Bülent Eker[1)]
Aysel İçöz[2)]

1) Namık Kemal University Agricultural Faculty, Biosystem Engineering Department Tekirdağ/TURKEY
buekeray@gmail.com

2)Namık Kemal University, Tekirdağ Vocational High School,Tekirdağ/TURKEY
aicoz@nku.edu.trb

QUALITY-BASED SOLUTIONS IN FOOD INDUSTRY MACHINERY

Abstract: *Mechanization is an indispensable element in every aspect of the food industry. Employees and enterprises in the food sector need tooling equipment to produce, collect, process, and store food. Nowadays, foods we drink and eat are prepared in the factories or in food enterprises and submitted to consumers as packaged food. Foodstuffs go through a long process of processing from the raw material stage until they are presented to consumers and become foodstuffs through the food machines. Food processing and packaging machines, which are new technology products and can be included in automation when necessary, are now taking place in food production industry increasingly. In this regard, producers can respond to increasing consumer demands with safer, more hygienic and higher quality productions. Changing consumer demands for food, production of new foodstuffs in the food sector, changing concept of packaging also cause change in the quality and design of food machines. Manufacturers are aware that they will increase the quality of their food production at each stage of their production and improve their image to a higher level when they use equipment that improves productivity and capacity, contributes to employee safety, and improves product hygiene. Because natural resources are increasingly consumed and food is a necessary factor for mankind to survive food is so important that it cannot be wasted. Identification and decreasing faults that occur during production and their effects on the production steps must be well known. Thanks to the developed machines, the waste from food production will be reduced and productivity will increase. Food producers have to adapt their equipment to new technology in order to reduce their production costs, raise their qualities and protect their image, to make their presence in market conditions permanent and to provide competitive advantage. This study will focus on the quality of equipment used in the food industry and their reflection on the sector.*

Keywords: *food industry, machinery, quality*

1. INTRODUCTION

As the society has developed over time, feeding system has transformed into a widespread and complex global system throughout centuries. The commitment of food science and technology professionals to improve food science, supply safe and abundant food , and contribute people to be healthier is an inseparable part of this evolution [1]. Food processing can be described as the transformation of raw ingredients and intermediate products into products, designed for human consumption, in order to improve the bioavailability, flavor, appearance, safety, storability and distribution of food stuffs and energy [2]. The rules of food production and processing are changing in parallel with consumer expectations. The designs; more hygienic,reducing yield loss, prolonging shelf life, each stage of which can be monitored and

controlled are included in product processing operations [3].

Food processing and packaging industry is becoming a trillion dollar worth global trade [4]. Worldwide processed food sales have exceeded $ 2 trillion. However, packaged food is worth about $ 1 trillion [5, 6]. Quality, cost, efficiency factors have obligatorily been considered in food processing and packaging [7]. Food processing and packaging industry has transformed food from one step to another based on appropriate techniques and methods [8]. The innovations of food processing techniques can make a significant contribution to meet needs. Sustainability enhancing technologies in the food processing sector include sensor technologies, sustainable packaging and cooling climate control, thermal pasteurization and sterilization, nanotechnology and micro-technology, innovative processes for the use of waste products, alternative processes, less energy or water and plant-based meat alternatives , and those requiring knowledge and information transfer [2].

In industrialized and developing countries, food producers and processors are demanding science and technology to provide safe, nutritious and affordable sustainable food supply and meet the rapidly increasing demand [9]. The systems and standards are acknowledged by today's food industries. Food processing and automation systems involve multidisciplinary activities. The importance of advanced automation and control solutions for the food industry have been emphasized. Other important aspects of food processing and packaging are toxin removal, marketing and distribution, preservation of taste, availability throughout the year and long shelf life [10]. The emergence of machinery, robotics and automation technologies has decreased the cost of processed food, compared to original food products [11]. The productivity of a typical food processing plant depends on preliminary preparation , processing and protection methods, packaging materials, systems, automation, instrumentation and control schemes for material flow, intelligence level of sensors, development in machines and and machineries (including robotic application), inspection methods, printing methods, security identification, graphic design and digital workflow, sanitation and sterilization, supply chain management [12,13]. Consumers all over the world desire their food to be of higher quality or better quality. In most cases, quality means different things to different people. Food quality can mean sensorial feature (appearance, taste), nutritive value (nutrient content), health benefits (functional substance) or safety (chemical, physical, biological). There is a general consensus on that food safety is people's fundamental right, and that various efforts are being made by all sectors to achieve safer food goal for everyone [3]. As a consequence of global economic development, there has been a dramatic increase in both quantity and diversity of food transported in international trade [3]. Food producers produce new products continuously following the trends of consumers. Food market has grown rapidly in recent years as a result of the changes in consumer habits [14]. Information technology plays an important role in other sectors as well as in the food supply chain. The successful utilization of information technologies in food supply chain can greatly enhance product safety and quality [15].

In this study, it has been aimed to have knowledge about the quality based solution proposals in food machines for the application of new tool equipments and processing technologies that meet increasing food demand, consume less water and energy, prevent formation of wastes, allow higher value food production, have integration ability into automation, provide food safety, produce less loss and waste.

2. FOOD QUALITY

One of the challenges faced by producers and supply chain is to increase consumer confidence in food quality and safety [2]. Increasingly more focusing on product safety and quality features has led to an increase in the role of formal product and process standards. The standards are commonly available in market economies, and play an essential role in the organizations of supply chain for most products and services, including conventional marketing systems [16, 17]. However, official standards are increasingly becoming the dominant mechanism of market and supply chain management in more valuable markets, as well as being a need for many uncoded buyers. The standards are often an important tool for product differentiation in such markets [17, 18]. Post harvest technologies can contribute to food safety in a variety of forms. The techniques for

reducing food losses require adaptation of cultural and economic conditions [19]. Food losses means decrease in originally edible food amount (dry matter) or nutritional value (food quality) that are initially available for human consumption [20]. Food losses occur during production, post-harvest and processing stages of food supply chain [21].

Allowing hygienic production during long working hours, not posing a threat to the safety of the workplace, accurate measurement, sealing are important features desired in food instrument equipments. Today, sensor-based food machines used in the food industry offer a variety of production options. Food collection and processing machines improve profitability, productivity, food quality and safety, processing capacity and usability.

3. EFFECT OF IMPROVING QUALITY ON REDUCING FOOD LOSSES

Raw food components undergo many changes in size, chemical composition, structure and color before being consumed as a final food product. This is the essence of the food processing. Approximately one third of the produced food is lost somewhere in the worldwide production and distribution chain. Food losses correspond to the decrease in the edible food amount throughout the supply chain. Food losses occur in the production, post-harvest, and processing stages of the supply chain. Food losses occuring at the end of the food chain (retail and final consumption) are called “food waste” which is related to the behaviors of retailers and consumers. [21].
40% of food losses in developing countries occur at post-harvest and processing levels, and over 40% of food losses in industrialized countries occur at retail and consumer levels [22].

Food chain transparency, traceability of raw materials and ingredients are becoming increasingly important [23]. Engineering studies play very important role in the production of food equipments that are needed by food and beverage industry.

The development of food quality depends on the use of high-tech instrument equipment. By this way it will be possible to analyze possible weak points of the production line, to measure and monitor productivity in the production process and to produce alternative solutions when necessary.

4. SAFE FOOD PRODUCTION

Quality control and assurance is a part of the entire food production chain. Food chain integrity includes all aspects of the food chain, including microbial and chemical food safety, origin, fraud and quality distinctness [24]. Despite the obvious advantages of processed foods, loss of control / visibility is seen as a major problem by most consumers, and can cause a negative attitude against “industrial food” which is thought to be of low quality [25]. The food equipments, smoothly designed, not containing dark / humid areas for contaminants or microorganisms, capable to operate at high speeds, to load and unload objects with high precision and accuracy, are needed. Thus, high quality, reliable and high performance solutions suitable for different areas of the food industry can be provided [26].

Although, it is assumed that the current food system produces enough food for the world population, the reason why large groups especially in developing countries can not access to adequate, safe and nutritive food is the lack of appropriate processing, protection, packaging and distribution technologies.

5. THE IMPORTANCE OF AUTOMATION IN FOOD PRODUCTION

Recently, a trend has appeared regarding on-site research activities related to how science, engineering and technology will be used in processes, production, machinery, planning, management, logistics and regarding communication [27]. The most important requirement in the food supply chain is real-time data management due to a variety of reasons, and the most important concerns are safety and security. In order to ensure the supply of quality products as well as their production; food processors must be able to produce, manage and track products, information and resources efficiently throughout the supply chain as well as enterprise-wide. Food safety, potential liability issues, concerns about the biosecurity -related issues between consumers and suppliers, data management ranging from raw materials to

food for food and food products increases the need for real-time information in terms of safety. As in other industries, a company-wide software system plays a vital role in the food industry. Most food industry use new methods and techniques to follow up performance. [28].

Automatic food inspection is required to reduce both labor costs and maintain high productivity, and it is possible to detect product contamination by this way. Image processing, known as the non-destructive method for food inspection and grading, has become a new trend [29]. Recent developments in hardware and software have expanded so as to include imaging techniques for advanced food quality and safety inspection, including disease detection, imperfections, and contamination. Processors and suppliers have adopted these techniques to protect food from interventions [15]

Food industry has faced with various challenges, such as government regulations, harsh working conditions, complex equipment requiring continuous maintenance to protect safety and standards. The need for continuous cleaning often creates a wet environment, which damages the machines and equipment. Recently, food processing and packaging companies have continually upgraded their automation and supply chain processes using advanced technology systems in manufacturing and production [30]. The designs, control systems and instrumentation, computer software and management, machine interfaces and technology trends of food processing integration methods helps the creation of indirect promotion and success plans, preparation of future customers, awareness of food processing integration methods [3**1**]. Properly selection of technology standards can enhance the effectiveness of food production, processing and packaging. The effective and excellent technologies, already available, can facilitate plug-and-play modular design strategy.

Traceability in food processing and packaging is crucial not only for safety, but also for preserving product originality. The ability to monitor and confirm a product is of a great importance. Traceability is generally understood as the completeness of information about each step in a process chain [5].

6. CONCLUSION

Competition and diversity in food sector ensure the development of safe and quality new food processing techniques to meet the needs of consumers. Enterprises that cost quality with high hygiene standards less than their competitors in market conditions can survive in challenging competition conditions. Establishing a standardized and scalable manufacturing system is crucial in terms of the existence of businesses. To attain competitive power; it is important for all processes to labeling and distribution, including raw material supply, manufacturing, packaging in aseptic processes, following up, complete food record, preventive activities to be get under control and directed correctly.

REFERENCES:

[1] Floros, J. D., R. Newsome, W. Fisher, G. V. Barbosa-Canovas, H. Chen, C. P. Dunne, J. B. German, R. L. Hall, D. R. Heldman, M. V. Karwe, S. J. Knabel, T. P. Labuza, D. B. Lund, M. Newell-McGloughlin, J. L. Robinson, J. G. Sebranek, R. L. Shewfelt, W. F. Tracy, C. M. Weaver, and G. R. Ziegler. (2010). Feeding the world today and tomorrow: The importance of food science and technology—An IFT scientific review. Compr. Rev. Food Sci. Food Saf. 9:572–599.

[2] Langelaan, H.C., Pereira da Silva F., Thoden van Velzen, U., Broeze, J., Matser, A.M., Vollebregt, M., Schroën, K. (2013). Technology options for feeding 10 billion people Options for sustainable food processing. State of the art report. PE 513.533 IC STOA 2013/122 November 2013

[3] Anonymos, (2005). Qualıty Control For Processed Foods. http://www.apo-tokyo.org/publications/wp-content/uploads/sites/5/pjrep-02-ag-ge-sem-02.pdf

[4] Mahalik, N.P. (2014). Advances in Packaging Methods, Processes and Systems. Challenges 2014, 5, 374-389; doi:10.3390/challe5020374

[5] Manalili, N.M., Dorado, M.A., Van Otterdijk, R. (2014). Appropriate Food Packaging in Developing Countries; Food and Agricultural Organization: Rome, Italy.

[6] Pingali, P.L. (2004). Agricultural Diversification: Opportunities and Constraints. In Proceedings of the FAO Rice Conference, FAO of United Nations, Rome, Italy, 12–13 February 2004.
[7] Hung, H.C., Sung, M.H. (2011). Applying six sigma to manufacturing processes in the food industry to reduce quality cost. Sci. Res. Essays 2011, 6, 580–591.
[8] Mahalik, N.P. (2008). Survey on Food Processing and Packaging Technology. Presented at Mini Symposium on Industrial Technology Links, Sponsored by Advance Technology Enterprises, California State University, Fresno, CA, USA, 13 March 2008; pp. 1–40.
[9] Floros, J. D. (2009). Getting real about our modern food system. ePerspective, Institute of Food Technologists–Food Technology. Accessed Apr. 3, 2011. http://foodtecheperspective.wordpress. com/2009/09/01/getting-real-about-our-modern-food-system/.
[10] Mahalik, N.P. (2009). Processing and Packaging Automation Systems: A Review. Special Issue on Advances in Food Automation. Sens. Instrum. Food Qual. Saf. 2009, 3, 12–25.
[11] Kapoor, R., Kulkarni, P., Jenkins, N., Krebs, M., Blevins, B.B. (2006). Technology Roadmap Energy Efficiency in California's Food Industry. In California Energy Commission Public Interest Energy Research Program No. CEC-500-2006-073; University of California: Davis, CA, USA.
[12] Anonymous, (2014a). Washing down Drives without Washing down Profits. Available online: http://www.gates.com/~/ media/Files/Gates/Industrial/Power%20Transmission/White%20Papers/WashingdowndrivesSM.pdf (accessed on 30 June 2014).
[13] Anonymous, (2014b). Food Packaging: Roles, Materials, and Environmental Issues. Available online: http://www.ift.org/ knowledge-center/read-ift-publications/science-reports/scientific-status-summaries/food-packaging.aspx (accessed on 30 June 2014).
[14] Porta et al., (2013). Edible Coating as Packaging Strategy to Extend the Shelf-life of Fresh-Cut Fruits and Vegetables. J Biotechnol Biomater 2013, 3:4 http://dx.doi.org/10.4172/2155-952X.1000e124
[15] Mahalik, N., Kim, K. (2016). The Role of Information Technology Developments in Food Supply Chain Integration and Monitoring.https://www.researchgate.net/publication/301262310_The_Role_of_Information_Technology_Developments_in_Food_Supply_Chain_Integration_and_Monitoring. Erişim tarihi (04.04.2017).
[16] Busch, L. (2000). The Moral Economy of Grades and Standards. Journal of Rural Studies, 16, 273–283
[17] Henson, S.J. and Reardon, T. (2005). Private Agrifood Standards: Implications for Food Policy and the Agrifood System. Food Policy, 30 (3), 241–253
[18] Henson, S. (2007b). New Markets and Their Supporting Institutions: Opportunities and Constraints for Demand Growth. RIMISP, Santiago.
[19] FAO, (2011). Global food losses and waste: Extent, Causes and Prevention
[20] FAO, 2013. Food wastage footprint: Impacts on natural resources.
[21] Parfitt, J., Barthel, M. & Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050, Phil. Trans. R. Soc., vol. 365, pp. 3065-3081
[22] Gustavsson, J., C. Cederberg, U., Sonesson, R., Otterdijk, Y., & Meybeck A., (2011). Global food losses and food waste, FAO, Rome, 2011
[23] Stuart, D., Woroosz, M. R. (2013). The Myth of Efficiency: Technology and Ethics inIndustrial Food Production [electronic resource].Journal Of Agricultural AndEnvironmental Ethics,26(1), 231-256.
[24] Hoorfar, J., Prugger, R., Butler, F. (2011). "Future trends in food chain integrity", in Food chain integrity, eds. J. Hoorfar, K. Jordan, F. Butler, R. Prugger. Part 4, Chapter 18, pp.303-308. Woodhead Publishing Limited,
[25] Van Boekel, M., Fogliano, V., Pellegrini, N., Stanton, C., Scholz, G., Lalljie, S., Somoza, V., Knorr, D., Rao Jasti, P., Eisenbrand, G., (2010). "A review on the beneficial aspects of food processing", Mol. Nutr. Food Res., 54, pp. 1215–1247,
[26] Maguire, E. (2017). Hygıenıc Desıgn Requırements For Food Processıng Machınery. http://www.picknpack.eu/images/workshop_Emma_Maguire.pdf
[27] Dobermann, A., Nelson, R., Beever, D., Bergvinson, D., Crowley, E., Denning, G., Giller, K., d'Arros Hughes, J., Jahn, M., Lynam, J., et al. (2013). Solutions for Sustainable Agriculture and

Food Systems, Technical Report for the Post-2015 Development Agenda; Thematic Group on Sustainable Agriculture and Food Systems of the Sustainable Development Solutions Network, Food Systems Development (Center for Transformative Action): New York, NY, USA, 2013.

[28] Anonymous, (2014c).Packaging Execution Systems Benefit Lean Manufacturing Initiatives. ARC Advisory Group, 2007. Available online: http://www.systech-tips.com/pes/pdfs/pes-english.pdf (accessed on 30 June 2014).

[29] Park, B., Kise, M., Lawrence, K.C., Windham, W.R., Yoon, S.C. (2008). Portable Multispectral Imaging Instrument for Food Industry. In Proceedings of the Food Processing Automation Conference, ASABE, Providence, RI, USA, 28–29 June 2008.

[30] Wegrzyn, T.F., Golding, M., Archer, R.H. (2012). Food Layered Manufacture: A new process for constructing solid foods. Trends Food Sci. Technol. 2012, 27, 66–72

[31] Fung, D.Y.C. (2014). Rapid Methods and Automation in Microbiology: Past, Present, and Future. In Proceedings of the Food Processing & Technology Conference, Las Vegas, NV, USA, 21–23 July 2014.