

PHYSICAL, CHEMICAL AND BIOLOGICAL POTENTIAL HAZARDS IDENTIFICATION OF SLAUGHTERHOUSE AND CHICKEN NUGGETS PRODUCTION PROCESS

IDENTIFIKASI POTENSI BAHAYA FISIK, KIMIA DAN BIOLOGI PADA RUMAH POTONG HEWAN DAN PROSES PRODUKSI *CHICKEN NUGGET*

Raynard C. Sanito

*Department of Environmental Engineering,
Faculty of Civil Engineering and Planning,
University of Science and Technology Jayapura,
Email: raynardsanito@gmail.com*

Diterima 25 Juli 2016 Disetujui 26 Mei 2018

ABSTRACT

Chicken nuggets, the one of protein rich foods, is produced from the chicken meat through several stages of the process. This research aimed to identify the potential hazards of chicken nuggets process in final products based on physical, chemical and biological hazards perspectives. The hazardous potentials were performed specifically using observations, interviews and investigations in a slaughterhouse unit and production unit. Furthermore, the finding of data was described qualitatively. The results of this study indicated that there were several potential hazards in physical, chemical and biological in a chicken nugget process. The ear problems, exhausted of workers, watered by heat frying oil were the examples of potential hazards in physical. In addition, contamination of heavy metal in product and the expired of food grade oil were an illustration of chemical potential hazards. Then, microorganisms in end products, the source of the pathogen were the examples of biological hazards potential. Finally, it could be concluded that chicken nugget factory possessed the physical, chemical, and biological potential hazards.

Key words: observations, interviews, findings, microorganisms.

INTISARI

Chicken nugget merupakan salah satu makanan kaya protein, yang terbuat dari daging ayam melalui beberapa tahapan. Penelitian bertujuan mengidentifikasi potensi bahaya dalam proses produksi *chicken nugget* pada proses produksi hingga menjadi produk akhir berdasarkan bahaya fisik, kimia, dan biologi. Analisis dimulai dari rumah pemotongan dan unit produksi Selanjutnya, berbagai temuan dari data yang ada dideskripsikan secara kualitatif. Hasil studi mengindikasikan bahwa ada beberapa potensi bahaya fisik, kimia, dan biologi dalam proses pembuatan *chicken nugget*. Gangguan pendengaran, pekerja yang kelelahan, tersiram minyak panas merupakan contoh dari bahaya fisik. Kemudian, kontaminasi logam berat pada produk dan *food grade oil* yang kadaluarsa merupakan ilustrasi dari bahaya kimia. Kemudian, mikroorganisme patogen yang mencemari produk merupakan contoh dari potensi bahaya ekonomi. Dapat disimpulkan bahwa dalam produksi *chicken nugget* dari pabrik memiliki potensi bahaya fisik, kimia dan biologi.

Kata kunci: Observasi, wawancara, temuan, mikroorganisme

INTRODUCTION

Chicken nuggets, one of the strategic food industries in Indonesia, has a significant role in order to support the requirements of food in Indonesia. This food, which is made from chicken meat or chicken slurry as a raw material, butter, and fried, is the favorite product to be consumed as a protein source. This food is simple to be prepared from the plastic packaging before it is being consumed and also has a unique shape.

Furthermore, this food also keeps and store in the refrigerator and will not expire easily.

Generally, the raw material of chicken nuggets derives from hatching eggs of chicks which is raised up to the mature chickens within three months. During the growth process, the chicks are usually injected with the vaccine and fed by high protein food to increase body weight and health condition. The chicken meats are usually supplied from the chicken breeders. After that, it will be transferred into the slaughterhouse because the chicken must be slaughtered. Furthermore, the raw materials

must be through the several stages until the final product can be processed through the several stages until the end product can be achieved.

Tsola *et al.*, (2008) claimed that the process of chicken nuggets productions had potential hazards for workers and products. It included the accident, potential of environmental pollution, and the contamination of products. Tsola *et al.*, (2008) mentioned that physical hazard, chemical hazard, and biological hazard might be found during the production process in a food factory. The Hazard Analysis Critical Control Point (HACCP) has the purposes to prevent the potential hazards in the production process to raise the food safety (Surak, 2002; Tsola *et al.*, 2008).

The emerging issues of hazards (physical, chemical and biological) such as disease, contamination of microorganisms, work accident, exhausted of the employees and environmental sanitation should be considered not merely in a production of high quality products but also maintained the employees work safely and healthy (Ministry of Labor, 1999a; Ministry of Labor, 1999b; Doyle and Ericson, 2006).

Although the factory of chicken nugget has been operated since a long time ago, it is still being evaluated in all of the potential hazards in every stage of the production process. A chicken nugget factory which is located in the Industrial Area. in East Java is one of the largest company in chicken nuggets production. In addition, the management of this factory is focusing continuously on a prevention of the hazard's potential.

The purpose of this study was to analyze and identify the potential hazards in the stages of production in chicken nuggets factory, particularly focusing on slaughterhouse and production unit.

The stage of the research was started in the chicken nuggets factory. This factory is located in Mojokerto, East Java, Indonesia. The location was in the industrial area which was relatively near other factories such as a plastic factory, metal factory and warehouse. Then, the comparison and identification of findings were described descriptively in the potential of hazards, the preventive actions and the waste in each of production process in accident, product and environment.

Furthermore, the observation was focused on potential hazards (physical, chemical and biological). The observation was started from receiving chicks, slaughterhouse and production process room (evisceration room, production room and packaging room). Then, the interviews were conducted directly with some informants based on the checklist and questionnaire. The informants were a supervisor, manager, and staff from each department. The interviews were started on exposing location for receiving chick, slaughtering room, evisceration room, production room and packaging room which accompanied by the area staff.

The results in observations and interviews were studied and processed according to the Indonesia regulation of occupational health safety and some literature which were related to physical, chemical and biological potential hazards.

RESULTS

The observations and interviews in the field indicate several potential hazards in physical, chemical and biology. The results of the analysis are shown in Table 1.

MATERIALS AND METHODS

Table 1. Some of Hazards Potential Analysis During Slaughter and Evisceration Processes (Observation Results on the Field)

Stage of production process/components	Identification of significant hazards at this stage	Is there a significant probability of hazard appearance?	Justification decision	Preventive actions	Waste
Receiving life chicken	Physical (P)	Yes	Digestive track full of feed	Evaluation of supplier from a breeder	
	Chemical (C)	Yes	Veterinary medicines, growth agents	Supplier evaluations, Veterinary certification, Checking the chicken before delivery, The Wastewater will be delivered into WWTP Plant from drainage	Feces
	Biological (B)	Yes	Contamination from pathogenic micro-organisms, disease birds	Feces from the truck washed and flowed in drainage into WWTP unit	

Stage of production process/components	Identification of significant hazards at this stage	Is there a significant probability of hazard appearance?	Justification decision	Preventive actions	Waste
Sortation (Antemortem / Inspection)	Physical (P)	No	Sortation is not using the machine		Dead Chicken or Carcass
	Chemical ©	No	Probably may not be found		
	Biological (B)	Yes	Contamination from pathogenic microorganism	Separate the dead chicken and damage it in burning facility	
Slaughtering	Physical (P)	Yes	An accident during cutting the caused by machine on the workers	Protection tools in the cutting machine, workers are learning the procedure of using the machine, safety tools, exhausted of the worker by the noise of boiler.	None
	Chemical (C)	No	Probably may not be found	Chemical are not using	
	Biological (B)	Yes	Contamination from pathogenic microorganisms	Contamination from microorganism	
Bleeding	Physical (P)	Yes	The cutting accident is caused by machine	Safety machine tools	Blood
	Chemical (C)	No	Probably may not be found		
	Biological (B)	Yes	Pathogen Microorganisms	Storage the blood during the processes and steam the blood	
Scalding	Physical (P)	Yes	Cutting Accident caused by machine	Check the machine, exhausted of worker	None
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		
Feather removal	Physical (P)	No	Probably may not be found		Fur of Chicken
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		
Head Pulling	Physical (P)	No	Probably may not be found		Destruction chicken, chicken fur and yellow skin.
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		

Stage of production process/components	Identification of significant hazards at this stage	Is there a significant probability of hazard appearance?	Justification decision	Preventive actions	Waste
Feet Cutting	Physical (P)	No	The workers only using the manual tools	Available of medicine box, management of range, exhausted of workers	Yellow skin from the chicken foot.
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		
Neck and Crop Slitting	Physical (P)	Yes	Cutting Accident caused by machine	Cutting from the machine	Skin of Neck,
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		
Internal Organ Pulling	Physical (P)	No	Probably may not be found		Wastewater
	Chemical (C)	No	Probably may not be found		
	Biological (B)	Yes	Intestinal contents are microorganisms carriers, Contamination of carcass (when the intestine is ruptured)	Washing the intestinal contents from microbe and flow it into WWTP from drainage	
Sortation II (post mortem / Inspection)	Physical (P)	Yes	Unsafety meals from postmortem	Separate the dead chicken and damage in burn facility	Rejected Product
	Chemical (C)	No	Probably may not be found		
	Biological (B)	Yes	Potential infection of disease	Damage it in the burn facility	
Giblet Pulling	Physical (P)	No	Probably may not be found		Gizzard and Skin
	Chemical (C)	No	Probably may not be found		
	Biological (B)	Yes	Pathogen Microorganism	Washing the intestinal contents from microorganism and flow it into a WWTP unit from drainage	
Inside and Outside Washing of Chicken's Body	Physical (P)	No	Probably may not be found		None
	Chemical (C)	No	Probably may not be found		
	Biological (B)	Yes	Pathogen Microorganism	Washing the intestinal contents from microorganism and flow it into a WWTP unit from drainage	

Stage of production process/components	Identification of significant hazards at this stage	Is there a significant probability of hazard appearance?	Justification decision	Preventive actions	Waste
Chilly	Physical (P)	No	Probably may not be found	Exhausted of workers and the skin is blistered by heat water	None
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found	Unsatisfactory chilling causes immediate development of micro-organisms	
Basic and Special Lines	Physical (P)	No	Probably may not be found		Plastic
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		
Weighing and Packing	Physical (P)	No	Probably may not be found		None
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		

Table 2. Some of Hazards Potential Analysis in Frying Process (Observation Result in Location)

Stage of production process/components	Identification of significant hazards at this stage	Is there a significant probability of hazard appearance?	Justification decision	Preventive actions	Waste
Tumbling (compacting shatter meat)	Physical (P)	Yes	Potential accident by machine	Inspection of the safety of machine routinely	Covering plastic
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		
Predust	Physical (P)	No	Potential accident by machine		Plastic wrapping of flour pre dust, Plastic Residue
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		
Bread Cumbers	Physical (P)	No	Potential accident by machine	Inspection of the safety of machine routinely	Plastic wrapping of flour pre dust, Plastic Residue
	Chemical (C)	No	Probably may not be found		
	Biological (B)	Yes	Potential contaminated from microorganism	Keep the room clean	

Stage of production process/components	Identification of significant hazards at this stage	Is there a significant probability of hazard appearance?	Justification decision	Preventive actions	Waste
Frying	Physical (P)	Yes	A potential accident during the frying processes	Blistered is caused by frying oil splash.	Oil spilled in drainage
	Chemical (C)	Yes	Heavy metals are dissolved in a fry process, expired food grade oil or food machinery grease which used for frying in the machine, spilled caused by frying oil	Check the MSDS, control the frying oil inventory warehouse.	
	Biological (B)	No	Probably may not be found		
Freezing	Physical (P)	No	Probably may not be found	Have a potential in a contamination with microorganisms, the product must be sterilized from microorganisms	Plastic waste
	Chemical (C)	No	Probably may not be found		
	Biological (B)	Yes	Probably may not be found		
Plastic Packaging	Physical (P)	No	Probably may not be found		Plastic waste
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		
Sealing	Physical (P)	No	Probably may not be found		None
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Probably may not be found		
Metal Detection	Physical (P)	No	Probably may not be found	Always checked the heavy metal in the meat routinely before packaging	Heavy metal and contaminated product
	Chemical (C)	Yes	Heavy Metal Which Dissolved in the meals		
	Biological (B)	Yes	Potential contaminated from microorganism		
Box Packaging	Physical (P)	No	Physical material is not found		Saving box
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Contamination from pathogenic micro-organism		
Product Frozen Save	Physical (P)	No	Probably may not be found		None
	Chemical (C)	No	Probably may not be found		
	Biological (B)	No	Potential contaminated from microorganisms		

The physical potential hazards were on the stage of production such as receiving live chicken, sortation, slaughtering, scalding, tumbling, and frying. Receiving live chicken has physical potential hazards such as digestive full of feed and accident which related with the machine, unsafety meals from postmortem, exhausted of work, and occupational disease (Presidential Decree of Indonesia Republic, 1993). The vehicle is usually

washed and cleaned rapidly for reducing the odor, fly and cockroach near the factory. In chemical potentials, there are several findings in receiving chicken process, frying, analyzing the final product, an accident from frying oil and food grade oil (food machinery grease).

The potential findings of chemical potential hazards are from veterinary medicine, heavy metal contamination in the frying process using deteriorated frying oil, food grade oil (food machine grease). In addition, the food

grade oil was used by dropping on the machine but for the nuggets do not adhere in the frying process. The stock of food grade oil was saved securely in the warehouse because it must be controlled to know the expired date and an explanation of the potential hazards. It was to prevent the opportunity for using the expired food grade oil (food machinery greases).

The observations and interviews in the field indicated several potential hazards in biological. The contamination of microorganisms such as bacteria or virus often grew rapidly in the wastes. Feces, intestine, wastewater were the examples of the media, that microorganisms lived inside. In addition, the biological potential hazards from the process indicated the pathogenic microorganism. Several sources, which have potential hazards from microorganism, were receiving chicken process from the supplier, sortation, slaughtering, bleeding, evisceration, and butter coating.

According to Surak (2002), microorganisms which are found in slaughtered poultry, are from two main sources. They are from an environment of slaughterhouse and a digestive of chicken. The pathogen microorganisms such as bacteria may be found in the poultry meat, are capable of causing born disease in human (Tsola *et al.*, 2008). Furthermore, according to James *et al.*, (2006) several bacteria can be found in internal and external washing, water-air chilling, cutting of bone, and packaging food. The microorganisms are *Salmonella* sp, *Campylobacter* spp, *C. perfringens*, *L. monocyctegenes* and *E. coli*. Furthermore, the pathogen microorganism can grow near the waste such as feces, organs and wastewater. After that, *Salmonella* sp and *Campylobacter* sp causes the deterioration in food quality and food born disease (Tsola *et al.*, 2008).

The wastewater has been flown through the drainage until arrives in the wastewater treatment plant. The source of wastewater composition is from washing vehicle (truck) contains of feces, water from the boiler and washing-result of organs, intestine, gizzard and meals. In addition, the capable of spoiling poultry meat may have microorganisms such as *Pseudomonas*, *Acinobacter*, *Flavobacterium*, *Corynebacterium* (Kotzekidou-Rouka, 1993; James *et al.*, 2006). The microorganisms in wastewater should be investigated due to prevent the biological hazard potential.

DISCUSSION

The Handling of Physics Potential Hazard

The handling of physical potential hazards by using the self-safety tools such as ears protection like ear plug might reduce the effect of noise (Labor and Transmigration Regulation of Indonesia Republic, 2010). The ear plug was used by workers with attach those tools in ears. During the survey, the workers have been using the earplug as safety tool for reducing the effect of noise. In addition, they also used safety shoes, safety masks and safety coats for protecting their entire body from potential accident. The value limit of physical factor was in an occupation location about 85 dBA (Ministry of Labor Decree, 1999).

The source of noise was from boiler, which was operated regularly using high temperature water. The using of hot water was for washing and facilitating the removal of chicken feathers. The high noise sound from boiler could decrease or damage the ability and function of ears. The noise could make fatigue and cause headache during their task. The production process had potential hazards like slipped and blistered caused by high temperature oil in frying process and high temperature water from chilling process. Near the frying machine, it had a drainage to flow the oil for reducing those potential hazards.

The Handling of Chemical Potential Hazard

The hazards handling of chemical potential hazards had several processes. The process of receiving chicken has tremendous potential hazards in veterinary medicine and growth agents, heavy metal contamination, deteriorated of frying oil, and deteriorated frying oil or food machinery grease. During the process of each department, the management had a prevention plan with the analyses on final product. This was to reduce the potential contamination of chemical hazards such as heavy metal in final product.

The frying process might have a chemical potential hazards. It might be described as compound in a high temperature of extrusion. It was often claimed as substance such as acrylamide (Mulla *et al.*, 2011). According to Kutting *et al.*, 2008; Mulla *et al.*, 2011 and Oracz *et al.*, 2011, acrylamide usually might be found from food grade oil (food machinery grease) and frying oil during the frying process.

Furthermore, acrylamide is a water-soluble, vinyl monomer had multiple chemical and industrial application (Kutting *et al.*, 2008). According to Kutting *et al.*, (2008) acrylamide had serious effect for health and could be found in blood. In addition, Kutting (2008) also claimed that acrylamide cause the tumor and it was a carcinogenic agents on following oral dosing in rat studies. The effects of Acrylamide must be analyzed in the oil due to those potential problems.

In frying process, the oil used for frying and food grade oil for machine were usually renewed. The deteriorated

frying oil would be given into another corporation for the recycling process. The company had a Material Safety Data Sheet (MSDS) documents of food grade oil. Interestingly, MSDS documents had a significant role in identifying hazardous materials and a first aid measure procedure (Cahyono, 2010). In addition, chemical potential hazards of workers

have many routes of exposure. Skin contact, eye contact, and inhalation were an illustration of chemical potential hazards (Anonymous, 1997). In the production process, it was observed that the employees always used their safety glasses with chemical resistant gloves, and hair protection. The details of hazards prevention of food grade oil during this study were shown in Table 3.

Table 3. Hazards Identification of Oil Food Grade (Food Machinery Grease) (Anonymous, 2007).

Hazard identification	Explanations	First aid measures
Skin absorption	Extensive / prolonged or repeated result in this product, which is caused by an absorption.	Washing the skin with soap and water. Remove the contaminated clothing and it must be washed before reused. After that, immediate get a medical attention if the product is injected under the skin. The contamination of shoes must be cleaned before re-use and discard if oil soaked.
Ingestion	Caused pulmonary injury and possibility of death.	Washing thoroughly with soap and waste contaminated clothing, launder the clothing before reuse.
Inhalation	Repeated and prolonged overexpose to oil mists may have a result in droplet deposition, oil granuloma formation, inflammation, and increased incident of infection.	Get medical attention immediately.
Chronic Effect	Prolonged or repeated contact with petroleum oil may remove natural oils and fats from the skin.	Vapor pressure is very low, inhalation under the ambient condition is normally not a problem, If it overcomes by vapor from physician. If breathing is an irregular or has been stopping, start resuscitation and administer oxygen. In addition, if it overexposed to oil mist, remove from exposure until excessive oil mist condition subsides.
Routes of Expose	Skin contact, eyes contact, inhalation	Flushing eyes immediately with plenty of water for at least 15 minutes until getting a medical attention. Furthermore, for a Skin, washing with soap, and a plenty of water. Medical attention should be required in an inhalation accident.

The Handling of Biology Potential Hazard

The biological potential hazards such as contamination from a slaughterhouse until a production unit were caused by a microorganism. The sources were from feces, dead chickens, innards, and wastewater treatment plant. According to Tsola *et al.*, (2008) total bacteria in internal external counted approximately 5.72 ± 0.08 , coliform and *E. coli* approximately at 3.41 ± 0.09 , *S. aureus* at 2.60 ± 0.09 . Tsola *et al.*, 2008 reported that total bacteria water–air chilling counted approximately at 4.60 ± 0.08 , coliform and *E. coli* 2.90 ± 0.06 , *S. aureus* 2.63 ± 0.05 . Furthermore, 4.72 ± 0.10 , coliforms and *E. coli* 2.86 ± 0.05 , *S. aureus* 2.90 ± 0.05 . Total bacterial counted approximately at 4.72 ± 0.10 , coliforms and *E. coli* 2.88 ± 0.06 , *S. aureus* approximately at 2.90 ± 0.04 . Those microorganisms caused deterioration of food quality and also a foodborne disease in many countries (Tsola *et al.*, 2008).

The amount of those microorganisms potentially contaminated in several areas and in the environment. Specifically to a safety product, the

company had a laboratory for checking and analyzing the microbiology aspects and quality of final product. The wastewater contained of microorganism from washing vehicle (truck) has contaminated with feces from the vehicle of the chicken, chill process, and evisceration. The wastewater contained of microorganism. In order to prevent the contamination of pathogen microorganism in the factory, the wastewater from the production process was usually treated in wastewater treatment plant unit. In the fact, the factory has different units of wastewater treatment plant such as grit chamber unit, fat trap unit, equalization tank unit, flocculation unit, coagulation unit, clarifier unit, sedimentation unit, and aeration tank.

Generally, the wastewater would be flown in the communal wastewater treatment plant and it would be processed before the effluent was exiled in the environment. The innards, feet skin, chicken feathers were collected in the container. The innards were commonly sold to the merchant. It showed that corporation had an attention to reuse of the waste and has implemented the prevention actions towards organic waste. However, chicken which was dead in the truck during transportation from breeder to factory, was destroyed in a furnace burner. After that process, it

transformed into the bottom ash and will be transferred to other corporation, whose have a

specialty to handling the waste.



Figure 1. The Source of potential hazards in chicken nuggets factory. The source of the photo in parentheses. (a).The worker is cleaning the feces in the truck. (b). Dead chicken in the receiving process. (c). Drainage, which is used by the factory to flow the wastewater, is consist of the pipeline from each room to flow the wastewater through this channel . (d). Wastewater treatment plant unit of the corporation .

The procedure to reduce the fly and cockroach, which had potential as the disease vector, the firm management usually control packages of the chicken feather in the packaging process and the feces of chicken. Then, they also washed the trucks to clean the feces. In other words, the top management had several actions to prevent environmental pollution.

CONCLUSION

Chicken nugget factory has the physical, chemical, and biological potential hazards in slaughterhouse unit and production unit. The potential hazards in physical related to an accident in occupation location, noise, slip, damage of ear and watered by high temperature oil should be concerned by management. In addition, the contaminations of heavy metal in end product by oil food grade and frying oil are the illustrations of chemical contaminations category. Biological potential hazards, especially the contamination of products, and the environment by microorganisms were serious issues, which was always supervised and prevented due to enormous problems to the end products and environment.

REFERENCES

- Anonymous, 1997. Material Safety Data Sheet: Food Machinery Grease USDA H1 PLD. (*Unpublished document*).
- Cahyono, A.B. 2010. Industrial Chemical Safety. *Gadjah Mada University Press*, Yogyakarta. (Translated)
- Cahyono, A.B., 2010. Keselamatan Kerja Bahan Kimia Di Industri. Gadjah Mada University Press.
- The decision of Decision of Indonesia Republic President, 1993. The decision of the Indonesia Republic about Disease Which Appears Caused By Occupation Relations.
- Doyle, M. P, and Ericson, M.C. 2006. Emerging Microbial Food Safety Issues Related to Meat. *Meat Sci.* 74:98-112.
- James, C., C. Vincent, T.A, Lime de, and S.J. James. 2006. The Primary Chilling of Poultry Carcasses – A Review. *Intl. J. of Refrigeration* 29:847-862.
- Kotzekidou-Rouka. P. 1993. Microorganisms in Foods and Food Microbiological Alterations. In *food Microbiology*. Thessaloniki University Press.
- Kutting, B., T. Schettgen, U. Schwegler, H. Fromme, W. Uter, J. Angerer, and H. Drexler. 2008. Acrylamid as Environmental Noxious Agent: A Health Risk Assessment for The General Population Based on The Internal Acrylamide Burden. *J. of Hygiene Enviro. Health* 212:470-480.

- Ministry of Labor, 1999a. The decision of Manpower Ministry about Hazardous Chemical Control in Occupation Location.
- Ministry of Labor, 1999b. The decision of Manpower Ministry: Value Limit of Physical Factors in Occupation Location.
- Mulla, M.Z., V.R. Bharadwaj, U.S. Annapure, R.S.Singhal. 2011. Effect of Formulation and Processing Parameters on Acrylamide Formation: A Case Study on Extrusion of Blends of Potato Flour and Semolina. *J. of LWT Food Technology* 44:1643-1648.
- Oracz, J., E. Nebesny, D. Zyzelewics. 2011. New Trends in Quantification of Acrylamide in Food Productions. *J. of Talanta* 86:23-24.
- Surak, J.G. 2002. *The Certified Quality Auditor's HACCP Handbook*. Wilwaukee: American Society for Quality.
- Tsola, E., E.H. Drosinos, dan P. Zoiopoulos. 2008. "Impact of Poultry Slaughterhouse Modernization and Updating of Food Safety Management Systems on The Microbiological Quality and Safety Products. *J. of Food Control* 19: 423-431.