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Effectiveness of hazard control through HACCP critical control points in the wet noodle production process on product quality

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ABSTRACT

Hazard Analysis and Critical Control Point (HACCP) is a food safety management system method developed by the Codex Alimentarius Commission (CAC) which is recognized by the international food safety community as a guideline for controlling food safety hazards. The HACCP system establishes a control system that focuses more on prevention than on testing the final product, so the effectiveness of its implementation cannot be precisely determined. The purpose of this study was to determine the effectiveness of the implementation of HACCP on product quality in meeting food quality and safety parameters according to the Indonesian National Standard (SNI) 2987:2015 (wet noodles). The study was conducted on small and medium enterprises (SMEs) producing wet noodles in Central Java (Indonesia). The analytical method used in this study is to compare the results of the initial product testing before the research intervention and the final product after the research intervention to determine the effectiveness of HACCP's critical control point (CCP) on product quality. The final product test results from the HACCP control intervention were able to correct the initial product discrepancy before the intervention, namely the quality parameters of ash content and total plate count contamination. However, there is one parameter that is out of the SNI quality limit for wet noodles, namely Staphylococcus aureus microbial contamination. This can be controlled by adding a water content critical limit in the CCP of the packaging process. The test results show that the control of hazards and risks through HACCP does not necessarily guarantee that product quality can fulfill food quality and safety requirements. Evaluation of CCP through the verification stage and final product testing must be carried out simultaneously until a product fulfill the quality and safety parameters on standards or regulation.

Keywords: Critical control point (CCP), Hazard Analysis and Critical Control Point (HACCP), Wet noodle, Quality, Standards.

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1. INTRODUCTION

Food is a basic human need to support and carry out daily activities properly. Good food will have a positive role in human health and life, so food safety is a crucial aspect so that food does not pose a hazard and risk negative impacts on health (Agustina, 2014). Hazards in the aspect of food safety are biological, chemical or physical contaminants, or food conditions that have the potential to cause adverse health effects (BSN, 2011). The hazard will pose a food safety risk, one of which is due to the presence of food contaminants. Food contaminants are materials or compounds that are accidentally added, but are present in food products that can enter and are contained in food products as a result of handling and/or processes starting from the production stage (Setyoko, 2019), packaging, transportation, storage and pollution from the environment (Hariyadi, 2010). Food contaminants have consequences on food safety, as they can have public health risk implications. Food contaminants consist of microbial contaminants, physical contaminants, and chemical contaminants (Hariyadi, 2010). Hazard and risks that may occur when a product contains a food safety hazard is causing illness or poisoning for those who consume it, which can further reduce the brand image of the product and company, reduced sales, loss of customers, consumer distrust of product quality, product recalls, hospitalization and in the final stage, can allow bankruptcy.

Wet noodles are food products made from the main raw material of wheat flour with or without the addition of other food ingredients and permitted food additives, which are obtained through the process of mixing, stirring, sheeting, slitting, cutting in the form of typical noodles with or without the cooking process (BSN, 2015). Noodle consumption in Indonesia in 2018 ranked second in the world after China with consumption of 12.54 billion packs (Sukamto et al., 2019), and is projected to increase every year (Firmansyah and Hidayatullah, 2020). The shelf life of wet noodle products is relatively short, 10-12 hours at room temperature (Astawan, 2006) because it has a relatively high water content (Enjelina et al., 2019) 35% for raw wet noodles and 65% for cooked wet noodles and no harmful ingredients in the form of formalin and boric acid are allowed (BSN, 2015). Food products that contain high water activity are very easy to be contaminated with bacteria and cause a danger of poisoning (Rindang, 2016). This condition makes wet noodle products mostly stored and circulated in the form of frozen food products, so that wet noodles have a moderate level of health risk (Daulay, 2020). This shelf life and level of risk require a control of food safety hazards in wet noodle products so that they are safe when consumed by consumers.

The quality parameters of wet noodles consisting of quality and food safety parameters are regulated in the Indonesian National Standard (SNI) 2987:2015. Product quality must fulfil applicable standards or regulations, while the process of monitoring and controlling quality is not easy because it has more than one parameter variable that must be considered, so that the complexity of the process also becomes more (Susanty et al., 2018). SNI 2987:2015 stipulates terms and definitions, composition, quality requirements, sampling and test methods for raw wet noodles and cooked wet noodles. This standard distinguishes wet noodles into 2 categories, namely raw wet noodles and cooked wet noodles. Raw wet noodles are wet noodles that have not undergone a boiling or steaming process, while cooked wet noodles are wet noodles that have undergone a boiling or steaming process. Quality is one aspect that must be considered in the manufacturing supply chain model, in addition to aspects of production, inspection and maintenance to maximize customer value and gain a competitive advantage in the market (Chen and Chou, 2020).

Previous research has developed a conceptual model that includes 3 main objectives of the HACCP system namely hazard identification, hazard assessment and hazard control) with appropriate items to provide a theoretical basis regarding the nature of the effectiveness of HACCP as well as the level of achievement of its objectives and consequently the extent to which the system is implemented effectively (Kafetzopoulos et al., 2013). The effectiveness of HACCP is defined as the level of achievement of the system's objectives, namely the identification, assessment and control of foodborne safety hazards (Psomas and Kafetzopoulos, 2015). 32 factors have been identified that influence the implementation and effectiveness of HACCP (Fotopoulos et al., 2011). Previous research has also been carried out on the effectiveness of HACCP implementation related to food safety, cost reduction (Minor and Parrett, 2017), profitability (economic benefits), productivity, increased market access and asset efficiency (Liu et al., 2021). The application of HACCP has been carried out on ready-to-eat food products, namely sea food (Al-Busaidi et al., 2017) (Santoso et al., 2020) (Setyoko and Kristiningrum, 2019), liquor (Yin et al., 2020), snacks (Carrascosa et al., 2016) (Setyoko, 2019). The implementation of HACCP is mostly carried out by large industries, SMEs have difficulty implementing it (Razak and Daud, 2020). HACCP is always associated with food safety systems (FSS), this research has an update on the effectiveness of the implementation of HACCP in improving the quality of ready-to-eat food products (wet noodles) produced by SMEs.

Previous research has been conducted to identify critical control points (CCP) as an effort to control food safety hazards. CCP was obtained using the Hazard Analysis and Critical Control Point (HACCP) method, so that the steaming, packaging and storage processes were obtained as CCP in the wet noodle production process. The HACCP system is a tool to establish a control system that focuses more on prevention than on testing the final product, so that the impact of hazard control cannot be known directly on the product. (Supriatna and Miskiyah, 2016). The HACCP method has drawbacks and limitations, namely it does not perform calculations and takes into account the effect of the existing control system on the reduction of hazards and product quality (Alijoyo et al., 2020). Because of these aspects, this study aims to determine the effectiveness of hazard control through 3 CCP in the wet noodle production process using the HACCP method on product quality according to SNI 2987:2015 (wet noodles).

2. Materials and Methods

2.1 Critical Control Points (CCP) in HACCP

HACCP is a tool for assessing hazards and establishing a control system that focuses on prevention rather than relying mostly on final product testing (BSN, 2011). The goal of HACCP is to maximize product safety in the food industry (Liu et al., 2021). HACCP can reduce the hazard of contamination to an acceptable level and avoid potential hazards that could result in an unsafe finished product. HACCP is also useful for reducing customer complaints and increasing product sales (Razak and Daud, 2020).

At the heart of the HACCP function is the enabling control over CCP in the production process, thus enabling manufacturers to control manufacturing quality. The critical limit is defined as an acceptable tolerance limit to secure the hazard, so that the control point can control the health hazard carefully and effectively (Setyoko and Kristiningrum, 2019). This predetermined critical limit must not be violated or exceeded, because if a critical limit value is violated and then the critical control point is out of control, it can cause a hazard to consumer health. Examples of critical limits that need to be set as a means of preventing hazards from arising, such as the maximum temperature and time for the thermal process, the maximum temperature to maintain cooling conditions, a certain temperature and time for the commercial sterilization process, the amount of pesticide residue that is allowed to be in food, the maximum pH that permitted, maximum filling weight, maximum allowable viscosity and so on (Setyoko and Kristiningrum, 2019). CCPs should be controlled by appropriate and appropriate monitoring procedures. The monitoring system consists of scheduled measurements or observations of control measures at the CCPs relative to its critical limits (Kafetzopoulos et al., 2013).

2.2 Quality Parameters of Wet Noodle in Indonesian National Standard (SNI) 2987:2015

The SNI that regulates the quality parameters of wet noodles is SNI 2987:2015 which is a revision of SNI 01-2987-1992 (Wet Noodles). This standard stipulates terms and definitions, composition, quality requirements, sampling and test methods for raw wet noodles and cooked wet noodles. The requirements for the quality of wet noodles are in accordance with SNI 2987: 2015 as follows in Table 1.

Standard requirements consist of 2 main parts, namely quality parameters and food safety parameters. Quality parameters consist of organoleptic, moisture content, protein content and ash content. Meanwhile, food safety parameters consist of hazardous materials (formalin and boric acid), metal contamination, microbes and deoxynivalenol. The measurement of each parameter of the standard has its own method, such as testing the growth rate of Staphylococcus aureus bacteria was carried out on special hatcheries after incubation at 35°C for 45 hours to 48 hours and followed by a coagulase test. Microbial contamination can occur in all food products, agriculture, animal husbandry, food crops, horticulture, and fisheries.

Table 1. Wet noodle quality requirements

No	Test Criteria	Unit	Requirements	
			Raw Wet Noodles	Cooked Wet Noodles
1	Organoleptic	-		
1.1	Smell	-	normal	normal
1.2	Taste	-	normal	normal
1.3	Color	-	normal	normal
1.4	Texture	-	normal	normal
2	Water content	Mass Fraction, %	max. 35	max. 65
3	Protein content	Mass Fraction, %	min. 9.0	min. 6.0
4	Ash content	Mass Fraction, %	max. 0.05	max. 0.05
5	Hazardous material			
5.1	Formalin (HCHO)	-	0 (not allowed)	0 (not allowed)
5.2	Boric Acid (H_3BO_3)	-	0 (not allowed)	0 (not allowed)
6	Metal contamination			
6.1	Lead (Pb)	mg/kg	max. 1.0	max. 1.0
6.2	Cadmium (Cd)	mg/kg	max. 0.2	max. 0.2
6.3	Tin (Hg)	mg/kg	max. 40.0	max. 40.0
6.4	Mercury (Hg)	mg/kg	max. 0.05	max. 0.05
7	Arsenic Contaminants (As)	mg/kg	max. 0.5	max. 0.5
8	Microbial contamination			
8.1	Total plate number	Colony/g	max. 1 x 10^6	max. 1 X 10^6
8.2	*Escherichia coli*	Most Probable Number (MPN)/g	max. 10	max. 10
8.3	*Salmonella sp*	-	negatif/25g	negatif/25g
8.4	*Staphylococcus aureus*	Colony/g	max. 1 X 10^3	max. 1 X 10^3
8.5	*Bacillus cereus*	Colony/g	max. 1 X 10^3	max. 1 X 10^3
8.6	Fungus/ Yeast	Colony/g	max. 1 X 10^4	max. 1 X 10^4
9	Dioxynivalenol	µg/kg	Max. 750	Max. 750

Source: (BSN, 2015)

The total plate number testing when sample is incubated in a suitable medium for 48 hours at room temperature (35 + 1) °C, other parameters also have their own methods.

The application of standards provides many benefits, both tangible and intangible, such as a more regular production process flow, increased consumer confidence, ease of market access and others (Susanto et al., 2017). The application of standards to products produced by business actors can increase the competitiveness of these products in both the domestic and international markets (Faisal and Trisnamansyah, 2017). The application of the standard provides an economic benefit to the party implementing the standard (Pudjiastuti and Adinugroho, 2011; Farkah, 2012; Mulyono and Pudjiastuti, 2013; Sari, 2012; Ulkhaq, 2011; Fu, 2016; Susanto et all., 2017).

2.3 Research Methodology

Assessment of the effectiveness of hazard control through HACCP in the wet noodle production process on product quality is divided into three stages. The first stage is to conduct initial product testing before the research intervention. The test is carried out in a laboratory accredited by the National Accreditation Committee, namely the Center for Agro Industry. The test is carried out in accordance with the parameters of SNI 2987: 2015. Samples were taken 3 batches on the criteria of the morning, afternoon and evening then mixed into one so that it became a homogeneous sample and product testing was carried out. Sampling method was carried out based on the Indonesian National Standard (SNI) 19-0428-1998 regarding the instructions for taking solid samples. According to this standard, samples are taken while the product is moving through the production line that transports the product from the production room to the warehouse. Samples are taken in several packages at the same time period. The second stage is the monitoring of CCP - HACCP in the production process according to the critical limit that has been carried out using the control form that has been prepared. Monitoring is carried out for 1 month, so that the production process runs according to CCP control procedures. In the last stage, the product of the research intervention was retested. The testing process is carried out as in the initial product testing in a KAN-accredited laboratory. The study was conducted on small and medium enterprises (SMEs) producing wet noodles in Central Java (Indonesia). The SME production site is located in a shophouse which is connected to a restaurant. The production process is located at the back of the shophouse, including the raw material warehouse and toilets, while the second floor is used for offices, prayer rooms and rest areas. Legally, SMEs were established in 2019 with an average production volume of 840 kg per month with 10 employees. Product marketing is done directly, both cooked and raw. Cooked noodles can be purchased and consumed directly at restaurants, which are cooked directly in the form of fried noodles and boiled noodles. Meanwhile, raw noodles are sold to consumers directly or online with a marketing area covering the entire territory of Indonesia by taking into account the availability of the appropriate delivery party. SMEs already have a distribution permit from the National Food and Drug Agency and a halal certificate. The analytical method used in this study is to compare the results of the initial test before the research intervention and the final product after the research intervention to determine the effectiveness of CCP-HACCP on product quality.

3. RESULTS AND DISCUSSION

3.1 Wet Noodle Production Process

The production process of wet noodle begins with receiving the raw material of wheat flour and additional ingredients of water and salt. Then the weighing is carried out according to the procedures owned by SMEs and mixing is carried out so that the ingredients are mixed homogeneously. Next is the loading of the noodle dough which includes sheeting, slitting, cutting. The finished noodles are then steamed and drained after the steaming process is complete. After the noodles have cooled at room temperature homogeneously, packaging is carried out. Storage is done in the freezer to maintain product quality, because the product is made without preservatives at all. Meanwhile, product sales are carried out independently by selling directly on the spot and through third party deliveries. Storage using a freezer with good and appropriate procedures and equipment conditions can maintain product quality, so that it has a longer shelf life.

3.2 Initial Product Testing

Initial product testing is carried out to determine the initial condition of product quality before any intervention from the research. Wet noodle product testing is carried out in an accredited laboratory of the National Accreditation Committee (KAN) for the application of SNI ISO 17025: 2017 regarding the general requirements for the competence of testing laboratories and calibration laboratories, namely the Central Agro Industry Center. Tests carried out in laboratories accredited by KAN, the test results will be better because the testing process is carried out by competent personnel, tools and methods recognized nationally and internationally. Test certificates issued by KAN accredited testing laboratories have been recognized by countries in the asia pacific region because they already have Mutual Recognition Agreements. The test was carried out according to the parameters in SNI 2987: 2015 (wet noodles), with the test results presented in Table 2.

Based on Table 2, there are two parameters in SNI 2987:2015 that cannot be met, namely the parameters related to ash content and the total plate number. The result of testing the ash content is 0.08%, while the requirements in the SNI are a maximum of 0.05%. The test results for the total plate number parameter are 9,6 X 10^7, while the requirements for SNI are 1 X 10^6.

The value of ash content that is not suitable is caused using raw water in the production process whose quality is not guaranteed. This SME uses refilled gallon drinking water. In addition, in some parts of the production process there are operators who do not comply in using gloves and masks consistently as presented in Fig. 1. Ash content shows the amount of minerals bound in a material (Yuniarifin et al., 2006). Organic materials in the combustion process will burn but the inorganic components will not. The water used in the production process must meet the requirements, if it does not meet the requirements, it can increase the ash content. Groundwater quality is affected by heavy metal pollution that enters the wastewater stream which is often discharged into water bodies without following the discharge limits determined according to environmental regulations (Krishna et al., 2019). If the water used in the production process is polluted, it will affect the quality of the resulting product. The ash content value is used to determine whether or not the management is good, knowing the type of material used, determining the nutritional value parameters of a food and estimating the content and authenticity of the ingredients used (Kartika, 2014). The higher the ash content in the food, the lower the nutritional value of the food (Wirawati, 2018). The ash content also affects the appearance of the noodles produced (Rosmeri and Monica, 2013). Ash content is an inorganic substance left over from the combustion of an organic material, the higher the ash content in a product, the lower the level of product cleanliness (Lubis et al., 2013).

The value of the total plate number cannot be fulfilled due to aspects of material, human and production processes. The material aspect is using water as raw material, which is less guaranteed, while the human aspect, production operators are inconsistent in using production equipment (production gloves, masks, headgear, and special production clothing). This condition allows and has the potential for bacterial contamination, dirt, hair and other things from the operator to the product. In the aspect of the production process, SMEs do not yet have a good procedure for the steaming and packaging process. The process of steaming should be determined by the procedure, especially regarding aspects of time, temperature, and quantity of steaming noodles. In addition to the gelatinase process, this process can also kill or inhibit bacterial growth if contamination occurs in the previous process. While the packaging process, SMEs do not yet have a procedure, especially the condition that noodles can be packaged from the aspect of temperature and moisture content homogeneously. Noodle products can be packaged if they already have a value according to room temperature and a water content value according to the standard. If this aspect is not fulfilled, it will make it easier for bacteria to multiply. The total plate number is the growth of aerobic mesophyll bacteria after the sample is incubated in a suitable medium for 48 hours at room temperature (35 + 1) °C (Susanto, 2018). Total plate number or the number of microorganisms, can be used as a parameter of quality in food products (Hartati, 2016). The lower the value of the total plate number in the resulting product, the higher the value of the application of Good Manufacturing Process (GMP) (Tivani, 2018). The total plate number is one of the microbial contaminations. Food can carry various types of microbes, which can come from the natural microflora of plants or animals, both from the environment and those that enter during harvesting or slaughtering, distribution, post-harvest handling, processing, and product storage can cause poisoning in the human body (Djaafar and Rahayu, 2007). The problem of agricultural land contaminated with heavy metals raises serious concern because the contaminants that accumulate in crops not only affect the growth and quality of crops but also threaten the health of consumers, therefore, contaminated crops should be banned as food ingredients (Cheng and Huang, 2006). Various industries also release heavy metals that pollute water bodies and greatly affect aquatic life, human health and the environment which in the later stages can affect the quality of foodstuffs such as water, agricultural products, plantations and livestock (Krishna et al., 2021).

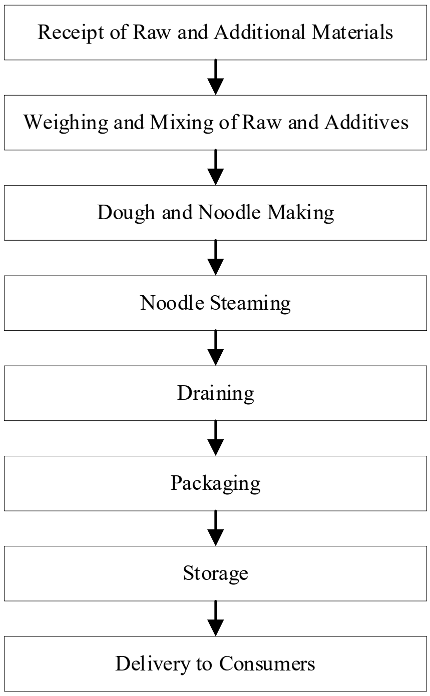

Fig. 1. The flow of the wet noodle production process.

3.3 Implementation and Controlling of CCP-HACCP

Each CCP in HACCP is defined as a critical limit that must be reached as an acceptable tolerance limit to secure the hazard, so that the control point can control health hazards carefully and effectively. The critical limit that has been set must not be violated or exceeded, because if a critical limit value is violated and then the critical control point is out of control, it can cause a hazard to consumer health. After determining the critical limit, monitoring or monitoring is carried out as a continuous monitoring and measurement plan to find out whether a CCP is in control and produce the right records to be used in later verification (Daulay, 2020). CCP control through setting critical limits is presented in Table 3. The percentage of CCP is in the minority, which is in 3 production processes (noodle steaming, packaging, and storage) from a total of 8 production processes in Fig. 1. Design of food safety hazard control to improve product quality through determining critical control points in the stages of the wet noodle production process with the amount minimal process control as part of built-in quality efforts in an effective, efficient and resource-saving way.

In addition to controlling and monitoring the production process in accordance with table 3, improvements were also made including replacing raw water materials into drinking water with quality in accordance with SNI 3553:2015: Mineral Water. Next is the mandatory, thorough, and consistent use of production equipment and clothing. Improving the cleanliness of the production process area is also one aspect that is improved in this research.

The HACCP method is able to control potential hazards along the production process chain (Santoso et al., 2020). The implementation of HACCP starting with hazard determination, prioritizing critical limits and close monitoring can ensure food safety stability (Yin et al., 2020). The application of HACCP is able to practically explore product safety management in food companies which is beneficial for profitability, productivity and market growth (Liu et al., 2021). Food safety management can be used as a method for marketing strategies for wet noodles (Hardiyansyah et al., 2015).

3.4 Final Product Testing

At this stage, product testing is carried out as a result of CCP control interventions in the wet noodle production process. CCP control is carried out carefully and consistently to maintain control accuracy. Product test results are presented in Table 4.

Based on Table 4, there are 2 parameters that do not meet the SNI quality requirements for wet noodles, namely total plate count contamination and Staphylococcus aureus (stage 1 final product testing). Total plate count contamination is the same quality requirement as the initial product test, where the product is not able to reach the required value. Although the total plate count contamination was not in accordance with the requirements of SNI, the level of tilapia had improved from the previous 9.6 X 10^7 colonies/gram to 9.6 X 10^6 colonies/gram. While the value of the ash content is not soluble in acid which in the initial product test does not comply with the requirements of SNI (0.08%), at this stage it becomes fulfilled, namely with a value of 0% (maximum SNI requirements of 0.05%). However, there is one parameter that is out of the SNI quality limit for wet noodles, namely Staphylococcus aureus microbial contamination with a value of 2.5 X 10^3 colonies/gram

Table 2. The results of the initial testing of wet noodle products

No	Test Criteria	Unit	Test Result	Information
1	Organoleptic	-		
1.1	Smell	-	Normal	Comply
1.2	Taste	-	Normal	Comply
1.3	Color	-	Normal	Comply
1.4	Texture	-	Normal	Comply
2	Water content	Mass Fraction, %	32.2	Comply
3	Protein content	Mass Fraction, %	9.29	Comply
4	Ash content	Mass Fraction, %	0.08	Not Comply
5	Hazardous material			
5.1	Boric Acid (HCHO)	-	Negatif	Comply
5.2	Asam borat (H_3BO_3)	-	Negatif	Comply
6	Metal contamination			
6.1	Lead (Pb)	mg/kg	0.24	Comply
6.2	Cadmium (Cd)	mg/kg	< 0.007	Comply
6.3	Tin (Hg)	mg/kg	< 0.8	Comply
6.4	Mercury (Hg)	mg/kg	< 0.005	Comply
7	Arsenic Contaminants (As)	mg/kg	< 0.013	Comply
8	Microbial contamination			
8.1	Total plate number	Colony/g	9.6 X 10^7	Not Comply
8.2	*Escherichia coli*	Most Probable Number (MPN)/g	< 3	Comply
8.3	*Salmonella sp*	-	Negatif	Comply
8.4	*Staphylococcus aureus*	Colony/g	0	Comply
8.5	*Bacillus cereus*	Colony/g	0	Comply
8.6	Fungus/ Yeast	Colony/g	< 10	Comply
9	Dioxynivalenol	µg/kg	< 200	Comply

Fig. 2. Operators do not use production gloves and masks

Table 3. Determination of critical control points for wet noodle production

No.	CCP	Critical Limit	Monitoring	Corrective Action
1.	Noodle Steaming	Temperature 100-105°C, for 30 minutes for 7 kg of dough	Measure the temperature in the skillet/pan after about 12 minutes of steaming using a thermometer-gun	If the steaming temperature is not reached, then increase the steaming time, and report it to the supervisor on duty
2.	Packaging	The noodle temperature corresponds to a room temperature of 20°C - 25°C homogeneously	The operator measures the temperature of the noodles using a thermometer gun	If the noodle temperature is not reached, set the air conditioner (AC) to condition and normalize the room temperature, back and forth the noodles and increase the draining/cooling time and report it to the supervisor on duty
3.	Storage	Minimum freezer temperature -8°C to -18°C	The operator ensures that the freezer temperature is reached -8°C to -18°C	If the freezer temperature is unstable or more than -8°C then move it to backup storage and report it to the supervisor on duty

with the SNI requirement of a maximum of 2.5 X 10^3 colonies/gram.

Contamination comes from food processors as well as from equipment used in processing and the processing environment. Contamination can occur due to direct contact between members of the body of a person who is sick with food, both intentional and unintentional (Djaafar and Rahayu, 2007). Microbes, especially pathogenic bacteria, can be found anywhere, in soil, water, air, plants, animals, foodstuffs, equipment for processing and even in the human body. Food carries various types of microbes, which can come from the natural microflora of plants or animals, both from the environment and those that enter during harvesting or slaughtering, distribution, post-harvest handling, processing, and product storage (Susanto, 2018).

Based on Table 4, the water content parameter increased from the previous 32.2% to 32.7% and was in line with the decrease in protein content from 9.29% to 8.18%. The water content in foodstuffs plays a role in the growth of microorganisms, so it really determines the quality and storage period. The more water content contained in wet noodles will trigger the presence of microbes to grow and multiply. Wet noodle products that have a higher water content value allow the product quality to decrease. The high water content results from the incomplete steaming process (Oleh et al., 2018) and the wet noodle packaging process is not according to the procedure. Water activity has a major influence on the texture of food products (Fridata et al., 2015). The resulting water content can affect the protein content of wet noodles (Dahot, 1998). The lower the water content, the higher the protein content (Setyowati and Nisa, 2014). The increasingly measurable protein content also depends on the amount of ingredients added and is largely influenced by the water content (Pratama et al., 2014). Under these conditions, moisture control can be added to the critical limit in the CCP of the packaging process. Each noodle that will be packaged must be checked for temperature using a thermometer gun and check the water content using a water content checker.

In the next step in final product stage 2, the water content is maintained by adding to the critical limit in the packaging process. The critical limit of the water content value is a maximum of 30% before the product is packaged, while maintaining the critical limit of the product temperature 20°C - 25°C homogeneously. After that, the product is tested again. The results of the microbial contamination test on the product after adding and monitoring the critical water content limit are presented in table 4 stage 2 final product testing result.

According to Table 4 (stage 2 final product testing result), microbial contamination can be controlled by maintaining the moisture content of the product before packaging. Other parameters can also be controlled. The test results show that hazard control through HACCP CCP does not necessarily guarantee that product quality can meet food quality and safety requirements. CCP evaluation through verification of final product testing must be carried out simultaneously when a product does not meet the quality parameters. The accuracy and reliability of the control and monitoring system is the key to the effectiveness of the CCP in controlling hazards (Doménech et al., 2008; Manning and Baines, 2004). Inappropriate monitoring procedures will result in the control measures not meeting the requirements for critical limits in the CCP. The CCP control and monitoring system for critical limits is carried out regularly and consistently. Determination of biological, physical and chemical hazard specifications is often insufficient to provide appropriate guidance mechanisms, and to monitor limits, resulting in ineffective application of HACCP (Trafiałek et al., 2015). Factors that make the implementation of HACCP ineffective are due to weaknesses in knowledge of significant hazard identification and errors in the hazard analysis process, including errors in the application of structured risk evaluation methods (Wallace et al., 2014). Monitoring systems are also used to determine when a loss of control as a deviation occurs at the CCP or to indicate that the product is being manufactured safely (Doménech et al., 2011). HACCP is truly effective only when it identifies appropriate controls and monitoring programs, which are validated to ensure that defined critical limits will result in safe food (Manning and Baines, 2004). Development of structured hazard assessment procedures related to hazard severity assessment, was the most problematic area in developing HACCP, with most non-compliance occurring in the areas of documentation, hazard identification and assessment, process flow diagrams and system verification (Dzwolak, 2019).

Final product testing remains the key, whether the resulting product can meet food quality and safety limits or not. After the final product test results are in accordance with food quality and safety limits, the CCP control and monitoring system against its critical limit can be said to have been effective and implemented consistently. Merely implementing the HACCP food safety system or meeting its requirements does not guarantee that food companies are able to achieve the highest level of product safety performance (Kafetzopoulos et al., 2013). It is necessary to evaluate and verify the production process, At this stage, the implementation of HACCP is effective to maintain and produce products with acceptable safety limits.

Table 4. Test results of wet noodle products after research intervention

No	Test Criteria	Initial Product	Final Product I	Final Product II	Information
1	Organoleptic				
1.1	Smell	normal	normal	normal	Comply
1.2	Taste	normal	normal	normal	Comply
1.3	Color	normal	normal	normal	Comply
1.4	Texture	normal	normal	normal	Comply
2	Water content	32.2	32.7	31,8	Comply (Improvement)
3	Protein content	9.29	8.18	9,95	Comply (Improvement)
4	Ash content	0.08	0	0	Comply (Improvement)
5	Hazardous material				
5.1	Formalin (HCHO)	Negatif	Negatif	Negatif	Comply
5.2	Boric Acid (H_3BO_3)	Negatif	Negatif	Negatif	Comply
6	Metal contamination				
6.1	Lead (Pb)	0.24	< 0.034	< 0,034	Comply (Improvement)
6.2	Cadmium (Cd)	< 0.007	< 0.007	< 0,007	Comply
6.3	Tin (Hg)	< 0.8	< 0.8	< 0,8	Comply
6.4	Mercury (Hg)	< 0.005	< 0.005	< 0,005	Comply
7	Arsenic Contaminants (As)	< 0.013	< 0.013	< 0,013	Comply
8	Microbial contamination				
8.1	Total plate number	9.6×10^7	9.6×10^6	7×10^5	Comply (Improvement)
8.2	*Escherichia coli*	< 3	< 3	< 3	Comply
8.3	*Salmonella sp*	Negatif	Negatif	Negatif	Comply
8.4	*Staphylococcus aureus*	0	2.5×10^3	0	Comply (Improvement)
8.5	*Bacillus cereus*	0	0	0	Comply
8.6	Fungus/ Yeast	< 10	< 10	< 10	Comply
9	Dioksinivalenol	< 200	< 200	< 200	Comply

The main perceived benefits of implementing HACCP effectively are improving product quality and safety and increasing market competitiveness enabling access to the most dynamic and highly competitive markets locally, regionally or internationally (Albusaidi et al., 2017).

4. CONCLUSION

The final product test results from the CCP HACCP control intervention were able to correct the initial product discrepancy before the intervention, namely the quality parameters of ash content and total plate count contamination, with other quality parameters can be maintained. However, the product of the research intervention, there is one parameter that is out of the SNI quality limit for wet noodles, namely *Staphylococcus aureus* microbial contamination. This is due to an increase in the water content of the product resulting from the research intervention. The value of the moisture content can be used as an additional critical limit in the packaging process in addition to the critical limit for the noodle temperature that has been set. The test results show that the control of hazards and risks through HACCP does not necessarily guarantee that product quality can fulfill food quality and safety requirements. Evaluation of CCP through the verification stage and final product testing must be carried out simultaneously when a product has not been able to fulfill the quality parameters. Further research can be conducted regarding the consistency of SMEs in implementing the control design of food safety materials that have been determined, perhaps after 6 months or 1 year after the implementation of this design. Aspects of replacing raw materials, replacing employees, replacing machines, employee compliance and changing production process procedures, it is necessary to know the effect on this design and can also be used as further research, considering that the condition of SMEs is very dynamic and easy to change.

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