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Food safety management and regulation: A systemic review

Ramezan Ali Mahian[1], Akram Arianfar[2]*

[1]Department of Food Science and Technology, Quchan Branch, Islamic Azad University, Quchan, Iran
[2]Young Researchers and Elite club, Quchan Branch, Islamic Azad university, Quchan, Iran

Abstract : Food supply chains of today are increasingly global, with organisations having to source materials from outside traditional boundaries in order to remain competitive. Additionally, the interconnectivity of these global supply networks can mean that a problem in one country often results in a global crisis. These and other trends bring with them many challenges that need to be managed to safeguard the end consumer. The safety and quality of the finished product is dependent on the integrity of the entire chain from the farm to the fork, which requires systems and approaches to be in place to ensure that there are no breaks or deviations that will result in adverse effects further downstream. Establishing internal management and team efforts focused on preventive causal based strategies is critical to developing successful continuous improvement safe and quality food transportation processes. Such processes must be capable of becoming food safety certified to standards that also require process quality controls. Management personnel, maintenance stations, implementation personnel, carriers, containers, bins and devices used to transport food all come under new requirements for protecting human health from cross and transported adulterants. Certification requires following sets of rules focused on full and partial certification that embrace new sanitation and traceability requirements.
Key words: Quality and safety standards, Food system, Food safety, HACCP.

1. Introduction

In 2010, the Food and Agriculture Office (FAO) of the UN, the World Organization for Animal Health (OIE) and the World Health Organization (WHO), signed'A Tripartite Concept Note' on sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces[1]. Practically, this global agreement is reflected, for example, in the EU legislative food safety framework[2] with a number of initiatives, one of them being that flexible provisions were adopted in legislation to protect the diversity of EU agricultural production[3], to serve consumers and the needs of small-scale producers[4].

Both Food Business Operators (FBOs) and Official Controllers (OCs) share the same common goals; safe food and safe food production. These common goals can only be achieved with an effective legislative interpretation and implementation by competent people and through effective communication, collaboration, cooperation and coordination at all levels. Most (European) companies participating in these studies managed to have fit-for-purpose and well elaborated quality assurance and quality control systems in place[5].

A food safety culture audit 'culture excellence' is proposed by Taylor Shannon International for the food industry, giving insights in strengths and weaknesses of the organizational culture[6]. Jespersen (2015) introduced a more observational method assessing the performance of certain behaviors to determine the maturity of the organizational food safety culture[7].

Despite the fact that food production and agricultural productivity have increased in the world, they are not sufficient to ensure that most vulnerable groups have access to food, and have sufficient food stability, which is the pillar that has made the least progress in the last decades due to volatility of international food prices, political instability[8], changes in climate patterns and climate extreme events, incidence of crop and pest diseases and reduction of water availability. In addition, in 2013 about 33% of all stunted children were from Asia and Africa[9] where undernutrition is widespread[10]. Certainly, hunger eradication, reduction of child mortality, improvement of maternal health and environmental sustainability are among the Sustainable Development Goals[11].

Routine food safety testing is carried out, according to legislative requirements[12], in food products to detect biological and chemical contaminants that can occur naturally or accidentally during the food production process. Deliberate contamination of our food chain is thankfully a very rare event. The European Union (EU) Bio-preparedness Green paper[13] concluded that the existing food safety framework needed to be complemented by a new framework that included security aspects, such as food defence practices.

Food safety testing is based on scientific knowledge of the critical points during the food production process combined with an understanding of the likelihood of natural and accidental contaminating agents in that food chain, the HACCP (Hazard Analysis and Critical Control Points) principles[14,15,16].

The asymmetrical threats that food defence practices hope to prevent, or respond to, stand in contrast to naturally or accidentally occurring contamination events (Fig. 1). Food safety testing is based on scientific knowledge of the critical points during the food production process combined with an understanding of the likelihood of natural and accidental contaminating agents in that food chain, the HACCP (Hazard Analysis and Critical Control Points) principles[17]. Using the same approach in food defence could be problematic where the motivation for an attack can be political, criminal or economic and the agents used may be novel to the food chain in question[18].

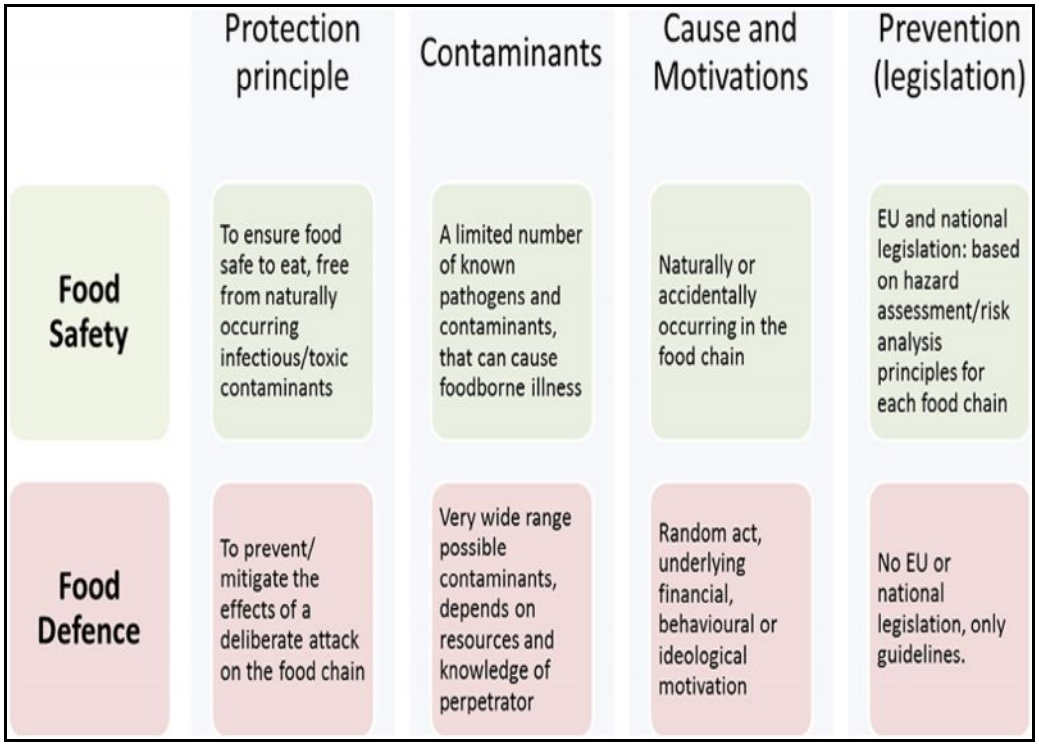

Fig. 1. The differences in food safety and food defence regarding protection principle, contamination, cause and motivations and prevention[19].

2. Standards for Food Security and Nutrition

In general, food needs that arise from sudden-impact disasters eg. Earthquake, floods, etc are urgent but temporary, whereas in slow-impact disasters like droughts, civil wars, etc, food needs develop gradually and tend to last longer[20]. Disasters can make pre-existing inequalities worse. Although the affected state is the main duty-bearers to ensure appropriate management of the food and shelter crisis followed by long-term rehabilitation, humanitarian agencies working alongside the local government also have a responsibility to work with the disaster-affected population in a way that is consistent with the rights. Food security during a disaster response is achieved through better preparedness. The level of preparedness must include risk assessment, contingency planning, stockpiling of equipment and supplies, emergency services and stand-by arrangements, communications, information management and coordination arrangements between various agencies involved. The Sphere handbook states that food security exists "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life"[21].

The world narrowly missed the Millennium Development Goal (MDG) target of reducing the proportion of the world's hungry by half[22]. Over the coming decades, anumber of factors and trends will have major implications for global food security and nutrition. A rapidly growing, increasingly affluent, and urbanizing global population[23] will transform food production systems by both increasing food demand and shifting the composition of food demanded away from staple foods toward more processed and higher quality diets, especially in developing countries (Fig. 2)[24].

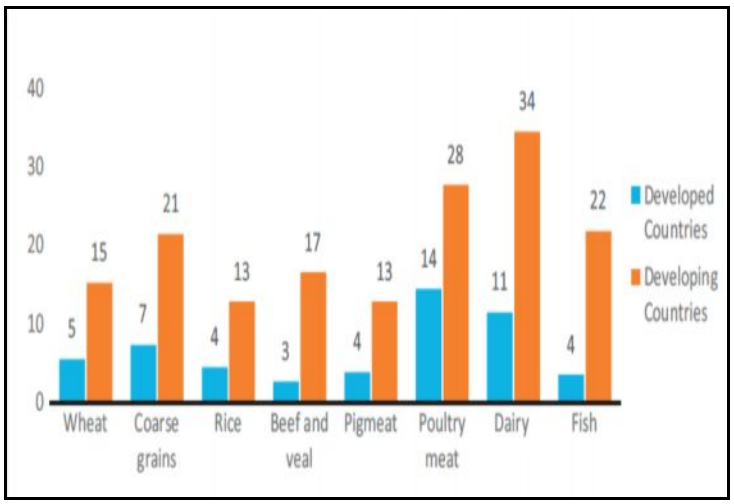

Fig. 2. Estimated change in food consumption, 2014 to 2024 (%)[25].

3. Rethinking and demystifying traditional beliefs about agricultural and food production systems

The path toward sustainable food security and nutrition is often riddled with inaccurate and oversimplified beliefs (Table1) regarding the requirements and impacts of such a strategy. Such "myths" pose a significant challenge to the effective design and promotion of more environmentally-friendly food systems. Are thinking of the global agricultural and food systems is thus essential, starting with the debunking of the myths and misconceptions about how to improve food security and nutrition along a sustainable path.

Table 1. Myths on sustainable food security and nutrition[26].

1	Tradeoffs are inevitable between environmental sustainability, food security, and nutrition
2	Technological silver bullets are all that is needed
3	Economic growth will automatically lead to reduction in hunger and undernutrition
4	Small farms should be supported at all costs
5	Technologies are always gender-neutral
6	Biofuels are always green

4. Generic food quality and safety standards

The three most important generic quality assurance systems in the food sector are Good Agricultural Practices (GAPs), Hazard Analysis of Critical Control Points (HACCPs) and International Organisation for Standardisation (ISO)[27].

Several other papers have addressed the development and use of quantitative approaches in risk assessment and safety standard development for food allergy and have addressed the advantages of these approaches[28,29]. Further development of threshold data bases and consensus on the application of such knowledge will bring this area of risk assessment to a higher level. Critical analyses and discussions on data gaps and uncertainty will be needed to direct future research and to reach consensus and acceptance of these approaches[30].

5. The role of self-efficacy in increasing food security

Food insecurity, or not having the resources to obtain enough safe, nutritionally adequate food to support an active, healthy life, is a significant public health issue in the United States. In 2013, 14.3% (17.5 million) of American households experienced food insecurity at some point during that year[31]. The underlying risk factors for food insecurity include unemployment, low levels of income and education, high housing and heating costs, lack of access to transportation, poor mental health and low social capital[31]. Many food pantry clients are not just in need of food, but are also in need of employment with livable wages, additional education, affordable health care, improved affordable housing conditions, mental health services, and affordable child-care[32].

6. There are demonstrated market solutions to food safety management

Several factors have led to the increased importance of private standards for food safety during the past decade. Henson and Humphrey (2010) discuss how private standards emerged from European retail chains as a response to concerns from consumers and civil society, and to address a perceived vacuum in public regulation following high profile food safety incidents (e.g., mad cow disease). Market power exercised by multinational retailers allowed them to use such standards to establish brand identity and reputation, and to make the standards *de facto* mandatory requirements for market access[33].

6.1. Developing countries have demonstrated successful compliance with private standards in export markets

In developing countries, efforts to improve food safety have been focused on market access requirements associated with high value products, particularly exports. Compliance with private food safety standards is found to lead to higher export sales or prices, revenues, and incomes in 10 studies of high value horticultural exports in at least 10 different countries in a recent review by Unnevehr and Ronchi (2014)[34]. In many cases there are other benefits, such as adoption of improved technology with spillover benefits for staple crops[35], higher or more stable labor income[35] or improved health through reduced on-farm exposure to pesticides [36].

7. UK approach to flexibilities permitted under EU Hygiene Regulations

Following the introduction of the harmonized EU Food Hygiene Package in 2006, the European Commission (EC) in 2009 initiated a number of fact-finding Food and Veterinary Office (FVO) audits of small-scale establishments in EU Member States (MSs). Six EU MSs, including the UK, volunteered for FVO audits. The purposes of these visits were to find out to which extent flexibilities were applied in the EU[37], and in longer-term consolidation and dissemination of 'best practice' guidelines through the Commission staff working documents on the Understanding of certain provisions on flexibility provided in the Hygiene Package[38].

In parallel with the EC initiatives, the UK Food Standards Agency (FSA) formed a Current and Future Meat Control (CFMC) task group on flexibility, and composed of the officials and industry representatives. The group faced a task to unwrap the fact that EU hygiene regulations provide FBOs with a variety of flexibilities, including through the use of subjective terms such as "adequate", "sufficient" and "equivalent". These terms have been interpreted for operators and officials in the UK meat sector in the Meat Industry Guide (MIG) and the Manual for Official Controls (MOC). After some deliberation the group provided a working definition of flexibility as 'an alternative way of achieving compliance through structure, production processes and official controls'. The group also agreed that any flexibility applied must not result in any increased risk to public

health, animal health and animal welfare. The task group produced two specific documents, first being guidance on the flexibilities available for small food production establishments in 2011[39] and then the flexibilities available for larger meat establishments in 2012[40] setting out a clear list of the existing flexibilities in current legislation, which all operators can access and consider in light of their production processes. Following this, a survey of all slaughterhouses was carried out in 2013 with the purpose of establishing the extent that structural and operational (production processes) flexibilities have been taken up by FBOs and if not, why not. The actual survey was also an educational opportunity for OCs and FBOs where they discussed in an open and focused way the possible flexible approaches without compromising food safety[41,42].

8. Politics, Economics, and Demographics of Food Sustainability and Security

The most recent figures from the FAO indicate that about 800 million people are undernourished in the world[43]. While this figure represents an improvement in the situation over the past 20 years, 800 million undernourished mouths is still too high a number. Indeed, if global food and water resources were rationally and democratically distributed among nations, every man, woman, and child would have access to adequate nutrition! Addressing the situation of undernourishment is becoming more challenging because of rapidly changing socioeconomic and climate change. For these reasons, policies aimed at improving the processes of food production and manufacture, sale, and transport and distribution will play an increasingly important role in ensuring sustainable food security in the modern world[44,45]. Hazard and Operability Analysis (HAZOP) is a structured and organized technique for risk management[47,48].

9. Conclusion

Installation qualification (IQ) should be performed on new or modified facilities, systems and equipme[49]. Installation qualification is conducted to prove that equipment/system has been installed as per user and manufacturer recommendation and verifying that all required utilities have provided safe operation of equipment/system[50,51]. Quality assurance in the food industry has become a reality. Based on requirements of the public sector, private safety and quality standards are emerging and implemented. In the process of change, compulsory standards such as HACCP are a prerequisite for companies' behavior. The additional standards, such as Eurep-Gap, are disseminated through the industry as well. Concluding, the food industry has responded to food scandals by installing new quality assurance systems, on top of public regulations. Due to the global nature of the food industry, the impacts on the market are twofold: consumers receive benefits in terms of more and better safe food globally, and suppliers in the food industry have been entrenched into a variety of assurance systems, adding up to costs and doubts about the effectiveness of the systems. However, the dissemination of the assurance systems, standards and certification schemes globally is relatively limited and may imply the reduction of market access of suppliers.

References

1. The FAO-OIE-WHO Collaboration. Sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces. World Health Organization. A tripartite Concept Note, 2010. [cited 2015 June 16]. Available from: http://www.who.int/influenza/resources/documents/tripartite_concept_note_hanoi_042011_en.pdf.
2. Relevant food safety legislation. (EU). Available from: http://eur-lex.europa.eu/homepage.html.
3. European Commission. Protected Geographical indications and traditional specialities quality schemes. (EU). [updated 2015 June 09; cited 2015 June 16]. Available from: http://ec.europa.eu/agriculture/quality/schemes/index_en.htm.
4. The European Commission Report. Report from the Commission to the Council and the European Parliament on the experience gained from the application of the hygiene Regulations (EC) No 852/2004, (EC) No 853/2004 and (EC) No 854/2004 of the European Parliament and of the Council of 29 April 2004. EC 2009. [cited 2015 June 15]. Available from:http://ec.europa.eu/food/food/biosafety/hygienelegislation/docs/report_act_part1_en.pd
5. Luning PA, Kirezieva K, Hagelaar G, Rovira J, Uyttendaele M, Jacxsens L. Performance assessment of food safety management systems in animalbased food companies in view of their context characteristics: a European study. Food Control., 2015,49: 11-22.
6. TSI. http://taylorshannon.com/, Accessed on 23.6.2015. In Taylor Shannon International., 2015.

7. Jespersen L. Food safety culture: Measure what you treasure. http://www. Food safety tech.com/Food Safety Tech/Features1/Food- Safety- Culture- Measure- What-You Treasuree2428.aspx accessed on 23rd of June 2015. In Food Safety Tech., 2015.
8. FAO, IFAD, WFP. The state of food insecurity in the world. Strenghtening the enabling environment for food security and nutrition. Food and Agriculture Organization of the United Nations (FAO), Rome., 2014.
9. UNICEF, WHO, The World Bank. Trends in child malnutrition. UNICEF-WHO- The World Bank joint child malnutrition estimates 2014. UNICEF, WHO and The World Bank, 2014, 4.
10. UNICEF. Undernutrition contributes to half of all deaths in children under 5 and is widespread in Asiaand Africa. ⟨http://data.unicef.org/nutrition/mal nutrition⟩., 2015.
11. Cruz-Garcia GS, Sachet E, Vanegas M, PiispanenK. Are the major imperatives of food security missing in ecosystem services research?, Ecosystem Services., 2016, 19: 19–31.
12. Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuff, Off. J. Eur. Union L., 2006, 364: 5–24.
13. Commission of the European Communities, Green Paper on Bio-Preparedness, Brussels. <http://ec.europa.eu/transparency/regdoc/rep/1/2007/EN/1-2007-399-EN-F1-1.Pdf>.2007, 1–17
14. Guidance document on the implementation of procedures based on the HACCP principles, and on the facilitation of the implementation of the HACCP principles in certain food businesses, European Commission, Health & Consumer Protection Directorate-General,<http://ec.europa.eu/food/food/ biosafety/hygienelegislation/docs/guidance_doc_haccp_en. pdf. 2005, 1–26
15. Sundarapandian V, A Novel Chemical Chaotic Reactor System and its Adaptive Control, International Journal of ChemTech Research, 2015, 8 (7), 146-158
16. Bhattacharya R, Ganesh Kumar V, Consequence analysis for simulation of hazardous chemicals release using ALOHA software, International Journal of ChemTech Research, 2015, 8 (4), 2038-2046.
17. Guidance document on the implementation of procedures based on the HACCP principles, and on the facilitation of the implementation of the HACCP principles in certain food businesses, European Commission, Health & Consumer Protection Directorate-General,http://ec.europa.eu/food/ food/biosafety/hygienelegislation/docs/guidance_doc_haccp_en.pdf. 2005, 1–26
18. Manning L, Soon JM. Food safety, food fraud and food defense: a fast evolving literature, J. Food Sci. 2016, 81 (4): R823–R834.
19. Pedersen B, Gorzkowska-Sobas AA, Gerevini M, Prugger R, Belenguer J, Maletti d M, Ljones M, Harstad Gilljam B, Tonsager J, Opstad AM, Davidson RK. Protecting our food: Can standard food safety analysis detect adulteration of food products with selected chemical agents?, Trends in Analytical Chemistry., 2016, doi: 10.1016/j.trac.2016.05.014.
20. Fisher D. Fast Food: Regulating emergency food aid in sudden-impact disasters. Vanderbilt J Transnational Law., 2007, 40: 1127-53.
21. The Sphere Project, Humanitarian charter and minimum standards in humanitarian response, The Sphere Project 2011, 145.
22. FAO. The State of Food Insecurity in the World 2015. Meeting the 2015 International Hunger Targets: Taking Stock of Uneven Progress. Rome, Italy. ⟨http://www.fao.org/3/a-i4646e.pdf⟩. 2015.
23. United Nations (UN) Population Division, World Urbanization Prospects: The 2014 Revision. [(2015-1-26) ⟨http://esa.un.org/unpd/wup/index.htm⟩. 2014.
24. Mark WR, Tokgoz S, Bhandary P, Msangi S. Scenarios for the Future of Food. In: 2012 Global Food Policy Report. Washington, D. C. ⟨http://www.ifpri.org/gfpr/2012/looking-ahead⟩. 2013.
25. OECD-FAO. OECD – FAO Agricultural Outlook 2015–2022. ⟨http://www.oecd. org/berlin/OECD-FAOHighlights_FINAL_with_Covers%283%29.(pdf)⟩. 2015.
26. Fan S, Brzeska J. Sustainable food security and nutrition: Demystifying conventional beliefs. Global Food Security, http://dx.doi.org/10.1016/j.gfs.2016.03.005i. 2016.
27. Trienekens J, Zuurbier P. Quality and safety standards in the food industry, developments and challenges. Int. J. Production Economics., 2008, 113: 107–122.
28. Crevel RW, Baumert JL, Baka A, Houben GF, Knulst AC, Kruizinga A G.…Madsen CB. Part II: development and evolution of risk assessment for food allergens. Food and Chemical Toxicology., 2014a, 67: 262-276.
29. Crevel RW, Baumert JL, Luccioli S, Baka A, Hattersley S, Hourihane JO.…Chung YJ. Part III: translating reference doses into allergen management practice: challenges for stakeholders. Food and Chemical Toxicology., 2014b, 67: 262-276.

30. Taylor SL, Houben GF, Baumert JL, Crevel RWR, Allen KJ, Dubois A.…Brooke-Taylor, S. Understanding food allergen thresholds requires careful analysis of the available clinical data. Journal of Allergy and Clinical Immunology., 2015,135: 583-584.
31. U.S. Department of Agriculture Economic Research Service. Survey tools. Food Security in the U.S. Website. ⟨http://www.ers.usda.gov/topics/food-nutrition- assistance/food-security-in-the-us/survey-tools.aspx#household⟩. 2015.
32. Feeding America. Annual report: bringing hope to 46 million people.Feeding America Web site. ⟨http://www.feedingamerica.org/about-us/about-feeding- america/annual-report/⟩, 2014.
33. Henson S, Humphrey J. Understanding the complexities of private standards in global agri-food chains as they impact developing countries. The Journal of Development Studies, 2010, 46: 1628–646.
34. Unnevehr L, Ronchi L. Food Safety Standards: Economic and Market Impacts in Developing Countries. View point Note Number 341. The World Bank Group, July. 2014.
35. Minten B, Randrianarison L, Swinnen J F M. Global retail chains and poor farmers: Evidence from Madagascar. World Development, 2009, 37: 1728–1741.
36. Kersting S, Wollni M. New institutional arrangements and standard adoption: Evidence from small-scale fruit and vegetable farmers in Thailand. Food Policy, 2012, 37: 452–462.
37. Food and Veterinary Office report. FVO General report of a mission series – Regarding the application of the Hygiene Regulations in small establishments – DG (SANCO) /2010 -6150; EC 2011. [cited 2015 June 15]. Available from: http://ec.europa.eu/food/fvo/overview_reports/details.cfm?rep_id=15.
38. The European Commission working document. Commission staff working document on the Understanding of certain provisions on flexibility provided in the Hygiene Package Frequently Asked Questions Guidelines for the competent authorities. EU 2010. [cited 2015 June 15]. Available from: http://ec.europa.eu/food/food/biosafety/hygienelegislation/docs/faq_all_public_en. pdf.
39. Food Standards Agency. Small and low throughput establishments: Examples of EU hygiene regulation flexibilities. UK 2011. [cited 2015 June 16]. Available from: http://www.food.gov.uk/business..industry/guidancenotes/hygguid/euhygieneregulationsflexibilities/#anchor_2.
40. Altal J, Alkadi H, Analytical method for determination Ochratoxine A in some kinds of food, International Journal of ChemTech Research, 2015, 8 (11), 343-349
41. Sundarapandian V, Adaptive Control of Rikitake Two-Disk Dynamo System, International Journal of ChemTech Research, 2015, 8 (8), 121-133.
42. Food Standards Agency. Larger meat establishments examples of flexibilities. UK 2012. [cited 2015 June 16]. Available from: http://www.food.gov.uk/sites/default/files/multimedia /pdfs/ exhygienregstable.pdf
43. FAO, IFAD, WFP. The State of Food Insecurity in the World 2015. Meeting the 2015 International Hunger Targets: Taking Stock of Uneven Progress. FAO, Rome, Italy.
44. Pasquale Ferranti. Food Sustainability, Security, and Effects of Global Change. Reference Module in Food Sciences, 2016, http://dx.doi.org/10.1016/B978-0-08-100596-5.03332-1. 2015.
45. Vishal Gupta N, Charan H Y., Hazard Operability Analysis (HAZOP): A Quality Risk Management tool, International Journal of ChemTech Research, 2016, 9 (3), 366-373.
46. Ram Mohan S.R, N. Vishal Gupta, Qualification of Tunnel Sterilizing Machine, International Journal of ChemTech Research, 2016, 9 (3), 400-405.
47. Vishal Gupta N, Shukshith K.S., Qualification of Autoclave, International Journal of ChemTech Research, 2016, 9 (4), 220-22.
48. Sundarapandian V, Global Chaos Control of the GeneralizeLotka-Volterra Three-Species System via Integral Sliding Mode Control, International Journal of ChemTech Research, 2016, 9 (4), 399-412.
49. Mansour H A, Performance Automatic Sprinkler Irrigation Management for Production and Quality of Different Egyptian Wheat Varities, International Journal of ChemTech Research, 2015, 8 (12), 226-238.
50. Abd El-Naby S K M , El-Sonbaty MR, Maha Ibrahim M, Mona Nassar A. Regulation of the banana fruits ripening by using different treated food paper packaging, International Journal of ChemTech Research , 2016, 9 (3), 118-126.
51. Hemalatha B, Meyyappan Rm, Microbial De-colorization of Acid blue 9: An Experimental Study, International Journal of ChemTech Research, 2015, 8 (4), 2073-2078.

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