and processed soymilk curd with dimethyl/diethyl yellow. Governmental responses and the analytical methods developed by the Taiwan Food and Drug Administration to address these incidents are also described. These methods were specifically developed to analyze the adulterated ingredients in finished food products. Other analytical methods to detect various adulterants are summarized and compared in this article. In conclusion collective action by regular monitoring along with improved analytical method and regulations will help to minimize adulteration problems in the future.

1. Introduction

Food safety is a global public health issue. Major food hazards include contamination with harmful microbes, pesticide residues, biological toxins, and food adulterants. These adulterations typically occur when (1) deleterious or expired food is mixed with or substituted for another food item, (2) an adulterated food item is purposely mislabeled, or when (3) toxic substances are added to a food item (Nasreen & Ahmed, 2014).

In recent years, various food adulteration or contamination incidents have occurred in many countries around the world. China experienced scandals involving the recovery of gutter oil in 2011 and the addition of melamine to milk powder in 2008, Europe experienced a scandal involving adulteration of beef with horse meat in 2013, and cases of olive oil fraud have also occurred in various countries. These incidents have had an impact both locally and internationally, leading to significant economic losses and concern for human health.

Illegal food adulteration incidents have frequently affected Taiwan as well. Table 1 lists some of the major illegal incidents that involved food safety in Taiwan between 2010 and 2015. Among these incidents, adulterations involving illegal additives were the most frequent. To ensure the safety and quality of food, the Taiwan Food and Drug Administration (TFDA), the central authority for food and drug management in Taiwan, developed official regulations and analytical methods to assess food quality and determine whether food has been adulterated. This article discusses five important food adulteration events that occurred in Taiwan between 2011 and 2015. We also discuss the analytical methods that were used to investigate these incidents.

2. Major food adulteration incidents: Taiwan (2011–2015)

2.1. Adulteration of emulsifiers with plasticizer

Plasticizers are the common names for phthalate esters (PAEs), which are widely used in industrial applications. Phthalates with high molecular weights, such as di-2-ethylhexyl phthalate (DEHP), di-isononyl phthalate (DINP) and di-isodecyl phthalate (DIDP), are used to increase the flexibility and durability of poly(vinyl chloride) (PVC) polymers. Considerable quantities of DEHP and DINP are found in a variety of PVC-related consumer products, including flooring and other building material, food packaging, and medical equipment. Phthalates with low molecular weights, such as diethyl phthalate (DEP) and dibutyl phthalate (DBP), are primarily used as solvents in perfume, cosmetics, or time-release medications (Stanley, Robillard, & Staples, 2003). Since PAEs are not covalently

* Corresponding author.
E-mail address: cdliao@fda.gov.tw (C.-D. Liao).

http://dx.doi.org/10.1016/j.foodcont.2016.07.043
0956-7135/

Abbreviations

TFDA	Taiwan Food and Drug Administration
PAEs	phthalate esters
DEHP	di-2-ethylhexyl phthalate
DINP	di-isononyl phthalate
DIDP	di-isodecyl phthalate
DEP	diethyl phthalate
DBP	dibutyl phthalate
GC/MS	gas chromatography mass spectrometry
LC/MS/MS	liquid chromatography tandem mass spectrometry
BBP	butyl benzyl phthalate
DNOP	di-n-octylphthalate
EPA	Environmental Protection Administration
MOEA	Ministry of Economic Affairs
DOH	Department of Health
SPME	solid-phase microextraction
LOQ	limit of quantitation
DMP	dimethyl phthalate
DIBP	diisobutyl phthalate
GC/FID	gas chromatography flame ionization detector
GC/ECD	gas chromatography electron capture detector
HPLC/UV	high performance liquid chromatography ultraviolet
EFSA	European Food Safety Authority
TDI	tolerable daily intake
SML (T)	total specific migration limit
ADI	acceptable daily intake
JECFA	Joint FAO/WHO Expert Committee on Food Additives
MRL	maximum residue limit
LC/DAD	liquid chromatograph photodiode array detector
CE/LIF	capillary electrophoresis with laser induced fluorescence
LC/MS	liquid chromatography mass spectrometry
TLC	thin-layer chromatography
ICP/MS	inductively coupled plasma/mass spectrometer
IOC	International Olive Council
FTIR	Fourier transform infrared spectroscopy
LF-NMR	low field nuclear magnet resonance
NMR	nuclear magnet resonance
DSC	differential scanning calorimetry
PAH	polycyclic aromatic hydrocarbon

Table 1
Major food safety incidents that occurred in Taiwan between 2010 and 2015.

Year	Incidents	Products affected	Types
2010	Clostridium botulinum contamination of soymilk curd	Soymilk curd	Microbial contamination
2010	Adulteration of black tea with coumarin	Black tea	Addition of illegal additives
2011	Presence of ractopamine and excess antibiotic (doxycycline) in meat from school lunch	Pork, chicken	Illegal use of animal drugs
2011	Adulteration of emulsifiers with plasticizer	Drink, fruit juice powder, yogurt powder, cake, bread	Addition of illegal additives
2011	Falsified expiry labels on snack food material	Chocolate, cake powder	Falsified expiry date
2012	Expired milk powder sold to upstream food company	Milk, Goat milk, flavored milk	Falsified expiry date
2013	Adulteration of starch products with maleic anhydride	Starch products	Addition of illegal additives
2013	Adulteration of edible oils with Cu-chlorophyll	Edible oils	Addition of illegal additives
2014	Presence of antibiotics (florfenicol, doxycycline) and coccidiostat (nicarbazin) in eggs	Eggs	Illegal use of animal drugs
2014	Phosphate used as water retention agent in meat	Pork, beef, lamb	Addition of illegal additives
2014	Sodium dithionite and sodium hypochlorite used as bleaching agents in vegetables	Bean sprouts	Addition of illegal additives
2014	Malachite green contamination of fish	Fish, clam	Illegal use of animal drugs
2014	Adulteration of lard with recycled cooking oil	Lard	Addition of illegal food ingredients
2014	Adulteration of processed soymilk curd with dimethyl yellow and diethyl yellow	Processed soymilk curd	Addition of illegal additives
2015	Addition of sodium hydroxymethanesulfinate in spring roll wrapper	Spring roll wrapper	Addition of illegal additives
2015	Addition of ammonium bicarbonate in soaked agent of kelp	Kelp	Addition of illegal additives
2015	Addition of industrial magnesium carbonate in peppers	Peppers	Addition of illegal additives
2015	Excess pesticide residues in tea leaves	Tea drinks	Excess pesticide residues
2015	Antibiotics (tetracycline) found in honey	Honey	Illegal use of animal drugs

bound to the matrix of a product, they have a high risk of leaching and contaminating the environment (Bosnir et al., 2003; Petersen & Breindahl, 2000).

Previous research determined that exposure to high doses of some types of phthalates can lead to severe changes in the testes of adult male rats (Gangolli, 1982; Gray & Gangolli, 1986). Phthalates have also been shown to induce testicular injuries in other species, such as mice (Heindel, Gulati, Mounce, Russell, & Lamb, 1989; Lamb, Chapin, Teague, Lawton, & Reel, 1987), guinea pigs (Gray, Rowland, Foster, & Gangolli, 1982), and ferrets (Lake, Brantom, Gangolli, Butterworth, & Grasso, 1976). Having observed the toxic effects of PAEs in animals, there is growing concern that these substances could seriously affect human health as well. In one human study, PAEs were found to increase the growth of breast cancer cells *in vitro*. Nonetheless, *in vivo* studies related to phthalate exposure are still limited (Breast Cancer Environ. Res. Centers, 2007).

PAEs that leach from containers or packages and migrate into food are seen as the primary cause of human PAE exposure. In 2005, the European Union restricted certain phthalates in toys and childcare articles (The European Parliament and the Council of the European Union, 2005). In Taiwan, it is illegal to use PAEs in food products. Limitation of DBP and DEHP in sanitation standard for the migration test of plastic food utensils, containers, and packages has been set at 0.3 and 1.5 ppm, respectively (Food Drug Adm. Minist. Heal. Welf., 2013a).