GMP Implementation and CCP Determination on Chocolate Candy Processing in ATP Nglanggeran Yogyakarta

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T Marwati[1]*, P P Hendrawanto[2], S Widodo[1], T F Djaafar[1], T Utami[2] and E S Rahayu[2]

[1]Postharvest Department, Assessment Institute for Agricultural Technology Yogyakarta, Indonesia
[2]Faculty of Agricultural Technology, Gadjah Mada University, Yogyakarta, Indonesia

*Email: watipasca@yahoo.com

Abstract. Indonesia is the third largest cocoa producer in the world after Ivory Coast and Ghana. With this potential, many industries in Indonesia process cocoa beans into various products, especially chocolate. One of the products in Agricultural Techno Park (ATP) Nglanggeran is chocolate candy. Chocolate candy must be safe for the consumer. Therefore this research aimed to assess the Good Manufacturing Practices (GMP) application and Critical Control Point (CCP) determination at the processing stage of chocolate candy in ATP Nglanggeran. In this study, observation and interview were conducted by the employees at Taman Teknologi Pertanian. Furthermore, assessment of GMP application with guidelines on Good Food Production Methods for Household Industries (*Cara Produksi Pangan yang Baik untuk Industri Rumah Tangga/ CPPB-IRT*) was conducted. Assessment of process was analyzed based on process flowchart, water content analysis and water activity analysis in samples of steaming, roasting, deshelling, mixing and refining, conching, and chocolate candy. The last step was Critical Control Point (CCP) determination at the chocolate candy processing. From the analysis results of water content and water activity obtained that the processing of chocolate candy had not been able to eliminate the contamination of fungi, especially *Aspergillus niger*. The Critical Control Point (CCP) of the process was at the roasting and conching processes.

1. Introduction

Indonesia is the third largest cocoa producer in the world after Ivory Coast and Ghana [1]. This makes cocoa is one of the potential commodities in Indonesia and can increase the country's foreign exchange. Because of its large production, the factories ranging from household scale to large industry began to process cocoa into products that are delicious and liked by many people, one of which is chocolate candy. Chocolate candy in the market are very varied, but the most famous are milk chocolate and dark chocolate [2]. Chocolate milk is a chocolate bar containing milk [3]. Chocolate milk candy is one of the products produced in Agricultural Technology Park, Nglanggeran, Gunungkidul, Yogyakarta.

High nutrients in chocolate candy and most consumers are children under 10 years old and women [4] make chocolate candy products need to be kept safe. As is known, high nutrition is one factor that makes chocolate candy susceptible to microbiological contamination, especially fungi and bacteria. Therefore it is necessary to have food safety management and rules about food security at processing chocolate candy.

Indonesia has Law Number 8 the Year 1999 regarding Consumer Protection. In the Consumer Protection Act, consumer rights are regulated in order to obtain comfort, safety, and safety in consuming goods and/or services. Thus, any business, whether large-scale households or large industries in Indonesia should produce safe and quality processed products. From the Act, the government created Good Manufacturing Practices (GMP) guidelines, one of the guidelines for Good Food Production Methods for Household Industries (Cara Produksi Pangan yang Baik untuk Industri Rumah Tangga/ CPPB-IRT) with 14 assessment aspects.

Food safety is related to the food-borne hazards present in food at the point of consumption. Food safety hazards can occur at any stage in the food chain, therefore the adequate control measures are necessary to avoid or minimize food safety hazards [5]. Evaluation of the final product does not guarantee that a product is safe and has good quality. It requires a food safety management system that analyzes the hazards from raw materials to ready-to-eat final products, by determining the Critical Control Point (CCP) at every stage of the process. The management system is known as Hazard Analysis and Critical Control Point (HACCP).

Hazard Analysis and Critical Control Points (HACCP) systems are science-based and systematic. It identifies specific hazards and measure for their control to ensure food safety. Each HACCP system is able to accommodate changes, such as advances in equipment design, processing procedures or technological developments [6]. The concept allows a systematic approach to identification of hazards and an assessment of the likelihood of their occurrence during the manufacture, distribution and use of food products, and determine the steps for their control [7]. The resulting HACCP plan can be integrated into a more general quality assurance and security plan.

The basis of HACCP is that it is a process control rather than a product control procedure and that focuses on control measures in a processing system that is very important for the health of consumers. There can hardly be HACCP without Good Manufacturing Practices (GMP). GMP is a description of all steps in a processing facility, while HACCP is documentation that important steps for consumer health are under control [8].

In determining Critical Control Point (CCP) required supporting data such as complete and clear verification of processing flow chart, water content analysis and water activity analysis (aw) of intermediate products and end products of chocolate candy. These data are needed in order to determine CCP to make the product free from contamination of fungi and mycotoxins, especially *Aspergillus niger* and Okratoksin A [9]. The review of GMP implementation, flowchart verification, water content analysis, water activity analysis (aw), and CCP determination are aimed at determining the successful production of safe and quality chocolate candy. Therefore, the aim of this research was to assess the Good Manufacturing Practices (GMP) application and to determine the Critical Control Point (CCP) of chocolate candy processing in Taman Teknologi Pertanian Nglanggeran Yogyakarta.

2. Materials and Methods

2.1. Materials

Materials used in this research was steamed cocoa beans, roasted cocoa beans, cocoa nibs, chocolate after mixing/refining, chocolate after conching and chocolate candy. Materials obtained during the processing of chocolate candy at Agricultural Techno Park (ATP) Nglanggeran Yogyakarta. The material was used for testing moisture content and water activity.

2.2. Observation
Field observations were based on Good Food Production Method guidelines for Home Industry (Cara Produksi Pangan yang Baik untuk Industri Rumah Tangga /PPB-IRT) consisting of 14 assessment aspects. Field observation was conducted on (1) Environment around Agricultural Technology Park (2). Chocolate candy production room (raw materials room, intermediate product room, end product room, machine room). (3). Chocolate candy production process (procedure and machine capacity, production time) and (4) Personal hygiene employee at Agricultural Techno Park.

2.3. Interview
The materials used were guidance questions and guidelines for Good Food Production Methods for Home Industry (CPPB-IRT) consisting of 14 aspects of assessment. Interviews were conducted with chocolate candy production employees at ATP Nglanggeran. This activity was conducted to know the implementation of Good Manufacturing Practices (GMP) by employees and to know in detail the flowchart of chocolate candy processing in ATP Nglanggeran used to determine the Critical Control Point (CCP) in the process.

2.4. Laboratory Testing for water activity and moisture content
Measurement of water content was done by Thermogravimetric and destilation method while water activity measurement using aw meter.

2.5. Assessment evaluation of Good Manufacturing Practices (GMP)
The materials used in the assessment of Good Manufacturing Practices (GMP) implementation were guidelines for Good Food Production Methods for Household Industries (CPPB-IRT) consisting of 14 assessment aspects. From each of these aspects checked whether there was a discrepancy in that aspect. There were are 4 types of mismatches: minor inconsistencies, major non-conformities, serious disagreements and critical nonconformities.

2.6. Critical Control Point (CCP) determination
The material used in the determination of the Critical Control Point (CCP) is the complete description of the chocolate candy, product targets, and flow charts of complete and verified chocolate candy processing. In determining CCP, the steps in preparing the Hazard Analysis and Critical Control Points (HACCP) included product descriptions, identification of product use objectives, flowchart determination, flowchart verification, hazard analysis, and CCP determination. The result of water activity analysis (aw) used as supporting data in determining CCP

3. Results and Discussion

3.1. The processing of chocolate candy
Figure 1 showed the main process flow scheme for processing dried cocoa beans into chocolate candy. Requirements for dry cocoa beans as raw material for chocolate candy in ATP Nglanggeran are seeds with a maximum water content of 7.5%. The steaming process using hot steam 80^{o}C for 30 minutes aimed to clean the surface of the cocoa bean skin and reduce the number of microflora as much as 2-3 log cycles. The presence of wet heating will increase the moisture of the product which can reduce the thermal resistance of the microflora [10].

Roasting was carried out at 120 - 125^{o}C for 30 minutes. After this process, the moisture content of the nib decreases to 2.5 – 3.0% and the seed coat becomes approximately 4% [11]. The purpose of this process wasto form flavour and aroma, kill fungi and microflora in dry cocoa beans, reduce the moisture of seeds, and make the skin become softer looser so that later it is easily separated by nib [12]. This stage

was a step that determines the safety of chocolate candy products because it can kill contaminants such as fungi and microflora with high-temperature heating. The finding of this process was that the temperature of the roasting machine was not monitored and sometimes reaches 150°C allowing the cocoa beans to burn.

The deshelling process separates the shell with the cocoa nib while milling converts the nib to paste. This conching process used a temperature of 50°C for 2 hours to smooth the mixture, form the final flavour and aroma, coat the surface of chocolate with fat, improve the flow properties, and make chocolate in dry conditions (low). This process also eliminated unwanted odours and flavours that feel bitter and sour. The final result of chocolate candy had aw point of 0.3 - 0.5 [13] and moisture content of 0.5 - 1.5% [11]. The conching process becomes the last heating process and determines aw chocolate candy products around 0.3-0.5 and moisture content around 0.5 - 1.5%. For this reason, this stage will determine the safety of chocolate candy from mushroom contamination. Tempering goal is that when the printing process is easy and chocolate is not hot. After printing, cooling and packaging are done until chocolate candy is ready to be marketed.

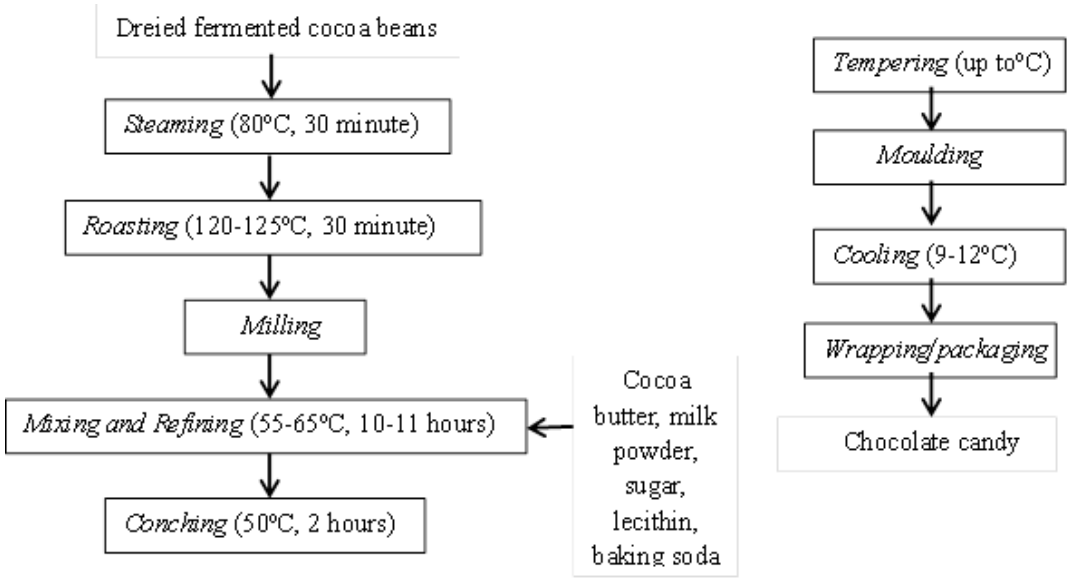

Figure 1. Flowchart for the processing of chocolate candy

3.2.Water activity and moisture content

Figure 2 showed that the highest water content was found in steaming cocoa beans with a moisture content of 11.68%, due to the addition of water to the process due to steam. Then the seeds enter the roasting process using a high temperature of 120 - 125°C. High temperatures will lower water content and will kill contaminants such as fungi and bacteria in seeds. Water content decreases in the deshelling sample of cocoa nib because there was separation with the skin. In the next process was mixing and refining, added cocoa fat, full cream milk powder, sugar, lecithin, baking soda, and vanilla so that the water content of the mixing process to 2.13%. Then the water content dropped on the conching sample to 1.73%. This was in accordance with the theory of which states that the process of conching was divided into 3 stages of dry stages, pasta stage, and liquid stages. At this dry stage many parts of the brown surface are not coated by fat, so water and volatile compounds will evaporate [14]. Conching process will make chocolate candy in dry conditions and then into the tempering machine, but this process was not done in the Agricultural Technology Park. The water content of chocolate candy was 1.87%, higher than the theory that should be a maximum of 1.5%. This indicated that the results were not according to theory.

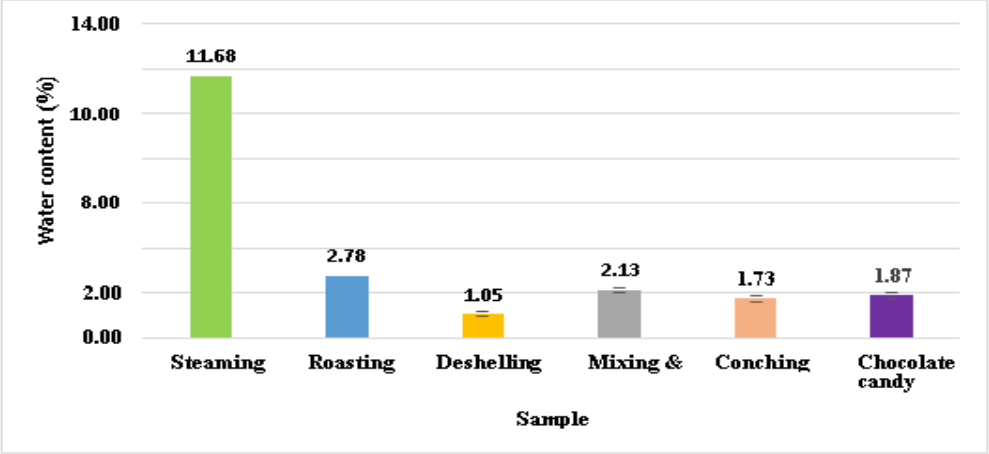

Figure 2. Water content of 5 (five) samples of intermediate products and one end product on the processing of chocolate candy

Figure 3 showed that the water activity in cocoa beans after steaming was 0.88 then decreases after roasting to 0.50. This was because the roasting process uses high heat and aims to reduce moisture in the cocoa beans. In cocoa beans after deshelling, aw increased to 0.52, and increased again in cocoa beans after mixing and refining to 0.57. This was because there are additional ingredients that can increase aw and open machines. The intermediate chocolate product after conching has an aw point of 0.64, and the final product is chocolate candy at 0.68. At aw 0.60 *Aspergillus* and *Penicillium* spores were able to survive for several years [9]. So at aw 0.68 it can still survive the spores of several fungal genera. This was evidenced by the results of direct platting of chocolate technology at the Agricultural Technology Park on DG-18 media for 5 days at room temperature. According to [15] chocolate candy in ATP contains *Aspergillus niger* with a black strain and wasthe dominant fungi in chocolate candy. Thus the measurement of aw on chocolate products was important to determine the possibility of the emergence of microbial contaminants, especially fungi.

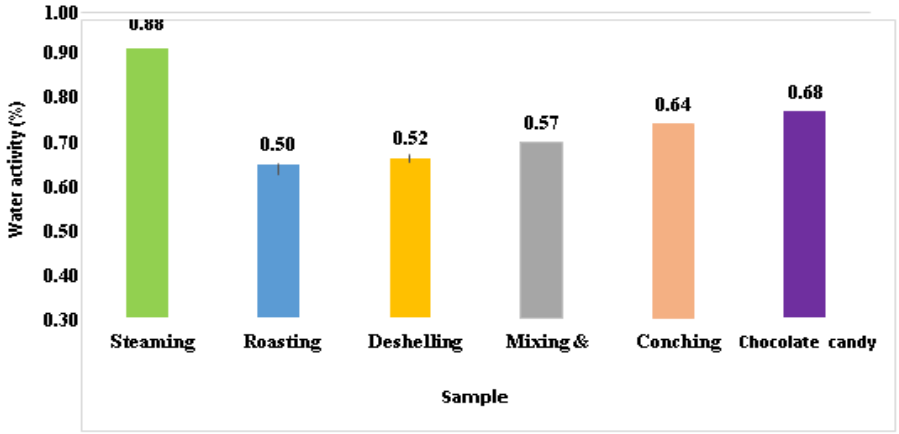

Figure 3. Water activity of 5 (five) samples of intermediate products and one end product on the processing of chocolate candy

3.3. Hazard analysis worksheet and identification of Critical Control Points (CCP) based on HACCP decision tree for chocolate candy production

The Decision Tree will help categorize hazards into Prerequisite Programs (PRP), Operational Prerequisite Programs (OPRP), and Critical Control Points (CCP). If the hazard is classified as in significant, it is included in the PRP category. For significant hazards, it is divided into 2 (two) categories namely OPRP and CCP. The hazard can be categorized as OPRP if it is significant and can be overcome in the next stage. If the next stage cannot overcome the hazard then the stage is categorized as CCP. The hazard analysis worksheets in Tables 1 show the different process steps which were each associated with different risk assessment

Table 1. Hazard analysis worksheet and identification of Critical Control Points (CCP) based on HACCP decision tree (Codex Alimentarius, 1999) for chocolate candy production

Process Stages	Hazard	Type of hazard	Source of Hazard	Assessment			Control Measures	Decision Tree				PRP/OP RP/CCP
				P	P	P		Q1	Q2	Q3	Q4	
Raw material reception	Contamination of mould	Biological	Beans storage in the moist and closed area	M	H	S	Storage of beans in a closed place and maintained moisture	Yes	No	Yes	Yes	OPRP
	Contamination with pesticide residue	Chemical	Pesticides provided during cocoa handling	M	L	NS	Choose the right supplier	Yes	No	No	-	PRP
	Physical contamination from plastic, paper, and gravel	Physical	Frompackaging and distribution of cocoa	L	L	NS	Sortation of raw material	Yes	No	No	-	PRP
Steaming	Contamination of *Salmonella, Staphylococcus aureus, Aspergillus*	Biological	Raw material	M	M	S	In the roasting process	Yes	No	Yes	Yes	OPRP
Roasting	**Contamination of *Salmonella* and *Staphylococcus aureus***	**Biological**	**From steaming processing**	**M**	**H**	**S**	**Use of a higher roasting temperature or a longer time**	**Yes**	**Yes**	**-**	**-**	**CCP 1**
	Burnt and broken seeds	Physical	Temperature and roasting time	M	L	NS	Monitoring the temperature rise	Yes	No	No	-	PRP
Winnowing	Contamination of nibs with shells	Physical	A machine that does not work well	M	L	NS	Manual deshelling	Yes	No	No	-	PRP
Milling	Contamination of *Staphylococcus aureus*	Biological	The employee does not apply personal hygiene	M	L	S	Use hair net, gloves and mask	Yes	No	Yes	Yes	OPRP
Mixing and Refining	Contamination of *Salmonella, Staphylococcus aureus*	Biological	Ingredients and personal hygiene of employee	M	H	S	Overcoming the conching process and the use of gloves, masks and headgear	Yes	No	Yes	Yes	PRP
	Contamination from pellet paint	Physical	Pellet paint that loose	M	L	NS	Periodic replacement of pellet	Yes	No	No	-	PRP
Conching	**Contamination of *Salmonella, Staphylococcus aureus***	**Biological**	**Improper Ballmill machine temperature**	**M**	**M**	**S**	**Monitoring conching temperature and time, and closing the top of the machine during the process**	**Yes**	**No**	**Yes**	**No**	**CCP2**
Tempering	Contamination from dust	Physical	Put in an open area	M	L	NS	Keep the production area clean	Yes	No	No	-	PRP
Casting and moulding	Contamination of *Staphylococcus aureus*	Biological	Personal hygiene of employee	M	L	NS	Use hair net, gloves and mask	Yes	No	No	-	PRP
Cooling	Fat bloom and sugar bloom	Physical	TheiImproper temperature of the cooling	L	L	NS	Temperature management	Yes	No	No	-	PRP
Wrapping/ Packaging	Contamination of *Staphylococcus aureus*	Biological	Personal hygiene of employee	M	L	NS	Use hair net, gloves and mask	Yes	No	No	-	PRP

Remarks : P = Probability ; S = Severity ; SR = significance; L = Low ; M = Medium ; H, High ; S = Significant ; NS = Not Significant ;
Q = Question ; PRP = Prerequisite Program ; OPRP = Operational Prerequisite Program ; CCP = Critical Control Point

The risk assessment for microbial contamination associated with spoilage and pathogenic microorganisms with raw materials receipt for chocolate candy production was high because various raw materials carry these microorganisms, for example, milk powder has been involved in a large number of salmonellosis outbreaks [10]. The main hazards identified in processing cocoa beans and chocolate production were physical, microbiological and chemical in nature. The most dominant hazard for cocoa processing is physical hazards due to the high physical contamination of raw materials, physical contamination during processing and physical hazards due to the failure of pre-requisite programs [16].

The main hazard in chocolate candy products at ATP Nglamggeran which has a low aw was the contaminant of *Aspergillus niger* and other fungi that can survive at aw 0.60 and mycotoxin production from these fungi on dry cocoa beans as the main raw material. Dry cocoa beans received in ATP were not processed directly but stored in an open plastic container in the steaming and roasting process room so that they were easily contaminated by mould because of the humid space. The steaming and roasting chambers were damp because there was a process of removing hot steam, while the windows in this room cannot directly reduce humidity so that fungal contamination occured.

The questions frequently asked for each processing step involve those regarding the adequacy of the technical infrastructure and preventive maintenance, the feasibility for their evaluation, their contribution in the control of recognisable food safety hazards, whether the effectiveness of the remaining control measures depends on them [17]. The answers to these questions determine whether a process step was a pre-requisite programme step or not.

Frequently asked questions for each step of processing involve those related to the adequacy of the technical infrastructure and preventive maintenance, feasibility for their evaluation, their contribution to the control of identified food safety hazards, whether the effectiveness of the remaining control measures depends on them [17]. The answers to these questions determine whether the process step was a pre-requisite program step or not. The hazard of receiving raw materials for cocoa beans is included in the OPRP category (Table 1) because there is no special storage warehouse. Then storage warehouse facilities need to be built first and then these hazards can be classified as CCP because they have critical limits that can be monitored

Contaminants of the mould of cocoa beans can be inhibited in the roasting process where this process will eliminate microbial contamination by high-temperature heating. This process will reduce moisture in the cocoa beans and make the condition not suitable for the growth of microbes. After the roasting process, therewas no more process that can kill these contaminants because of heating after a maximum roasting of 65^{o}C. Then the roasting process was a Critical Control Point 1 (CCP 1). Critical Control Point 2 (CCP 2) was in the conching process where this stage is the last heating and aimed to make chocolate in dry conditions. Under these conditions, water activity the chocolate candy was lower and can prevent mould contamination.

4. Conclusion

Based on the Good Manufacturing Product (GMP) implementation study using the CPPB-IRT, the processing of chocolate candy in ATP Nglanggeran Yogyakarta still need to be improved on several aspects and included in the level IV which means that internal audit needs to be done every day. The Critical Control Point (CCP) of chocolate candy processing in ATP Nglanggeran, Yogyakarta was at the roasting stage (CCP 1) and conching stage (CCP2).

5. References

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