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Application of HACCP (Hazard Analysis Critical Control Point) in Croissant Production Process in CV. P-RS – Bali

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A B S T R A C T

CV. P-RS is a company engaged in the production of pastry, bakery, and also pastry & bakery one of Croissant, ingredients provider. Croissant is a type of pastry (laminated roll-in fat), more precisely folded pastry covered with fat (korsvet) or butter with the addition of yeast in the dough. Most of its products are distributed to hotels, restaurants, cafes, catering and retail throughout the island of Bali. Therefore, the quality of all their products is guaranteed. The implementation of an Integrated Quality Management program based on the concept of HACCP (Hazard Analysis Critical Control Point) must be applied in the entire series of handling and processing processes. The implementation of the HACCP food safety management system in CV. P-RS has been running in accordance with SNI 01-4852-1998 regarding the hazard analysis system and critical point control (HACCP) as well as guidelines for its application. The things that underlie the need for the implementation of a food safety management system in CV. P-RS is a trend in consuming safe products accompanied by meeting the needs of consumers who want safe products. Critical Control Point (CCP) of the croissant production process includes weighing of raw materials and supporting materials, metal detecting, and oven.

1. INTRODUCTION

1.1. Research Background

The development of technology and information that is growing has resulted in the emergence of a world free market, which leads to the increase of competition in the international market, especially in the food industry. The demand to face the free market becomes an important reason for the food industry in Indonesia to further improve the quality and guarantee the safety of processed food products. High Quality Safe food processed products in the food industry in Indonesia will be able to maintain the market and business continuity which in turn can provide foreign exchange for the country [1].

One way to ensure the safety of products to be marketed is to use a food safety quality control system that has clear objectives and stages, namely the HACCP (Hazard Analysis Critical Control Points) method. According to Muhandri and Kadarisman [2], HACCP is a system used to categorize hazards and determine a control system that focuses on prevention. One of the reasons for the importance of implementing the HACCP system in the food industry is because during the production process there are possibilities for contamination to occur that can harm consumers. HACCP can be applied to the entire food chain from primary products to final consumption and its application has to be guided by scientific evidence of human health risks [3].

CV. P-RS is a company engaged in the production of pastry, bakery, and also pastry & bakery ingredients provider. Most of its products are distributed to hotels, restaurants, cafes, catering and retail throughout the island of Bali. Therefore, the quality of all their products is guaranteed. The raw materials used are food products that are very sensitive to microbiological hazards. In addition, they also have a risk as a cause of disease and poisoning because they are very easily contaminated by pathogenic microorganisms as well as easily damaged because their constituent components are very good for the growth of microorganisms. Thus, good handling is necessary to prevent this risk. A good way of handling and processing can run optimally if the implementation of GMP and SSOP runs according to the procedure.

1.2. Literature Review

Croissant or crescent bread is a type of pastry (pastry) originating from France, named so because of its shape resembling a crescent moon. According to the legend, this bread came from Europe to celebrate the victory of the Franks over the

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Umayyad forces in the battle at Tours in 732, with a crescent-like shape. Whilst, in the other legends or according to other sources this bread was first created in Buda or Vienna in 1683 to celebrate the victory of the Christian forces over the Ottomans in the battle for the city, as depicted on the Ottoman flag. The timeframe for its manufacture according to the original procedure may take several days; Therefore, it requires a high level of patience. Nowadays, large quantities of croissants are usually made by machine. This bread has a multi-layered texture due to a manufacturing technique known as laminating, which involves folding the dough many times and smearing it with butter. In France, croissants are generally sold without stuffing and eaten without additional butter. However, in other countries, there are also croissants containing chocolate, meat, and so on as shown in Figure 1. [4], [5].

Fig. 1. *Croissant*

Croissant is a type of pastry (laminated roll-in fat), more precisely folded pastry covered with fat (korsvet) or butter with the addition of yeast in the dough. Croissants are made by repeatedly folding the dough and rolling it out to form a textured dough that folds over with a soft and flaky final product. The volume development process in making croissants comes from an increase in volume due to fermentation and an increase in volume due to the effect of frying in the dough, where the water vapor in the dough layer consisting of layers of dough and fat evaporates due to the roasting process [6].

Good Manufacturing Practices (GMP) is a guideline of how to produce food which aims to ensure that producers meet predetermined requirements to consistently produce good safe food products with high quality. GMP is a minimum requirement for sanitation and processing that must be applied by every business actor in the food sector. GMP is a starting point for controlling food safety risks. The scope of GMP covers 8 aspects, namely the environment and location, buildings and facilities, sanitation facilities and activities, pest control systems, employee hygiene, process control, supervisory management, records and documentation [7].

Requirements in GMP include the demand for buildings and facilities to have a layout that minimizes cross-contamination. Requirements for equipment also include equipment layout to minimize contamination, as well as requirements regarding process control including procedures for handling raw material, maintenance, processing, storage, pest control, waste handling, and so on [8].

Sanitation Standard Operating Procedure (SSOP) can be defined as a written procedure that must be carried out by manufacturers to meet sanitary conditions and practices. The SSOP is an important part of the prerequisite program for a Hazard Analysis Critical Control Point (HACCP) system. SSOP is based on Current Good Manufacturing Practice (CGMP) which is mandatory for food companies and importers under the jurisdiction of the Food and Drugs Administration (FDA) [9]. SSOP has 8 keys that become references in its implementation, namely water and ice safety; cleanliness of surfaces in direct contact with food; hand washing, sanitation and toilet facilities; labeling and storage of chemicals; pest control; waste treatment; and employees' health [10].

Hazard Analysis Critical Control Point (HACCP) is a quality management system particularly for food handling or processing to forsee possible hazards during the production process by determining critical points that must be conscientiously monitored. Furthermore, the Critical Control Point (Titik Kendali Kritis) is defined as a stage in a process, which if not properly controlled will result in the risk of discomfort, and the inadequacy of the resulting product. In other words, it is every stage in a process where biological, chemical and physical factors controllable/controllable [11].

The main objective of HACCP is the anticipation of hazards and identification of control points that prioritize precautionary measures and do not rely on final product testing. The HACCP system is not a zero-risk food safety assurance system. However, HACCP is designed to minimize the risk of food safety hazards in a food production process. Previously, the National Food Processors Association's Microbiology and Food Safety Committee stated that HACCP is the only concept that is suitable for the "zero-defects" program, which means the generation food products that are free from pathogenic bacteria that can cause food poisoning [12].

The application of HACCP in the food industry is specific for each type of product, each process, and each factory and requires basic prerequisites in the form of implementing GMP and SSOP. An important factor for the successful implementation of HACCP in the food industry is highly determined by management's commitment in providing safe food. Ratih (2013) stated that in the food industry, the stage of the food safety management process starts from the receipt of raw materials, processing, packaging, storage, distribution to retailing [13].

HACCP was adopted by the Codex Alimentarius Commission in 1993 and was refined in 1996 by compiling guidelines for the implementation of HACCP with systematic implementation steps in 12 steps, consisting of five preparatory steps and seven HACCP principles. The twelve steps of the HACCP Guidelines in Indonesia have been adopted by the National Standardization Department [14].

1.3. Research Objective

The implementation of an Integrated Quality Management program based on the concept of HACCP (Hazard Analysis Critical Control Point) must be applied in the entire series of handling and processing processes. In its application, it involves all components directly or indirectly so that the production process can be controlled and produce quality products.

2. MATERIALS AND METHODS

The implementation of HACCP follows the 7 principles of the HACCP system recommended by the Indonesian National

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Standard [14] issued by BSN, including: 1. Principle 1: Hazard analysis and prevention 2. Principle 2: Identification of Critical Control Points (CCP) in the process 3. Principle 3: Establish critical limits for each CCP 4. Principle 4: Establish a monitoring method for CCPs 5. Principle 5: Establish corrective actions 6. Principle 6: Compile verification procedures 7. Principle 7: Establish procedures for recording (documentation) Hazard analysis which is carried out by listing all possible hazards in raw materials and process stages by referring to related references such as journals, books, standardization documents and other research results. The identified hazards are then tabulated into a table with the source of the hazard, the level of risk and the preventive measures. The level of risk is determined based on how big the consequences will be caused by a hazard and how often the hazard is likely to occur. Each stage of the process is determined to, whether or not, include CCP through consideration of the level of risk and based on answers to questions from the CCP decision tree. Process stages that do not include CCP, may include control points (CP), which means that if these stages are not controlled properly, they can cause quality defects [15].

2.1. Receipt of Raw Materials

Receipt of raw materials involves the administration and warehouse departments. The administration department orders raw materials according to requests from the production department. The raw materials used will affect the production process in producing quality products. To produce quality products, a quality evaluation is carried out to maintain the materials used in accordance with the quality requirements set by the company, so as to produce products that comply with the quality standards set [16]. If the goods ordered have been in accordance with the order, they then are stored by the warehouse. If the goods ordered do not match or are damaged during shipping, the goods will be returned and exchanged.

2.1.1. Material Weighing and Mixing Process

All ingredients are weighed according to a recipe that has been determined by the company. Weighing must be done properly so that there are no mistakes in adding ingredients so high quality croissants can be well produced. It is recommended not to use a spoon or cup as a measure in weighing [16].

According to Koswara [12] the purpose of mixing is to make and develop the adhesive properties of the dough by stirring, pulling, and kneading. Mixing should continue until a smooth dough is formed. The dough has become pliable is if it no longer sticks to the container or in your hands and when the dough is stretched it will form a thin, elastic layer. Stirring that is done too briefly will result in a dough that is not evenly mixed and sticky; on the other hand, stirring that is done for too long will make the dough incompact and stiff [16]. The addition of cold water with a temperature of ±5°C while mixing aims to reduce the temperature of the hot dough due to the mixing process.

2.1.2. Dough Weighing Process

The dough that has been mixed until smooth is then weighed. Before being weighed, the croissants are cut into pieces weighing 2 kg which are then put in a plastic bag. Proses penimbangan harus dilakukan dengan cepat karena proses fermentasi tetap berjalan. The weighing process must be done quickly because the fermentation process continues. Weighing the dough is done using a scale so that the weight of each croissant dough is the same.

2.1.3. Dough Cooling Process Phase I and Dough Laminating / Flattening Process Phase I

Cooling is a temporary rest period given so that the croissant dough relaxes and to make it easier for the dough to handle at the later stage. The resting time of the croissant dough in this first stage takes place in a blast freezer at a temperature of -30°C to -40°C for 30-35 minutes with the aim of ripening the gluten and making the croissant dough frozen The cooling process must be in accordance with the predetermined length of time. The cooling process that is carried out for too long can cause the dough expand too large and hardened making it difficult to flatten.

The first stage of laminating or flattening the dough is done using a dough sheeter machine. In the first stage of flattening, 500 grams of butter is added to the dough for croissant dough weighing 2 kg which is then flattened with a dough sheeter machine. The main purpose of this process is to form a dough layer with a thickness of 12 cm and to form a thin dough skin surface (film) without tearing it. Flattening the dough using a dough sheeter was effective to produce an even croissant dough so every dough has the same thickness. The process of laminating / flattening of dough in making croissants can be seen in Figure 2.

Fig. 2. The Process of Laminating Croissant Dough Phase I

2.1.4. Dough Cooling Process Phase I and Dough Laminating / Flattening Process Phase I

The 12 cm thick croissant dough that has been laminated/flattened is then rested in the blast freezer at a temperature of -12°C - 18°C for 90-120 minutes with the aim of ripening the gluten and to make it frozen. If this second stage of cooling process is carried out for too long, it can cause the dough to harden so it will be difficult to do the flattening process to become a croissant sheet.

The main purpose of re flattening the croissant dough in this stage is to flatten the butter in the previous stage and to form a layer of croissant dough into thin sheets with 2.5 mm thickness and 34 cm width. Flattening the dough with a dough sheeter was effective to produce flat croissant dough sheets. However, using a sheeter dough machine for too long will cause the croissant sheet to become too thin so that it is not as expected.

2.1.5. Cutting and Forming Process

Furthermore, the croissant sheet is cut into a triangle with a weight of 28-30 gram. This aims to uniform the shape and size of the croissant that has been cut according to the standards set by the company. After cutting, the next process is the formation of

croissants by rolling the croissant triangles into three levels. Croissant sheet cutting must use a sharp knife in order to get a nice and even cut. The process of cutting and forming croissants can be seen in Figure 3.

2.1.6. Proofing Process/Dough Development

After the dough has been well formed the bread is proofed first before it is put into the oven. This is done so that the dough develops well which consequently resulted in good shaped and high quality bread [16]. Proofing process means is leaving the dough in a proofing machine where the temperature is maintained warm (29-32°C) for 80-100 minutes. Croissant dough will be more elastic and inflate to 2 times its initial size. In this process the yeast breaks down the sugar in the dough and produces carbon dioxide gas (CO2) so that the dough can expand. The volume of the dough after this stage can expand up to 2½ times from the original [17].

Fig. 3. Croissant Sheet Cutting and Rolling Process

2.1.7. Baking Process

Croissants are baked at 180-200°C for 10-13 minutes. This process can be considered to complete when the surface of the croissant skin has turned brown. This can occur due to the browning reaction between protein and carbohydrates. Baking time that is too long will make the bread dry [17]. A croissant can be said to be well-baked if the inside of the croissant is yellowish white, soft, and the top skin is golden brown. However, it is not allowed to open and close the oven door prematurely during the baking process because it can cause the croissants to not expand properly.

2.1.8. Cooling Process

Once the croissants are well-baked, the cooling process is carried out at room temperature around 25-29°C for 20-40 minutes. Cooling aims to lower the temperature of the croissant to avoid the texture of the croissant being hard. The cooling process can be seen in following Figure 4.

2.2. Packaging

The chilled croissants are then put into LLDPE plastic packaging. LDPE (Low Density PolyEthylene) plastic is the top choice for industry actors who need packaging that has high durability and strong elasticity. This packaging process is done manually and aims to maintain quality, prevent damage, protect against pollution. LLDPE packaging is strong, lightweight, low moisture penetration, stable at high temperatures, and quite shiny. One plastic packaging bag can fit 10 croissants. They are then put on the cardboard when before distributed.

Fig. 4. Croissant Cooling Process

3. RESULT AND DISCUSSION

3.1. The Implementation of HACCP on Croissant Production

HACCP has been applied as a food safety tool by CV. P-RS because the croissant products produced must have good quality. The preparation of the HACCP plan begins with the step of establishing a HACCP team [11].

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3.1.1. HACCP Team Establishment

The HACCP team is responsible for writing the SSOP, making the HACCP plan, implementing HACCP and conducting verification. HACCP team at CV. P-RS consists of employees from various departments in the processing and cold storage division. The HACCP team is led by a senior quality assurance manager (Quality Control).

3.1.2. Product Description

The next step in implementing HACCP is product description. Codex (1997) says that the product description describes the characteristics of the product, chemical/physical structure, processing treatment, packaging, shelf life, storage method and distribution method.

The ingredients used to produce croissants are flour, sugar, salt, yeast, improver, and water. The production process includes material receiving, material preparation, material weighing, material mixing, dough weighing, first stage dough cooling, first stage dough laminating, second stage dough cooling, second stage dough laminating, product cutting, dough development, baking, cooling, and packaging. The packaging uses LLDPE plastic with a weight of 25.30 grams, a length of 8.9 cm, and a height of 4 cm. Ready-to-eat croissants should be stored at a temperature of 5-10°C with a shelf life not any longer than 4 days.
Product Market

Croissant products at CV. P-RS has a market segment for all ages except toddlers that should be under parental supervision. Croissant products are products that can be consumed directly (ready to eat). Croissants can only be marketed for local consumption and are not exported abroad.

3.1.3. Flowchart Construction for Preparation Process

The flow chart was compiled by the HACCP team. Flow diagram describes the entire series of process that occur from receipt of materials until the final product is distributed. The diagram is not always the same but it is possible to be modified if there are problems or improvements in the future. Changes to the flow chart are recorded in the HACCP document change log.

3.1.4. Verification of Preparation Process Flowchart

Flow chart verification is administered by observing the congruence between the processing procedures in the document and the processing conditions at the factory. Flow chart verification is also carried out if there is a change in the production stage at the request of consumers or for other reasons.

3.1.5. Hazard Analysis

A food hazard can be caused by biological, chemical or physical factors that are possible to cause disease or injury in the absence of control whereas hazard analysis is the process of gathering and evaluating food-related hazard information under certain considerations. The aim is to decide which information is significant and should be addressed in the HACCP plan. The hazard analysis in the croissant production process is carried out to determine in advance the hazard factors and potential hazards. These hazardz are then categorized based on their form (either biological, chemical or physical). In addition, this analysis is also aimed to determine the risk or significance of the identified hazards and to determine preventive measures [18].

In analyzing the hazard, two stages were carried out, namely hazard identification and hazard evaluation. The results of this stage are the significant hazards obtained and the precautions for these significant hazards [19]. Hazards are divided into 3 different groups, namely biological hazards (bacteria, molds, yeasts and parasites) chemical hazards (poisons or materials that are not suitable for consumption and contaminated with products) and physical hazards (chips of gravel, hair, insects, metal scraps, pieces of wood etc. Contamination of the product can be caused by lack of sanitation and hygiene [20].

3.1.6. Critical Control Point (CCP) Establishment

Critical Control Points are determined using a decision tree in each production process flow from receiving raw materials to final product storage. Determination of CCP on the croissant production process at CV. P-RS can be seen in Table 1.

The next step is determining critical limits for each CCP, monitoring CCP actions, correcting actions for CCP deviations and documenting records. This limit should not be exceeded because it is a tolerance which ensures that the hazard can be controlled and guarantees the safety of the resulting product [21]. The critical limit separates the safe from the unsafe [10]. The critical limit set by CV. P-RS can be seen in Table 2.

Table 1. Determination of CCP on the croissant production process

Input/ stages	**Hazards**	**Q1**	**Q2**	**Q3**	**Q4**	**CCP/ Not CCP**
Raw Material Receiving	Biological: *Salmonella, E.coli, Staphylococcus aureus*	Y	N	N		Not CCP
Weighing of ingredients according to the recipe (Raw Materials and Supporting Materials)	*Chemical: Arsen (As), Cadmium (Cd), Lead (Pb), Mercury(Hg), Tin (Sn), Copper (Cu)*	Y	Y			CCP
Mixing All Ingredients Into the Mixer	Phisical: Metal flakes of the mixer	Y	N	N		Not CCP
Dough Cutting According to Standard Weight	Physical: Knife flakes	Y	N	N		Not CCP

Description:
Y= yes, N= no, dan CCP= critical control point
*Q1= Are there precautions at this stage or at a later stage against the identified hazards?
*Q2: Is this stage specifically designed to eliminate or reduce the likelihood of the hazard occurring to an acceptable level?
*Q3: Can the hazard contamination occur beyond an acceptable level or can it increase to an unacceptable level?
*Q4: Will the next step eliminate the hazard or reduce its presence to an acceptable level?
Critical Limit Setting

Table 2. Critical limit setting of the croissant

Input/ stages	Hazards	CCP/ Not CCP	Critical limitations
Weighing Ingredients According to Recipes (Raw Materials and Supporting Materials)	*Chemical: Arsen (As), Cadmium (Cd), Lead (Pb), Mercury(Hg), Tin (Sn), Copper (Cu)*	CCP	The proportions numbers of the ingredients are according to the product recipe
Metal Detecting	*Physical: unidentified object (metal)*	CCP	*Detected: Fe = 2.0 mm* Non Fe = 3.5 mm Sus = 3.0 mm
Product baking in 180-200°C for 10-13 minutes	Biological: *Koliform/Colifor m, Salmonella, E. coli*	CCP	Temperature: 180°-200°C for 10-13 minutes

3.1.7. Defining Monitoring Procedure

The National Standardization Department [14] explains that monitoring is a scheduled observation of the CCP which is compared to its critical limit. Dewanti and Hariyadi [10] added that the monitoring procedure includes what is monitored, who does the monitoring, when the monitoring is carried out, and how is the monitoring conducted.

Monitoring action that can be carried out in the Weighing section of raw materials is by checking the gramation of each ingredient used according to the product recipe when weighing; whilst, the same action that can be done to the metal detector is by testing the sensitivity of the metal detector machine before each process and 30 minutes before being used by the Quality Control staff. In addition, temperature control can be carried out during the oven process. Monitoring specified in CV. P-RS can be seen in Table 3.

According to Dewanti and Hariyadi [10] if the monitoring action fails, the corrective action serves to ensure that the food product produced is safe. Corrective action for deviations that occur is if the proportions of the ingredients used is less than the recipe, it is necessary to add the ingredients until they are appropriate, if the proportions is excessive then reject the results of the weighing process. Furthermore, as for the metal detector, reject products that are detected to contain metal by a metal detector. Corrective action during baking is if the oven temperature during checking/verification does not match the number indicated by the oven, then reject the product or extend the baking time. Corrective action specified in CV. P-RS can be seen in the following Table 4.

3.1.8. Verification Measure

Verification in the HACCP plan are the activities that determine the validity of the HACCP plan and certify that the system is operating according to the plan (National Advisory Committee on Microbiological Criteria for Foods) [22], [23]. Verification procedure applied in CV. P-RS, namely the weighing of raw materials and supporting materials is carried out every 1 year by conducting chemical tests on the final product. Meanwhile, the verification procedure for metal detecting is carried out by verifying the sensitivity of the metal detector. Furthermore, microbiological tests are carried out on the product every 1 year in the baking process for this procedure. Verification action specified in CV. P-RS can be seen in Table 5.

Table 3. Determination of croissant monitoring procedure corrective action

CCP process stages	Critical Limits	Monitoring procedure				
		What	How	Where	Who	When
Weighing Ingredients According to Recipes (Raw Materials and Supporting Materials)	The proportions of the ingredients according to the product recipe	The proportions of the ingredientsduring weighing process	Checking the proportions of each ingredient used according to the product recipe when weighing	Production area	QC & production staff	When materials are being weighed during the production process
Metal Detecting	Detected: Fe = 2.0 mm Non Fe = 3.5 mm Sus = 3.0 mm	metal detector sensitivity	Checking with metal fragment	Production area	QC & production staff	Everytime after product packaging is finished
Product baking in 180-200°C for 10-13 minutes	Biological: *Koliform /Coliform, Salmonella, E. coli*	temperature	Temperature control during baking process	Baking area	QC & production staff	Everytime after products are baked

Tabel 4. Corrective action for the croissant production

CCP process stages	Critical Limits	Corrective actions
Weighing Ingredients According to Recipes (Raw Materials and Supporting Materials)	The proportions of the ingredients according to the product recipe	If the proportions of the ingredients used is less than the recipe, it is necessary to add the ingredients until they are appropriate; if the proportions is excessive then reject the results of the weighing process.
Metal Detecting	*Detected: Fe = 2.0 mm* Non Fe = 3.5 mm Sus = 3.0 mm	Reject products that are detected to contain metal by a metal detector Do double check on products produced in the same batch
Product baking in 180-200°C for 10-13 minutes	Biological: *Koliform/Coliform, Salmonella, E. coli*	If the oven temperature during checking/verification does not match the number indicated by the oven, then reject the product or extend the baking time

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Table 5. Croissant verification measures

CCP process stages	Critical Limits	Corrective actions	Verification Measures
Weighing Ingredients According to Recipes (Raw Materials and Supporting Materials)	The proportions numbers of the ingredients according to the product recipe	If the proportions of the ingredients used is less than the recipe, it is necessary to add the ingredients until they are appropriate; if the proportions is excessive then reject the results of the weighing process.	Conducting chemical tests on the final product every 1 year
Metal Detecting	Detected: Fe = 2.0 mm Non Fe = 3.5 mm Sus = 3.0 mm	1) Reject products that are detected to contain metal by a metal detector; 2) Do double check on products produced in the same batch	verifying the sensitivity of the metal detector
Product baking in 180-200°C for 10-13 minutes	Biological : *Koliform/ Coliform, Salmonella, E. coli*	If the oven temperature during checking/verification does not match the number indicated by the oven, then reject the product or extend the baking time	Administering microbiological tests on the product every 1 year

3.1.9. Documentation and Recording

Documents or data records are written evidence that an action has been taken. Documents are prepared using forms/forms. Documentation and recording carried out in the CV. P-RS includes HACCP team documentation, product descriptions, process flow charts, monitoring records of all stages of the process from receiving raw materials to final product storage, corrective action records, verification measure records, and others.

4. CONCLUSION

The implementation of the HACCP food safety management system in CV. P-RS has been running in accordance with SNI 01-4852-1998 regarding the hazard analysis system and critical point control (HACCP) as well as guidelines for its application. The things that underlie the need for the implementation of a food safety management system in CV. P-RS is a trend in consuming safe products accompanied by meeting the needs of consumers who want safe products. Critical Control Point (CCP) of the croissant production process includes weighing of raw materials and supporting materials, metal detecting, and oven.

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