

Evaluation and Improvement of Chocolate Bar Production at CV. XYZ Factory

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ABSTRACT

CV. XYZ is a chocolate bar industry in Yogyakarta. The Village community carries out the industry. It creates cocoa product innovation from upstream to downstream products. This research contributes to evaluating the chocolate tempering to determine the fat content of the chocolate bar obtained. The proper tempering techniques and defect evaluation are conducted to determine the reasons for defects in chocolate bars. Good chocolate characteristics consist of the chocolate bar, such as being quickly released from the cast/not sticky, obtaining a glossy/glossy surface on the chocolate bar, being hard and crunchy when broken, and being resistant to melt at room temperature. The standard for the tempering process is set by CV. XYZ produces chocolate bars from the tempering process to produce chocolate bars with shiny/glossy look and crunchy.

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1. INTRODUCTION

Cocoa (*Theobroma cacao*) is one of the plantation commodities in Indonesia. Cocoa is one of the essential commodities for Indonesia's economic growth and one of the world's largest cocoa producers (Rivaldy et al., 2014). The cocoa product production has unique properties than other foods because of their properties that other foods do not have: solid at room temperature, brittle when broken, and melting perfectly at body temperature (Lip & Anklam, 1998).

One way to improve the quality of chocolate is through tempering, a process that involves a series of stages of heating, cooling, and stirring at low speed. The tempering process can increase the melting point. Several studies on the process of making chocolate have investigated the effect of crystal shifts on cocoa butter and tempered chocolate preparations in several different flow geometries (Bolliger et al., 1999).

Evaluating the tempering process and defects in chocolate bars is important because Tempering chocolate is a mandatory technique in couverture chocolate processing. Couverture has cocoa butter in it. Tempering chocolate is to stabilize its cocoa butter content before use. During the tempering process, the cocoa butter content in couverture chocolate must undergo a stable crystallization process. The best type of crystal needed in chocolate products is beta-crystal, which is a small crystal structure with a glossy texture. The best chocolate product observed with the beta crystals type in preparing chocolate. Beta crystals have a small structure to produce a texture capable of forming large crystal groups (Nurhidayah, 2015).

According to some literature, tempering is the last process in making chocolate bars before chocolate forms. The hardness of chocolate bars will be better if the fat is in the beta structure. Beta crystals give the chocolate the best appearance and texture and produce mutually stable crystals. Beta crystal keeps its texture and appearance last as long as it is at room temperature. Then in the tempering process, the chocolate cooling temperature increases and decreases due to the crystallization process, resulting in a type change. Changes in the type of lipid crystals differ in the chocolate product. They are affected by the changes in crystallization temperature, so the process of changing temperature in this tempering is carried out/aimed at getting more and more types of beta crystals (Shuai Ren, 2016).

The temperature in the tempering process must also be considered. If it is too hot, the chocolate will agglomerate, forming a texture that is not good. The correct tempering process will result in a nice melted chocolate appearance. As a result, the chocolate will be glossier, and a softer texture will appear when eaten.

Damaged products are rejected stocks that are usually made by accident. The product is beyond repair and cannot be sold to customers. The mold appearance usually observes rejected chocolate. In other words, it is detrimental to the company because it reduces the stock of sale, resulting in a decrease in income. Meanwhile, defective chocolate is a minor quality deviation that can still be reprocessed. Therefore, this study evaluates the tempering process and the fat content produced during tempering.

2. MATERIALS AND METHODS

2.1. Materials

The ingredients used in the tempering of chocolate bars include cocoa beans which are processed into cocoa powder, powdered sugar, powdered milk (raw material), lecithin, vanilla (additional ingredients), chocolate paste (intermediate material), and cocoa butter (Side product). The final product produced by CV. XYZ is dark chocolate and milk chocolate.

2.2. Research Methods

1. Interview method

The interview is a data collection technique through a one-way question-and-answer process, meaning that the questions come from the interviewer, and the interviewee gives the answers. According to Hopkins, interviews are a way to find out certain situations in the classroom seen from another point of view (Sutrisno Hadi, 2011). The analysis method was conducted through interviews submitted to Ms. Surini as the chairman and finance and Mrs. Surgiyanti as the general part of the CV. XYZ. Questions asked as follows:

- a. How many formulations of ingredients are used in the tempering process in the manufacture of chocolate bars?

- b. How much capacity does the Melanger tool have, and how many chocolate bars are produced daily?
- c. What temperature is used in the chocolate tempering process at CV. XYZ?
- d. What causes defects in chocolate bars?
- e. How long does it take to make a Melanger tool?
- f. Is there a standard from CV. XYZ in the manufacture of chocolate bars, and what are the criteria?
- g. How long does it take to soften the chocolate bar product?

2. Tempering formulation

The capacity of Melanger tools is 2 kg. The number of chocolate bars that could be produced was 18–20 a day with 2.7 kg weight. The process took 12–16 hours. The chocolate bars at CV. XYZ has two flavors, namely milk and dark chocolate. Based on an interview with Surgiyanti's mother, the chocolate bar could be softened after 10 hours at room temperature. Tools and materials needed to produce the milk and dark chocolate:

a. Milk Chocolate

The tools used in making milk chocolate are a Melanger, pan, stove, basin, thermometer, ice cubes, stirrer, printer, and piping bag. The ingredients used in manufacturing milky chocolate are cocoa fat, chocolate paste, sugar, milk, lecithin, and vanilla (more than dark).

b. Dark chocolate

The tools used in making dark chocolate are a melanger, pan, stove, basin, thermometer, ice cubes, stirrer, printer, and piping bag. The ingredients used in making dark chocolate are sugar, chocolate paste (more), chocolate fat, milk (less than milky), lecithin, and vanilla.

The tempering process is an essential process that is carried out before printing is carried out because the tempering process can produce chocolate bars that are glossy and have a good texture and appearance. Therefore, an appropriate and correct tempering process is carried out to make good-quality chocolate bars.

2. Direct observation/observation method

Observation is a data collection technique carried out through observation, accompanied by recordings of the state or behavior of the target object (Abdurrahman Fatoni, 2011). The observation was carried out by measure:

- a. Showcase the temperature at the time of chocolate after printing and measure the room temperature (after removal from the showcase).
- b. Length and width of the mold used.
- c. Weight of chocolate bars

3. Method of analysis with a fishbone.

The fishbone diagram (also called cause-effect diagram) was used to analyze the methods for improving quality (Munawan and Mustafa, 2018). This method is used to determine the cause of the defect that may occur in chocolate bar products in the CV. XYZ Nglanggeran.

3. RESULT AND DISCUSSION

CV. XYZ produces chocolate bars from the tempering process to produce shiny chocolate bars with a crisp texture. The composition of the ingredients used in the manufacture of milky chocolate bars and dark can be seen in Table 1.

Table 1. The composition of chocolate bar ingredients in CV. XYZ

Product Types of Chocolate	The composition of the material (g)					
	Chocolate Paste	Brown Fat	Sugar	Milk	Lecithin	Vanilla
Milky Chocolate	300	500	500	500	10	10
Dark Chocolate	1300	400	300	-	10	10

Lecithin was used as an emulsifier in chocolate making to reduce the interfacial pressure between fats and water and maintain the emulsion's stability in the dough. The minimal viscosity change in lecithin concentration is 0.5 g/100 g reflecting the character of the lecithin function in the emulsion formed by the brown material. Cocoa fat was added to make the chocolate surface shiny and give it a cocoa flavor. Cocoa fat also determines the level of hardness in a chocolate bar. It is crucial to sort good quality cocoa fruit beans as raw materials.

In the tempering process, cocoa fat bars are melted in hot water and on the stove at a temperature of 100 °. The next step is weighing the ingredients with the established formulation and mixing the ingredients inserted into the melanger tool for smoothing (conching stage). In the chocolate bar tempering process, the chocolate paste was raised in temperature until it reached 50-55 °C, then lowered using the ice bath until it reached 27 °C. Then, the temperature was raised by heating it to 32 °C. The chocolate paste was printed and put into the showcase (cooling temperature) for ± 15 minutes at 23 °C. After removal from the showcase (28 °C) the last step was the packaging.

The reaction of flavonoid compounds influences the formation of color in processed chocolate, and the occurrence of a browning called the Maillard reaction is the reaction between amino acids and reducing sugars at high temperatures. In this reaction, the carbonyl group of reducing sugar interacts with the protein's nucleophilic group of the amino acid under alkaline conditions so that a brown pigment complex (melanoidin) is formed (Ramlah, 2016).

3.1. Defect Chocolate Bars

The results of the chocolate bar defect can be seen in Figure 1. The brown surface is uneven, not shiny, and a fat bloom appears. This signals under tempering, so that fat particles do not spread evenly throughout the chocolate. When eaten and held, it is not crispy and mushy and when broken it does not sound clunky aka not solid / crispy, and melts easily at room temperature. The cause of the chocolate bar defect at CV. XYZ based on interviews was poor tempering techniques, namely the grinding and stirring process that was not optimal.



Figure 1. Chocolate Bars Defect Products.

Figure 2. shows a chocolate bar that complies with CV standards. XYZ not experiencing product *defects*. Chocolate bars that conform to CV standards. XYZ is one that has a *glossy*/ shiny brown surface texture and when broken it will sound cliché indicating that the chocolate bar has a dense and crispy texture and when eaten and touched it is not mushy and dense.



Figure 2. Glossy Chocolate Bars Products.

Blooming occurs because fat or sugar crystals are diffused to the surface so that they look like small spots with a mushroom-like appearance, causing the brown surface to become less attractive (Hasibuan, Lestari, and Lubis, 2020). The causes of fat bloom include the insufficiency of the crystallization process during the tempering process, the process of mixing inhomogeneous flavors in the chocolate coating, recrystallization without the right tempering process, the temperature difference between the inside and outside of the chocolate, improper cooling process, fat migration, and inappropriate storage conditions (such as improper temperature and humidity) (Afoakwa, 2010). Here's an example of an under tempered chocolate experiencing fat bloom addressed in Figure 3.



Figure 3. Fat Bloom Chocolate.

3.2. Proposed Improvements of Chocolate Production

Chocolate with crystal type VI is then heated and lowered at a specific temperature to minimize the types of crystals and increase the crystals of type V. Therefore, it is necessary to make suggestions for improvements for CV. XYZ because it still produces chocolate defects and poor texture of chocolate. One of the processes that can be improved is the chocolate bar tempering process carried out before printing. In existing conditions, there was some unwell-formed chocolate, rough texture, then fat bloom. The tempering process improves the texture and appearance of the chocolate bar. Therefore, with the above problems, an evaluation process is carried out on CV's chocolate bar production process. XYZ as follows:

1. Evaluation of the tempering process after melanger

After mixing the ingredients in the melanger tool, a tempering process is carried out to produce a good chocolate texture and appearance. Meanwhile, the cocoa fat added could be arranged, especially V crystals. The more types of V crystals, the better the chocolate bar produced. Tempering process after the melanger in CV. XYZ lacked temperature control; hence suggestions for improvement in the tempering process after mixing in the melanger are needed. The attention of temperature control is also required at room temperature to produce a good chocolate bar and an excellent tempering technique because the temperature in tempering and room temperature is related to the characteristics of chocolate bars. The tempering temperature was controlled by raising the chocolate melting point (50-55 °C), then holding the chocolate at a lower temperature (27 °C), then heating it to 32 °C.

2. Tempering in CV. XYZ was done manually

Tempering process carried out in CV. XYZ was done manually by using a stove with a pot of hot water, balls filled with ice cubes, and regular stirring. Improvement is suggested to carry out chocolate tempering with a machine system that can control temperature.

3. Temperature measurement is done manually

The thermometer did temperature measurements. Therefore, suggestions for improvements that can be made is to use a tempering device with a temperature sensor.

4. Formulations used

Formulation of ingredients used on CV. XYZ was not quite right therefore improvements were needed in improving the formulation. Composition used to produce a good chocolate bar is cocoa butter 35%, cocoa liquor 15%, sugar 25%, and a mixture of lecithin and milk 25% (Shuai Ren, 2016). The following is a flowchart of improvements that can be proposed to CV. XYZ can be seen in Figure 4.

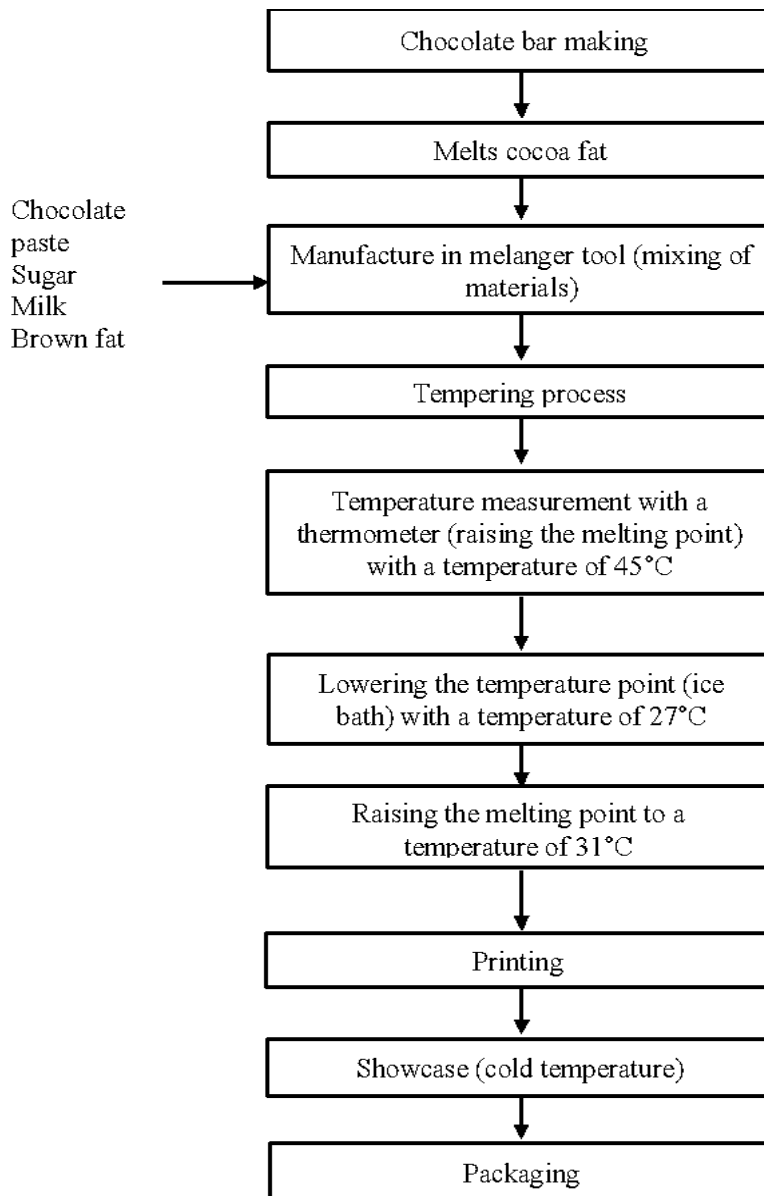


Figure 4. Improvements proposed to CV. XYZ

Flow chart showed improvements on the controlling temperature of chocolate. There are six crystalline forms for chocolate. The more V-type crystals, the better the chocolate. V-type crystals provide the best look and texture and create the most stable crystals, so the texture and appearance will not degrade over time. The brown type of crystallization changes with temperature. During the process, the chocolate is first heated to 45 °C to melt all six crystalline forms. Then, the chocolate is cooled to about 27 °C which allows the formation of type IV and V. At this temperature, the chocolate is stirred to create many small crystal "seeds" that will serve as nuclei to create small crystals inside the chocolate. The chocolate is then heated to about 31°C to remove any type IV crystals, leaving only type V. Tempering is a very important step during chocolate making. It is necessary and the last step before printing. By regulating the temperature, cocoa butter can produce many small crystal seeds and only has V-type crystals. A study showed that chocolate is seeded by adding small fat crystals at 34 °C and the viscosity of the plastic increases (Shuai Ren, 2016).

3.3. Fishbone Diagram Analysis

Fishbone diagrams were used to improve quality, also called cause-effect diagrams (Munawan and Mustafa, 2018). This method is used to find out the causes of defects that may occur in chocolate bar products in CV. XYZ. Causes of chocolate bars in CV. XYZ defect can be seen in Figure 5.

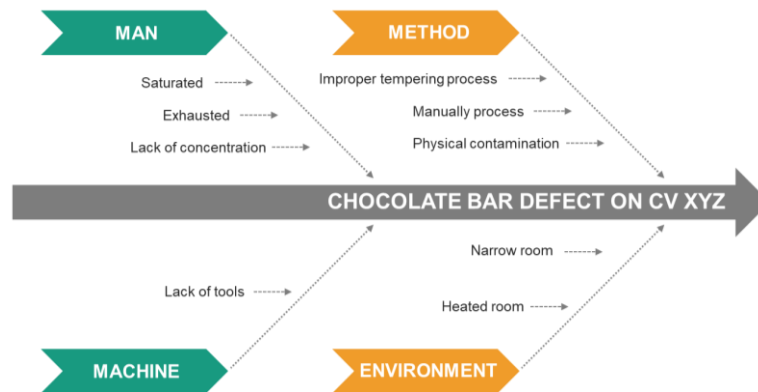


Figure 5. Fishbone Diagram Defect Chocolate Bar

The fishbone diagram shows several things that cause chocolate bars to defect and must be repaired. Based on the fishbone diagram analysis data, the company must make improvements to the chocolate bar production process. Suggestions for improvements to minimize the causes of defects in chocolate bar products of CV. XYZ were as follows:

1. Workers must be more careful, meticulous and painstaking in working so that they able to overcome product defects, and comply with standards.
2. Pay attention to the process in tempering techniques and the temperature used to produce chocolate bars that are in accordance with the standards.
3. Increase the power source so that it can use an automatic packaging tool.
4. Improve monitoring and evaluation of the production process.
5. The workers have enough rest at work therefore they are not easily exhausted, and concentrate more.
6. Increasing the number of tools and machines so that they can produce many products with maintained quality.

4. CONCLUSION

Tempering process is the most important step to get a crispy, crunchy, and shining/glossy chocolate bar. The cause of the chocolate bar defect at CV. XYZ was due to poor tempering techniques, grinding and stirring processes that are not optimal, improper tempering standards, and extrinsic factors or factors from outside production.

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