Accepted Manuscript

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PII:	S0956-7135(18)30162-2
DOI:	10.1016/j.foodcont.2018.04.007
Reference:	JFCO 6069
To appear in:	*Food Control*
Received Date:	04 January 2018
Revised Date:	31 March 2018
Accepted Date:	06 April 2018

Please cite this article as: Ying-Hua Song, Hui-Qin Yu, Wei Lv, Risk analysis of dairy safety incidents in China, *Food Control* (2018), doi: 10.1016/j.foodcont.2018.04.007

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ABSTRACT

In order to improve the condition of food safety management and prevent the dairy safety incidents effectively, supply chain and fault tree analysis (FTA) can be integrated to analyze the cause of such issues comprehensively. As a result, the main cause of the dairy incident can be found. Based on the analysis and identification of hazards in dairy foods across the entire supply chain from raw material sources to end-customers, the basic events which can lead to dairy incidents are given, and the accident tree of dairy foods is constructed. After a qualitative and quantitative analysis on the tree on the tree, the minimum cut sets and path sets are calculated. Then, the accidents mode and the accidents control mode are obtained, respectively. The Sanlu milk powder incident and the Fuyang milk powder affair are selected as the cases to prove the feasibility of FTA. We have analyzed 34 basic events quantitatively. Then 114 minimum cut sets and 78 minimum path sets are obtained. From the analysis of structure importance degree of the basic events, the most critical factors are production enterprises lack feedback mechanism (X_1), Food and Drug Administration failed to sample (X_{33}), Ministry of Health and other government departments overlook or don't have a good supervision (X_{34}), supermarkets and other distributors make a wrong judgement and sell unsafe dairy (X_{32}), the industrial and commercial department failed to sample (X_{31}), personal preference (X_2), family members need dairy (X_3), supermarkets and other dealers promote unsafe dairy (X_4), and their structural importance coefficients are 1, 1, 1, 0.567, 0.5, 0.25, 0.25, and 0.25, respectively. The corresponding dairy safety strategies are discussed qualitatively, which include: dairy enterprise establishes a feedback mechanism and strengthens industry self-regulation; regulatory authorities strengthen supervision; supermarket and other dealers enhance self-construction; consumers learn how to differentiate between unhealthy and healthy dairy foods; the government makes related food safety laws.

KEYWORDS: Risk analysis; Dairy; Food incidents; Fault tree analysis; Countermeasure

1. Introduction

In recent years, the food safety incidents happened frequently all around the world, and then the problems related to food quality and safety have attracted much social attention (Jing Wang & Huili Yue, 2017). Milk products are important components of the diets for many populations (Handford et al., 2016). However, dairy safety incidents have been widely reported in countries such as Japan, China, Pakistan, India (Takashi Yorifuji et al., 2016; Naveen Kumar, Harish Kumar, Bimlesh Mann, & Raman Seth, 2016; Shaikh et al., 2013). Many countries have made efforts to improve dairy safety, and the governments have established laws, regulations, standards, institutions and methods for regulating food safety (Myoung Su Park, Ha Neur Kim, & Gyung Jin Bahk, 2017). Naveen Kumar et al. (2016) used unmodified silver nanoparticles to detect the melamine in milk. Xiaoyu Zhao & Ligang Chen (2016) used a magnetic molecularly imprinted polymer based on carbon nanotubes with ultra high performance liquid chromatography and tandem mass spectrometry to analyze melamine in milk powder. Myoung Su Park et al. (2017) used coding to systematically analyze the food safety incidents and found out at what stage a breakdown in food safety is likely to occur. These studies are certainly helpful for better dairy safety management. However, developing the best strategy for dairy quality control requires systematic risk analysis, which should be based on comprehensive studies from 'farm to fork'.

There are many approaches for reliability and availability analysis such as Reliability Block Diagram (RBD), fault tree analysis (FTA), Reliability Graph (RG), Monte Carlo Simulation, Markov Chain and Failure Modes Effects and Criticality Analysis (FMECA) (Cheol, 2011). FTA is a well known engineering approach and one of the most widely used by practitioners (Karim, 2013). It was originally employed in the design of US Air Force's Minuteman missile system to analyze the whole system (Sohag, 2017). As a well-established and well-understood technique, FTA has been used in a variety of fields, including but not limited to automotive, aerospace, nuclear industries, off-shore platforms, data centers and web shops (Walker & Papadopoulos, 2009; Fritz Sihombing, Marco Torbol, 2018; Enno Ruijters, Mariëlle Stoelinga, 2015). Shuanglong Kan, Zhiqiu Huang (2017) have applied fault tree analysis for software safety analysis and the method has been proved effectively. Dragana Makajic-Nikolic et al. (2016)