

## MANAGEMENT OF FOOD SAFETY IN THE INDUSTRIAL SETTING

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### Summary

Food industry, including the primary, manufacturing, retail and service industry, is by far the largest industry in the world. For the food industry, over and above being a legal

obligation, food safety constitutes one of the most fundamental and vital aspects of its operation. Food safety is the backbone of consumer trust, and consumer trust is the most precious asset of a food business.

Ensuring food safety in today's world has become a very complex task, as a plethora of contaminants of chemical, microbiological and physical nature may at any stage of the food chain find their way into the food supply. Additionally, during food preparation, there is a risk of mishandling, as well as of contamination and/or growth of pathogens. Improvements in science and technology, combined with highly developed food safety and quality assurance systems have allowed the food industry to confront these threats and provide consumers with high quality and safe food products.

Management of human resources in the food industry (including management commitment) is key to adequate implementation of the food safety assurance system. Together with the education of professional and domestic food handlers, it constitutes one of the most important interventions in ensuring food safety.

One of the main challenges to food industry is the continuous changes in food operations and products as well as in the environment (e.g. emergence of new foodborne hazards, change in climate and water resources, change in regulatory requirements and lifestyle). Management of these changes is essential for maintaining the safety of the food supply.

## **1. Introduction**

Irrefutably, one of the most important assets of a food company is the trust of customers and consumers. As such, over and above being a legal obligation, food safety constitutes one of the most fundamental and vital aspects of any food operation and is the backbone of consumer trust. Ensuring food safety in today's world has become a daunting task as on the one hand, the food industry is confronted with a very broad range of chemical, microbiological and physical hazards that may find their way into the food at any stage of the food chain. On the other hand, measures taken to protect consumers are often intertwined with other considerations. In addition to food safety, a successful food industry must also meet an array of consumer or customer expectations which vary with lifestyle, values, culture and level of education and perception.

For most consumers, in addition to fulfilling their nutritional needs, food is a pleasure and an emotional experience. With the change of lifestyle and family structure in modern society, consumers expect but also need food that is more convenient in terms of accessibility, transportation, storage, preparation and use. They give preference to foods that suit their cultural and traditional values. Many also attach importance to its attractiveness, e.g. color of the product or its packaging. Price is another important determining factor for many consumers as they seek foods that offer the best value for price. In the last decade or two, due to increased awareness of the role of food in health and better prevention of diseases, many consumers have been giving particular attention to the safety and nutritional quality of foods. Other factors which may also impact consumers' decisions with regard to their preference for one brand over another are issues related to the environment, animal welfare, ethical practices and in general their

perception of the responsible behavior of a company.

However, food is also a means of subsistence for many people. The food industry, including the primary, manufacturing, retail and service industry, is by far the biggest industry in the world. According to Nestlé estimates, the food market is estimated to be \$ 4.6 trillion, representing 10% of the world GDP. According to the International Labor Organisation, in countries that have official statistics, the food manufacturing industry alone employs 22 million people. As such, the food industry is an engine for economic development in terms of providing food for the world population, supporting international trade and food export, which is a source of foreign exchange, as well as providing job opportunities. It is also recognized that economic development plays an important role in health, as poverty and underdevelopment are recognized underlying factors for various diseases, as well as food contamination and the diseases it causes.

Activities related to food at different stages of the food chain, from primary production to processing, manufacturing, transport and preparation in food service establishments - directly or indirectly - provide job opportunities to a considerable proportion of the world population and therefore is a source of income. Thus, as part of their social responsibility, food industries also have obligations towards their employees, their job security and the economic role that they have in the community where they are established.

Meeting food safety requirements, where these are unjustifiably stringent or where legislation is not applicable, can be at the cost of compromising the livelihood of many people and crippling the frail economies of certain countries. For instance, the EU harmonized standard for aflatoxin decreased African export revenue from Europe by 59 percent for cereals and 47 percent for dried and preserved fruits and edible nuts, compared to export revenue under the pre-EU-harmonized standards. This decrease amounts to approximately US\$400 million. Compared to the international standards (i.e. Codex Alimentarius standards), the EU harmonized standards decreased the value of African export by US\$ 670 million (Wilson and Otsuki, 2003). Box 1 presents the role of one food company, as an example of the contribution of a food industry in the community.

Since the Nestlé Group began investing in China two decades ago, the Company has opened 21 factories in 18 different sites across the country and today employs about 13,000 people.

With regard to activities in the milk area only, Nestlé buys fresh milk from some 40,000 Chinese farmers and provides them with an overall regular total income of around CHF 500,000 per day, fostering a rural sustainable development for the communities concerned. At least 200,000 people benefit directly and indirectly from Nestlé's milk activities in China. In addition to being a regular buyer of fresh milk, Nestlé has provided daily technical assistance to the farmers over the last 20 years, helping them to increase the quality, quantity and efficiency of their fresh milk production.

Box 1. An example of the role that a food company plays in the subsistence of communities and the economic development of the country

A number of other factors further increase the complexity of managing food safety. Globalization, international trade in food and feed, international travel and modern means of communication contribute to the world becoming a single market. Governments and consumers as well as ethical considerations require that ideally, industry apply the same standard of food safety all over the world.

On the other hand, the environment (e.g. contamination of natural resources), the socio-economic situation and infrastructure, consumer culture value perception and food habits differ and what can be achieved in one country may not always be possible in other countries. In addition to these complexities, daily progress in science and technology unveils new concerns.

Despite these challenges, the food industry, supported by measures taken at governmental level, has succeeded in achieving a high degree of food safety and has progressively strengthened its food safety measures. This chapter aims to present an insight into the risks that the food industry is confronted with at different stages of the food chain and the measures that it uses to control them.

The chapter depicts the important role of food technologies in ensuring food safety and the modern approach to the management of safety in the food industry (For the purposes of this document, industry includes all types of operations associated with the production, storage and handling of food, from primary production through retail and food service level.).

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### **Bibliography**

ADA (2000). Position of the American Dietetic Association: Food Irradiation, *ADA Reports*. 100(2).246-253

Adams M., Nout M.J.R. (2001). Fermentation and Food Safety. pp 290. Aspen Publishers Inc. Maryland.

Andrew C.V. *et al.* (2007). Reduction in the Incidence of Invasive Listeriosis in Foodborne Diseases Active Surveillance Network Sites, 1996–2003. *Clinical infectious Diseases*, **44**, 513– 520.

Antunes P., Machado J., Peixe L. (2006). Illegal use of nitrofurans in food animals: Contribution to human salmonellosis? *Clin Microbiol Infect.* **12**(11), 1047-9.

Archer L.D. (2004). Freezing underutilized food safety technology? *International Journal of Food Microbiology.* **90**(2), 127-138.

Asao T., Kumeda Y. , Kawai T., Shibata T. et al. (2003). An extensive outbreak of staphylococcal food poisoning due to low-fat milk in Japan: estimation of enterotoxin A in the incriminated milk and powdered skim milk. *Epidemiology and Infection*, **130**(1),33-40.

- Baars J. A. (2000). The dioxin in chicken incident in Belgium in 1999: trouble or trifle? *Arhiv za higijenu rada i toksikologiju*, **51**(3), 311-20.
- Bennet J.W. and Klich M. (2003). Mycotoxins. *Clinical Microbiology Reviews*, **16**(3), 497-515.
- Braden, C.R. and Tauxe R.V. (2006). Surveillance of emerging pathogens in the United States. In *Emerging Foodborne Pathogens* (Eds. Y. Motarjemi and M.Adams).pp 23-49. Cambridge: Woodhead Publishing Ltd.
- CAC (2003). Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application. Annex to Recommended International Code of Practice General Principles Of Food Hygiene to CAC/RCP 1-1969 (Rev. 4 - 2003); FAO/WHO Secretariat of the Codex Alimentarius Commission, Rome.
- CDC (1999). Press release. <http://www.cdc.gov/od/oc/media/pressrel/r990114.htm>.
- Curriero F.C., Patz J. A., Rose J.B. and Lele, S. (2001). The association between extreme precipitation and waterborne disease outbreaks in the United States 1948-1994. *American Journal of Public Health*, **91**(8), 1194-1199.
- Doyle M.P., Erickson M.C. (2006). Reducing the carriage of foodborne pathogens in livestock and poultry. *Poultry science*, **85**(6), 960-73.
- Hennessy T.W., Hedberg C.W., Slutsker L. *et al.* (1996). A national outbreak of Salmonella Enteritidis infections from ice cream. *The New England Journal of Medicine*, **334**(20), 1281-6.
- FAO (2001). Manual on the application of the HACCP system in mycotoxin prevention and control. 73, Food and Agriculture Organisation, Rome
- Fischer W. *et al.* (2002). Contaminants of milk and dairy products: a critical review. In *Encyclopedia of Dairy Sciences*. (Eds. H. Roginski, JW Fuquay and FP Fox), London: Academic Press.
- Golab E., Szulc M., Wnukowska N., Rozej W., Fell G., Sadkowska-Todys M. (2007). Outbreak of trichinellosis in north-western Poland – Update and exported cases, June-July. *Euro Surveillance* **12**(7).
- Gorris L.G., Basset J. Membré, J.-M. (2006). Food Safety Objectives and related concepts: the role of the food industry. In *Emerging Foodborne Pathogens* (Eds. Y. Motarjemi and M.Adams). pp 153-175. Cambridge: Woodhead Publishing Ltd.
- Gray P.S. (1999). The regulation of food safety-general aspects. In: *International Food Safety Handbook*. (ed. K van der Heijden,; M Younes, ; L Fishbein, and S. Miller) New York: Marcel Dekker, Inc.
- Hall G.V., D'Souza R.M., and Kirk M.D. (2002). Foodborne diseases in the new millennium: out of the frying pan into the fire? *The Medical Journal of Australia*, **177** (11/12), 614-618.
- HPA. 2007 Listeria contamination of sandwiches. Health Protection Report, **1**(12): <http://www.hpa.org.uk/hpr/archives/2007/hpr1207.pdf>.
- ICMSF (1998). Fish and Fishery Products. In *Microbiological Ecology of Food Commodities*. ICMSF, Blackie Academic and Professional. Springer.-Verlag, Berlin.
- ISO. (2005). ISO 22 000: Food safety management systems - Requirements for any organisation in the food chain. International Organisation for Standardisation, Geneva.
- Jeyamkondan S., Jayas D. S., and Holley R. A. (1999). Pulsed electric field processing of foods: a review, *Journal of Food Protection*, **62**(9), 1088–1096.
- Khasnis A. A. and Nettleman M. D. (2005). Global Warming and Infectious Disease Archives of Medical Research **36**, 689–696
- Knura, S., Gymnich S., Rembalkowska E. and Petersen, B. (2006). Agri-food production chain, In *Safety in the Agri-food chain*. Eds PA Luning, F Devlieghere R Verhé, 19-65, Wageningen Academic Publisher, The Netherlands.
- Käferstein F., Abdussalam M. (1999). Food Safety in the 21st Century. *Bulletin of the World Health Organisation*, **77**(4), 347-51.
- Lehmacher A., Bockemühl J., Aleksic S. (1995). Nationwide outbreak of human salmonellosis in

Germany due to contaminated paprika and paprika-powdered potato chips. *Epidemiology and Infection*, **115**(3), 501-11.

Majchrowicz A. (1999). Innovative Technologies could improve food safety. *FoodReview*, **22**(2), 16-20.

McMichael A. and Githeko, A. (2001). Human health. In *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. pp. 451-486. (eds. J. J. McCarthy, O. F. Canziani, N. A. Leary, D. J. Dokken, K. S. White) Cambridge University Press, Cambridge.

Michino H., Araki K., Minami S. *et al.* (1998). Recent outbreaks of infections caused by *E. coli* O157: H7 in Japan. In *Escherichia coli* O157:H7 and other shiga toxin producing *E. coli* O157 and other shiga toxin producing *E. coli* strains. (Eds. JB Kaper and AD O'Brien) pp.73-81. ASM Press, Washington D.C.

Ministry of the Environment (2002). "Minamata Disease: The History and Measures" Government of Japan. <http://www.env.go.jp/en/chemi/hs/minamata>

Molins R.A., Motarjemi, Y. and Käferstein F.K. (2001). Irradiation: a critical control point in ensuring the microbiological safety of raw foods. *Food Control* **12**, 347-356.

Motarjemi Y., Käferstein, F., Moy, G., Miyagawa, S. and Miyagishima, K. (1996). Importance of HACCP for public health and development: the role of the World Health Organisation. *Food Control*, **7**(2)77-85.

Motarjemi Y. *et al.* (1995). Food Technologies and Public Health, WHO Document WHO/FNU/FOS/95.12. World Health Organization, Geneva

Motarjemi Y. *et al.* (In Preparation). Process Induced Food Toxicants and Health Risks. (Eds. Richard H. Stadler, David Lineback). John Wiley & Sons Inc, New Jersey.

Motarjemi Y. (2007). Food safety: learning from incidents. Paper presented at the 10<sup>th</sup> Asean Food Conference, Kuala Lumpur.

Ohlsson T. and Bengtsson N. (2002). Minimal Processing technologies in the food industry. Woodhead Publishing, Limited, Cambridge

O'Brien S.J. and Fisher, T.S.I. (2006). Surveillance of emerging pathogens in Europe. In *Emerging Foodborne Pathogens* (Eds. Y. Motarjemi and M. Adams). pp 50-76. Woodhead Publishing Ltd, Cambridge.

Pariza M.W. (1996). Toxic substances in foods. In: *Present Knowledge in Nutrition*. Seventh Edition. (Eds. Ekhard E. Ziegler and L.J. Filer, J.R.), ILSI Press, Washington, DC.

Promed, (2007a). Trichinellosis, human- Poland. 11 July, [www.promed.org](http://www.promed.org).

Promed, (2007b). Leptospirosis – Jamaica. 16 October. [www.promed.org](http://www.promed.org).

Promed, (2007c). Leptospirosis - Dominican Republic. 19 November. [www.promed.org](http://www.promed.org).

Promed, (2007d). Salmonellosis, frozen poultry pie. 30 October. [www.promed.org](http://www.promed.org).

Reason, J (1995). Understanding adverse events: human factors. *Quality in Health Care*. **4**, 80-89.

Reason, J (1997). *Managing the Risks of Organisational Accidents*, Ashgate Publishing Limited, England.

Rovira J. Avrelja Cencic A., Santos E. and Jakobsen M. (2006). Biological hazards. In *Safety in agri-food chain*. (Eds. P.A. Luning, F. Devlieghere and R. Verhé). Wageningen Academic Publishers, The Netherlands.

Ryan C.A., Nickels M. K., Hargrett-Bean N. T., Potter, M. E *et al.* (1987). Massive outbreak of antimicrobial-resistant salmonellosis traced to pasteurized milk. *The Journal of the American Medical Association*, **258**(22), 269-3274.

Ruegg P.L. (2003a). The role of hygiene in efficient milking, *Dairy Updates*. Milking and Milk Quality No. 406, 1-8. The Babcock Institute, University of Wisconsin.

Ruegg P.L. (2003b). Practical Food Safety Interventions for Dairy production. *J. Dairy Sci.*, **86** (E. Supp.): E1-E9.

Scanlan F.P. (2005). Why rapid testing. *Rapid Methods* ed. Van Amerongen, A; Barug, D and Lauwaars, M. Wageningen Academic Publishers.

- Siegel-Itzkovich, J. (2004), Babies fed defective formula are still being treated for neurological damage. *British Medical Journal*, **329** (7475), 1128.
- Tang Y.W., Wang J.X., Xu Z.Y., Guo Y.F., Qian W.H., Xu J.X. (1991). A serologically confirmed, case-control study, of a large outbreak of hepatitis A in China, associated with consumption of clams. *Epidemiology and Infection*, **107**(3), 651-7.
- Te Winkel G.P. (1997). Biosecurity in poultry production: where are we and where do we go? *Acta veterinaria Hungarica*. **45**(3), 361-72.
- Tiju, J. and Morrisson, M. (2006). Nanotechnology in Agriculture and Food. A nanoreport forum. Nanoforum. www.nanoforum.org.
- UK FSA (2006). Benzene in soft drinks, March. www.food.gov.uk
- US FDA (2006). Data on Benzene in Soft Drinks and Other Beverages. www.cfsan.fda.gov
- Van der Giessen J., Fonville M., Bouwknegt M., Langelaar M. and Vollema A. (2007). Seroprevalence of *Trichinella spiralis* and *Toxoplasma gondii* in pigs from different housing systems in The Netherlands. *Veterinary Parasitology*, **30** (148) (3-4): 371-374.
- Weiss J., Takhistov P. and McClements, D.J. (2006). Functional Materials in Food Nanotechnology. *Journal of food science*. **71**(9): R107-R115.
- Wilson J., Otsuki, T. (2003). Food Safety in Food Security and Food Trade: Balancing Risk Reduction from Trade in Setting Standards. In: Food Safety in Food Security and Food Trade. Edited by L. J. Unnevehr, International Food Policy Research Institute. Washington. D.C.
- White P.L., Baker A.R., James W.O. (1997). Strategies to control *Salmonella* and *Campylobacter* in raw poultry products. *Revue Scientifique et technique*, **16**(2), 525-41.
- WHO (1957). Milk Hygiene. Report of a Joint FAO/WHO Expert Committee. First Report. Geneva: World Health Organization. (WHO Technical Report Series, No 124).
- WHO (1976). Microbiological aspects of food hygiene. Report of a WHO Expert Committee with the participation of FAO. Technical Report Series 598. World Health Organisation, Geneva.
- WHO (1984). The role of food safety in health and development. Report of the Joint FAO/WHO Expert Committee on Food Safety. Technical Report Series 705. World Health Organisation, Geneva.
- WHO (1988). Food irradiation, a technique for preserving and improving the safety of food. World Health Organisation, Geneva.
- WHO (2000). Foodborne Diseases: a Focus on Health Education. World Health Organisation, Geneva
- WHO (2007). INFOSAN, 12, February, World Health Organisation, Geneva.
- Yuste, J. Capellas M., Pla R., Fung D.Y.C., Mor-Mur M. (2001). High pressure processing for food safety and preservation: a review. *Journal of Rapid Methods and Automation in Microbiology*, **9**, 1-10.

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- WHO. (2000). Foodborne diseases: focus on health education, World Health Organization, Geneva.
- Adams M and Motarjemi Y, (1999). Basic Food Safety for Health Workers, World Health

Organization, Geneva.

- Motarjemi, Y (2001). An introduction to the Hazard Analysis and Critical Control Points System and its application to Fermented Foods. In *Fermentation and Food Safety*, Martin R. Adms and M.J. Robert Nout., Aspen Publishers, Gaithersburg, Maryland.
- Motarjemi, Y and Mortimore, S (2005). Industry's need and expectations to meet food safety. *Food Control*, 16. 523-529.

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