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Revisiting the melamine contamination event in China: implications for ethics in food technology

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Food technology is a burgeoning field of applied science, invading many areas of the food industry and making contributions to economic advancement; however, little research has focused on ethical aspects in this field. This article attempts to fill this knowledge gap by revisiting the tainted milk event in China in 2008, followed by a detailed discussion of the application of food technology ethics in industrial contexts. Through the lesson learnt in the Chinese food industry, it is hoped that more global concerns on ethical issues in food technology will be raised, thereby creating a more humane food production industry.

Introduction

Food is the basic necessity of life. With expanding global populations and improving living standards, demands on both the quality and quantity of food have increased worldwide. In response to this, great endeavors have been made by food scientists over the last several decades. Nowadays, uses of food are no longer limited to attainment of satiety (Vitaglianea, Napolitanoa, & Fogliano, 2008); the uses of some food products like chitosan have been extended to biotechnological and therapeutic applications (Lai & Lin, 2009). Today research in food technology spans innumerable fields of inquiry, ranging from product development (Hassan-Zadeh, Sahari, & Barzegar, 2008; Smoliner \textit{et al.}, 2008; Wattanathorn, Chonpathompikunlert, Muchimapura, Priprem, & Tankamnerdthai, 2008) to production management (Liu & Schaffner, 2007; Parkar, Flint, & Brooks, 2004; Schaffner & Schaffner, 2007), from food safety to technology research (Ginzlea, Loponen, & Gobbettic, 2008; Loveday & Singh, 2008; Siracusaa, Rocculib, Romanib, & Rosa, 2008). Despite this broad coverage of topics, ethics in food technology has been only sporadically mentioned.

In Hong Kong, several scholars have attempted to tackle the challenge of food safety (Chan & Chan, 2008; Poon & Au, 1997; Ting, Sin, Ho, & Chung, 2006). For example, based on the revised crisis preparedness model, Chan \textit{et al.} have developed a crisis management plan to safeguard public health and restore confidence in food safety in the local public and stakeholders (Chan & Chan, in press). Yu, Ng, Cheung, and Young (1995) have also established a dynamic model for assessing the transport of radionuclides through the food chain following fallout from nuclear weapons testing and nuclear accidents. In spite of these efforts, little work has focused on ethical aspects in this field.

Such a knowledge gap, however, does not devalue the importance of ethics in food technology. As stated by Wei Zheng, a Chinese minister of the Tang Dynasty, \textit{“Water can float a boat, but can also overturn it”}. Whether technological advances are a boon or bane is largely determined by human ethics and manipulation. This article attempts to revisit the melamine contamination event in China in 2008. It is hoped that the lesson learnt in the Chinese food industry will stimulate the food industry worldwide to reconsider the importance of ethics in food technology and to raise greater awareness of conduct in food production.

Literature source

Information used in this article came mainly from a library catalogue search in the Hong Kong University Libraries and an online database search on PubMed and...
Medline from 7th November to 17th December 2008. News of food problems in China were retrieved via WiseSearch, Academic Universe, Factiva and ProQuest. More than 50,000 entries were found by using the following keywords in our search for information: “melamine”, “food”, “food safety”, “milk”, “morality”, “food technology” and “ethics”.

Overview of the melamine event

Melamine (also known as tripolycyanamide) has a number of industrial uses including the production of glues and plastics. According to US Food and Drug Administration (FDA) (2007), the tolerable daily intake (TDI) is around 0.63 mg/kg of a person’s weight. There is no approval for direct usage of melamine in food, nor are there any guidelines in the Codex Alimentarius (World Health Organization, 2008); however, as its nitrogen content by mass is up to 66%, melamine was illegally added to watered-down milk in China to boost its apparent protein content as measured by the standard Kjeldahl and Dumas tests.

The tainted milk event is one of the most influential food safety crises to have been reported in mainland China in recent years. Though it surfaced on 11th September, its preliminary symptoms had manifested three months earlier as parental complaints about Sanlu milk powder to AQSIQ (General Administration of Quality Supervision, Inspection and Quarantine). Since July 2008, an abnormally high prevalence of renal stone cases had been discovered among mainland infants; however, no action was taken at that time (Ma, 2008). Not until later, when the event became public, did the mainland authorities endeavor to mitigate possible public health hazards and penalize the relevant perpetrators. In addition, medical care was provided free-of-charge to affected children under the Minister of Health, and a large-scale food investigation was carried out to comfort panicked parents on the safety of Chinese food. Unfortunately, the panic escalated. By 22nd September, more than 52,857 children had been treated for renal complications and at least 4 had died.

The health impact of the event seems not to be limited to the mainland but to have spread to areas importing dairy products from China. In Hong Kong, where over 90% of food is imported, more than 15,000 children had attended designated clinics by September 28. Hitherto, 10 suspected kidney stone cases pertaining to tainted milk consumption have been found (Centre for Health Protection, 2008). As melamine contamination spread to different brands of milk and milk-containing foods, imports and sales of Chinese dairy products were banned by over 10 countries, including Colombia, Japan, Malaysia, Philippines, Singapore and Taiwan. In the United Kingdom, all Chinese products containing more than 15% milk ingredients were subjected to strict documentary and physical checks (Food Standards Agency, 2008), whereas in the USA, the government advised citizens traveling to China with children to bring along their own baby food. Consequently, the influence of the food scare extended from public health to economic levels.

In response to the milk adulteration with melamine, mainland authorities attempted to enact the Emergency Public Health Response Regulations that had been drawn up in response to the outbreak of SARS (Severe Acute Respiratory Syndrome) in 2003. However, as those regulations were drafted to deal with infectious diseases instead of food problems, no effective strategies had been formulated. In early October, authorities in China set melamine limits at 1 ppm in infant formula and 2.5 ppm in other products with milk content of 15% or above (such as liquid milk and milk powder). In addition, a new norm regulating the entire chain of dairy production was issued by the State Council, and the addition of illegal substances to fresh milk can now lead to the death penalty.

Although new norms pertaining to milk contamination have been introduced, are they the final solution to food safety issues? As evidenced by past experience in China, where the first food safety law was promulgated in 1965 and relevant legal frameworks were established in the 1990s, legislation alone seems not to completely eradicate unscrupulous food production in real practice. In the period from 1998 to 2007, thousands of people were sickened by food poisoning every year (Fig. 1). Selected major food safety incidents reported in China over the past 5 years are listed in Table 1.

In fact, legislation has long played a crucial role in food security (Kastli, 1955) via its regulatory effects on practices in the food sector and its public educational functions. The latter were first supported by Hsun Tzu and his pupil Han...
Fei Tzu in around 200 B.C. in China. According to these two philosophers, though human nature is fundamentally evil, it can be made good via education and acculturation (Cai, 1996; Goldin, 1999; Han, 1964, 1992; Hsu¨ n-Tzu, 1963). As proposed by Han (Han, 1964, 1992; Zhang, 1974), one of the most efficient ways to facilitate this process is by law. Regardless of this, legislation can mainly function well as a way to handle the aftermath of an event; its effectiveness in malpractice prevention in the industrial context might not be as significant as perceived. In addition, since the Second World War, there has been a rise in the concept of Taylor’s system which stands for the systematic scientific examination of all stages of the manufacturing process via piece-rate bonus schemes and time study of each industrial operation (McNeil, 2002; Taylor, 1947). This led to an evolutionary change in agricultural and food production practices, leading to blurring of overall responsibility for the entire food manufacturing process, and posing considerable challenges in terms of accountability for food problems in a modern society.

In view of the gap in legislation, the Chinese government appears to need additional measures to secure food safety and restore public confidence. Reforming existing milk-production processes is required, but other coordinating measures such as addressing corruption, certifying industrial production standards (e.g. ISO 9001), imposing strict rules on industrial compliance with asserted food production guidelines (e.g. GMP), and forcing the adoption of systemic food safety management plans (e.g. HACCP) by the local food industry may also be needed. Despite this, to quote Premier Wen Jibao in a recent public address (Chen, 2008), “Many factories and milk dealers are lacking the most fundamental business morals and social responsibility. They are just cold-blooded”; it is human ethics that ultimately determine the boon and bane of food technology, affecting the success of a food safety security system. Modern reality forces us to be serious about food technology ethics, which is a topic that has been little discussed in either academic or industrial sectors, and to explore how it can be applied in the industrial context in practice.

The social importance of ethical practices in food technology

Ethics is a burgeoning field of philosophy, exploring the values and conducts underpinning moral behaviors. With the emergence of the concept of morality, ethics has been

| Year | Incident | Action taken |
|------|----------|--------------|
| 2004 | Counterfeit milk formulae in China. Around 70 babies died of malnourishment. 100–200 babies in Anhui Province suffered from malnutrition. Industrial-grade salts were used to pickle vegetables, and pesticides containing dichlorvos (DDVP) were used to preserve these products. In order to reduce production costs, cornstarch was used instead of mung beans to produce cellophane noodles. In addition, lead-based whiteners were added to make the cornstarch transparent. Industrial alcohol was blended with rice wine in alcoholic drinks. 4 men died of alcohol poisoning and 8 were hospitalized. | 47 perpetrators were arrested and in total 45 types of substandard milk formulae were discovered in Fuyang markets. The Chengdu Quality Inspection Department further inspected pickled vegetable products. Beijing authorities ordered inspection of the incident. The culprit companies were ordered to cease production and distribution. Several unlicensed liquor manufacturers were forced to close by mainland authorities. |
| 2005 | Sudan red dye, a chemical banned from food processing in China since 1995, was found to be illegally used in food. | Officials announced the reform of the existing food safety system on national and local levels. |
| 2006 | Use of prohibited drugs and chemicals (e.g. malachite green) in fishery. | Inspections were carried out. Several cities in mainland China banned the import of turbot fish from Shandong Province. |
| 2007 | The potentially carcinogenic chemical, magnesium trisilicate, was added to deep-frying oil to make the oil reusable for a greater number of times. | Health officials in areas like Xianyang, Yulin, and Xi’an inspected the suspect restaurants and confiscated the frying powder. |
| 2008 | Jiaozi produced by a food company in Hebei Province was found to be tainted with methamidophos. Several people became ill after consumption of the food. Infant milk formulae were adulterated with melamine to enhance the protein content measurement. | Inspections conducted jointly by the Chinese authorities and the Japanese government were carried out to disclose the underlying cause of the incident; however, the cause of the event has not yet been confirmed. Over 50,000 children were affected and measures pertaining to the tainted milk were imposed worldwide. |
Food-related ethical discussion started in the contexts of medicine, education, politics, research, commerce and social behaviors (Chadwick, 1998). Food-related ethical discussion started thousands of years ago. Historical evidence for this traces back to the ancient Greeks, and is evident in literatures left by ancient Roman and early Christian scholars (Zwart, 2000). A detailed historical development of food ethics was successfully presented by Zwart in 2000, and selected ideas pertaining to food in major historical periods are listed in Table 2. Despite such early recognition of the importance of ethics in relation to food, most of the effort made in this area is limited to food preparation; as such, exploration of morality in the application of food technology in the industrial context is lacking. Such ignorance, however, appears not to have lowered the importance of food technology ethics. Instead, its social impacts as manifested by the occurrence of food safety problems seem to be urging both the academic and industrial sectors to pay attention to the issue.

In fact, along with industrialization and capitalism, cooperative labor tends to be more specialized, thereby widening the distance between food consumption and its production. Under such circumstances, consumers have to place unidirectional trust in the governance structure and safety of the existing agri-food system. This trust relationship is basic to a harmonious society. Violation of it by food suppliers is not only inconsistent with social norms, but also evokes far-reaching distrust of the food system underpinning social stability. In order to uphold the integrity of a society, legitimate practice in the food sector and fulfillment of food security, which according to the FAO (Food and Agriculture Organization of the United Nations, 1996) means that “all people at all times have access to safe and nutritious food to maintain a healthy and active life” (Sec. 1.4), are pivotal. And at the most fundamental level of attaining these in corporate and industrial practice, ethical attitudes towards the application of food technologies and related knowledge are at the core.

### Food technology ethics in the industrial context

Ethics in food technology can be attained via responsible conduct in the application of related technologies and knowledge. In the industrial context, such legitimate conduct can be dichotomized into the following two areas: public good-oriented management (PGOM) and environmental welfare. They are related to corporate responsibility to human societies and the external environment, respectively. In fact, although public good orientation in industrial entities is important, ethics in food technology can never be assumed unless the welfare of primary non-social stakeholders (including the natural environment, future generations and non-species), as named by Wheeler and Sillanpaa (1997), are taken into account. However, as issues of environmental welfare have been widely discussed in the area of environmental ethics (Beamon, 2005; Minter & Collins, 2008; Muzinic, 2005), the following sections will mainly focus on PGOM.

#### Moral basis of PGOM

As demonstrated in the melamine contamination event in China, unless there is general commitment in food sectors to self-observation, self-monitoring, self-discipline and practices of moral and social obligations, it is very unlikely that the safety and quality of food production will be

| Period                | Selected notions pertaining to food |
|-----------------------|-------------------------------------|
| Ancient Greece        | • Humans and other animals should live in accordance with nature.  
                        | • Food products yielded by nature have to be improved and refined before consumption.  
                        | • It is the refinement of food that differentiates humans from animals. |
| Ancient China         | • Food is important for survival, but its importance does not overwhelm the dignity and virtues of man.  
                        | • The sorts of food being consumed can ultimately influence the internal balance and thus the overall health of an individual. |
| Medieval times        | • Food consumption is an object for moral exercise and self-discipline.  
                        | • Food intake should be in accordance with laws stated by the Hebrew Bible. |
| 16th century          | • The perceived virtue of abstention from food intake is mistaken.  
                        | • Intake of a large quantity of food can function as a remedy against melancholy and temptation, or even as a proof of social status.  
                        | • Civilization of food consumption is advisable (for instance, people tended to use separate places for slaughtering, dissection and meat consumption). |
| 17th–18th centuries   | • Food intake and the health status of the physical body are interrelated.  
                        | • Consumption of food should be discouraged if, for some reason, it is used as a way to benumb the mind and deprive people of their intellectual faculties. |
| 19th–20th centuries   | • Food production and consumption involve a social dimension. Lack of self-restraint and disregard of food ethics can lead to global crises like starvation.  
                        | • The desire for food is one of the strongest desires in animated life.  
                        | • Food products made in the social environment of capitalism are, or will be, incarnations of social conflicts and alienation. |
promoted; in general, such moral practices could be accomplished via public good-oriented management underpinned by normative ethics on all levels of food technology application.

One of the possible normative ethical bases in PGOM is deontological (obligation-based) ethics, which is one of the most important philosophical notions for right/wrong judgment. It believes that, regardless of consequential benefits, actions are wrong if the primary motive for those actions is immoral (Kasper, 2005). As exemplified by the tainted milk event, because the motive for adding melamine to milk was to cheat the protein content measurements for financial gain, in the deontological sense, the corresponding actions resulting from this motive were unacceptable. From the deontological point of view, cost and benefit considerations should not override the responsibility that has to be shouldered to the common good.

In addition to the deontological basis, another potential normative ethical concept supporting PGOM is utilitarianism, which is an ideology of consequentialism. Contrary to the deontological approach, it states that the morality of an action is determined by its overall contribution to the utility (i.e. happiness and pleasure) of a society (Goodin, 1995). This idea was first proposed by Epicurus (DeWitt, 1954; Mitsis, 1988) and was later systematized by Jeremy Bentham, who suggested that pain and pleasure are two constitutional factors governing the operation of a society, hence any actions that could bring the greatest amount of pleasure to people in a community would be “correct” and “good” (Rosen, 2003). Utilitarianism is one of the most prevalently used approaches for judgment making in both industrial and commercial sectors. Areas ranging from policy planning to economic analysis are also very often based on utilitarianism, using income or other economic parameters as the measure of welfare or utility (Pinstrup-Andersen, 2005). From the utilitarian perspective, it is conceivable that applications of food technology and related knowledge in ways that are potentially harmful to public health should be discouraged.

Implementation of PGOM practices
PGOM in the industrial context should be composed of four domains of operations (Table 3): industrial objective formulation, pre-usage evaluation, technology implementation, and strategic reevaluation. It should be noted that merely nominally following all the basic guidance listed in Table 3 is not automatically equivalent to being ethical, unless the core of PGOM, i.e., the motive for common good and the sense of social responsibility, is recognized and fulfilled by the corporate executive and managerial teams.

As far as social responsibility is concerned, it is inevitably associated with the norm of “social contract”, which is unwritten agreements between members in a community, having binding effects on legal governance, community order and social cooperation. It is under this premise that a mutually beneficial community can be established and social liberties can be maintained. This notion is consistent with the idea of “Rituals” in Confucianism. According to Confucian thought, rituals are an integrated system of norms and etiquette. They function as a frame of reference for the legitimacy and propriety of acts in everyday life. As the violation of rituals may disturb the social order (Cai, 1986), a high level of agreement with social norms is essential in both social and industrial domains.

Table 3. Four domains of public good-oriented management.

| Domain                        | Steps                                                                 |
|-------------------------------|----------------------------------------------------------------------|
| Industrial objective formulation | • Perform a situation analysis, both internally and externally, to evaluate how the presently used technological practices link with the common good.  
• Set objectives (both short- and long-term) and mission statements (the role the company should play in society), and craft vision statements based on the public good.  
• Suggest strategic plans to provide details of how ethical objectives set could be achieved practically. |
| Pre-usage evaluation          | • Consider the legality of the selected technology.  
• Evaluate the scientific “facts” of the technology intended to be used, and the impacts, both positive and negative, of the technology on society.  
• Consider whether the application of the technology will ultimately violate any of the objectives and mission statements set during the industrial objective formulation process. |
| Technology implementation     | • Assign specific processes to specific personnel or groups to maintain accountability for each of the industrial practices.  
• Allocate sufficient resources (e.g. technology support and personnel) to ensure that the technology can be fully implemented.  
• Assess costs and impacts on different parties and prerequisites for resources when the technology is in use. |
| Strategic reevaluation        | • Reassess existing industrial practices or policies to identify areas that have to be changed or revised in order to further comply with public interest.  
• Evaluate the feasibility, acceptability and suitability of continuing to adopt the existing technology.  
• Conduct strategic analysis (e.g. SWOT analysis) regularly to evaluate the weakness and strength of continuing to adopt the existing chosen technology in industrial practices, and to see how it complies with the public good-oriented mission and industrial objective set. |
in the most basic sense. According to him, any perceived differences (such as education, race, wealth and social status) among people are merely artifacts made by humans; therefore, offering care and love to anyone should be equivalent, and acts that are harmful to others should be avoided. He believed that people are morally obliged not only to their families and acquaintances, but also to those they do not know. With the fulfillment of Mo-Tzu’s ethical ideology in the industrial context, it is believed that food manufacturers could be more empathetic and perceptive with regard to the concerns of the public, and self-monitoring of industrial practices could be achieved.

In addition to the core sense of social responsibility among managerial staff, proper coordination between internal stakeholders of an industrial entity (including investors, owners, employees, suppliers, and other workers involved in any level in the food production chain) is another prerequisite to public good-oriented management. This is understandable because PGOM is merely a “paper program” unless it can be implemented in an effective manner, and the responsibility of implementing relevant strategies lies completely with operational staff. Therefore, compliance of grass-roots staff with the managerial team is needed in PGOM. For more details of the responsibilities of major internal stakeholder groups in PGOM, please refer to Table 4.

**Challenges in practice**

Ethical and legitimate practices during the use of food technology are doubtless the most ideal state in food production, and are arguably the obligations of the food industry worldwide. Nevertheless, despite the successful implementation of ethics in food technology, it is worth noting that some external social factors may still impose challenges in practice. Examples of these include poverty and deficient social resources.

From a macroscopic point of view, compared with developed countries, developing areas are encountering more challenges in complying with the basic principles of food

| Stakeholder                          | Responsibilities                                                                 |
|--------------------------------------|----------------------------------------------------------------------------------|
| Investors                            | • Ensure the applicability of the PGOM executed.                                 |
|                                      | • Provide advice on modifications of the PGOM plan under the premise that profit motives do not override the common good. |
| Owners and managers                  | • Provide clear guidelines to grass-roots staff to enable them successfully to fulfill the public good-oriented objectives and the mission statement of the industrial entity. |
| Employees and workers                | • Follow operational guidelines issued by the technical and management team at any level of the food production chain. |
|                                      | • Give feedback on first-hand experiences of the weaknesses, gaps or defects in the PGOM plan in practice to managerial staff. |
| Suppliers and business partners      | • Ensure that the public good orientation of the business partner will not be violated in any way by its involvement in the partnership. |
|                                      | • Comply with and respect the public good-oriented objective of the business partner during commercial cooperation. |

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In fact, due to human reliance on food for survival and in the sense that both the bane and boon of technologies in food are its considerable dependence on human manipulation, in order to get the best outcomes from food technological advances, a sense of social responsibility is essential to food manufacturers. Responsible industrial practices in food can often be manifested as follows:

1. producing food whose qualities and hygienic standards meet or exceed the stringency of regulatory requirements;
2. stimulating healthy food choices by consumers and promoting public health via producing and supplying wholesome food to the market;
3. ensuring that the food produced is suitable and not harmful for consumption, and recognizing the vulnerability of public health to food intake;
4. upgrading health and safety standards in food processing and handling operations.

Ethical judgments and practices in food production should also be promoted, and hints to accomplishing this can be drawn from the Confucian moral maxim suggested in the Analects of Confucius in 15:24 (Confucius, 1938): “Do unto others in a way you would have them do unto you”. According to the maxim, each of us is obliged to treat others in the same moral way in which we would like to be treated. This idea signifies the importance of self-discipline and propriety as a way to live, and this empathetic notion is the norm in the social context (Confucius, 1938) but is also applicable to industrial practices. Other major concepts with regard to moral deeds and obligations can be found in the work of Mencius (Mencius, 2003; Shun, 1997) and Mo-Tzu (Mo-Tzu, 1963). According to Mencius, man is born to have four virtues: “Benevolence”, “Righteousness”, “Courtesy” and “Wisdom”, and all social actions performed should be in accordance with these four principles (Mencius, 2003). For Mo-Tzu (Mo-Tzu, 1963), he asserted that individuals in a society are fundamentally equal
technology ethics, as industrial practices there are very likely in an atmosphere of poverty, ever-shrinking resources and hunger. Under such circumstances, the introduction of ethics in food technology may further force them to sacrifice the profits of production and further add to their financial stress burden. Consequently, even though the need for moral conduct in food technology may be widely appreciated, their motivation to actually practice it might be limited.

Education is also a prerequisite in fulfillment of food technology ethics as evidenced by the Chinese experience in the tainted milk scandal. In China, the food industry is often organized as a small-scale, labor-intensive one, lacking capital and hi-tech operations. Small-scale farmers have usually received little education on formal farming and husbandry practices; they might have thought that mixing certain “magic” chemicals (e.g. melamine) and preservatives to milk could make it look more nutritious and longer lasting, thus rendering it more profitable, with little understanding of the severity of the problems caused by their actions. This problem of under-education among workers in the agri-food system not only devastates food security but also compromises the carefully planned PGOM in some humane industries. Provision of professional training and workshops to relevant workers prior to commencement of their work may be useful in alleviating the under-education problem in a country, but support from the government and respective industrial entities would be a sine qua non.

Further, as shown in the tainted milk event, misuse of food technology can lead to crises which not only cause profound economic stress to the country but also jeopardize the psychological health of the public and discredit the psychological security of individuals in the community. In fact, along with individualization and hedonism in modern society, food consumption is no longer limited to fulfillment of basic biological needs, but is central to a sense of self and expresses social, cultural and geographic variations (Lupton, 1996). In view of this, it is high time that we afforded special consideration to collaboration between food researchers and other scholars, including those with expertise in ethics, social science, politics and commerce. Along with exchange of knowledge among disciplines, it is expected that a more integrative understanding of the multiple dimension of food science and technology can be achieved, thereby facilitating the establishment of more suitable and prompt measures and ethical practices in response to technological advances.

Conclusion

Food technology has permeated every aspect of the food industry, providing effective technological knowledge and facilitating the process of new product development; however, scant efforts to explore ethics in this area have been made thus far both in the industrial and academic milieus. To fill this knowledge gap, this article attempts to reconsider ethical issues in food technology via revisiting the melamine contamination event in China. However, two limitations in this article should be noted. First, this article is not a research paper; therefore, the extent of its analysis may be limited by the availability of information sources. Second, the authors’ bias may be involved in the interpretation of others’ work. For these reasons, for those who would like to assay the event more comprehensively, interviews with and surveys on dairy product manufacturers, wholesalers, retailers, parents of the affected children and care-providers in mainland China for their first-hand experiences of the event are strongly recommended for future research. In addition, this article is only intended to be the lead-in to the topic of food technology ethics; more effort will be required from scholars to deepen our understanding in this area and improve managerial strategies for its practical fulfillment in routine industrial operations.

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