SANITARY PRACTICES OF CHOCOLATE MANUFACTURING

by

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DECLARATION

The work described in this thesis was carried out by me at the Ceylon Biscuits limited, Makumbura, Pannipitiya and Faculty of Applied Sciences under supervision of Mrs I Wickramasingha and Mr R Cooray. A report on this has not been submitted to any other University for another degree.

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AFFECTIONATELY DEDICATED
TO MY EVER LOVING
PARENTS, BROTHER, SISTER,
TEACHERS AND FRIENDS.

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ABSTRACT

Chocolate is now become a leading confectionery product in Sri Lanka. This study was directed towards identifying chocolate manufacturing process such as preparation of ingredients, mixing and refining Production methods of chocolate such as Molding, Enrobing and Panning were studied

In this study some parts were concentrated on current good manufacturing practices and improves sanitary conditions of chocolate manufacturing.

And also this study was focused on simply establish and implement of Hazard Analysis Critical Control Point (HACCP) system. Some tests are carried out to check product safety parameters. Experimental results were used to determine some possible hazards and critical points. Other observations and guidelines were used to get some ideas about Good Manufacturing Practices.

HACCP system was implemented to increase food value with its safety aspects and to give benefits to consumer

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CHAPTER I

INTRODUCTION

Chocolate manufacture has become one of the major confectionery industries in Sri Lanka. Cocoa powder, milk powder, sugar, fat and emulsifiers are the main ingredients of chocolates. Establishment of good sanitary practices are very important in chocolate industry. The wholesomeness of prepared food can and should be safe guarded through sanitary practices in preparation and storage. Food contaminated with poisonous substances and certain microorganisms can cause food poisoning. A clean and sanitary establishment is the result of a planned program that is properly supervised and followed according to schedule. Properly functioned sanitary practices give benefits to producer as well as customer.

The progressive food processing or preparation firm should take responsibility for establishing and maintaining sanitary practices HACCP is the current trend and may be replaced by total quality management.

Prerequisite programs can be and effective way to manage the repetitive hazards that occur through out the facility at a number of possible locations. However, the dangerous of them forgetting about these hazards and simply concentrating on the specific hazards managed within the HACCP plan. Hazard analysis critical control point system should be applied as a systematic approach to hazard identification, risk assessment and hazard control through out any product/ process /packaging line at a manufacturing site and includes the distribution system.

1.1 OBJECTIVES

Studying the process of chocolate manufacturing
Identifying the sanitary practices of chocolate manufacturing and improve sanitary techniques

CHAPTER II

LITERATURE REVIEW

2.1 INGREDIENTS OF CHOCOLATE MANUFACTURE

The basic ingredients required for chocolate manufacture are cocoa nibs, cocoa liquor; sugar other sweeteners, cocoa butter, fat, milk powder, milk crumb and emulsifiers.

2.1.1 COCOA NIBS, COCOA LIQUOR

These are prepared by using following methods such as roasting, winnowing and nib grinding. Lower temperature roasts are usual for milk chocolate and for some dark chocolates. It is appropriate here to mention imported liquor, which means that it has been produced in the area where the beans are cultivated. (Minifie, 1989)

2.1.2 SUGAR AND OTHER SWEETENERS

High-grade sugar should be used in manufacturing chocolate. It must be dry and free from invert sugar. Washed raw sugars are sometimes used in health food chocolates, but they usually contain some invert sugar and moisture. Dextrose and anhydrous corn syrup are used as partial replacements for sugar. Anhydrous corn syrup is very hygroscope and can cause trouble with moisture absorption during refining. (Minifie, 1989)

2.1.3 COCOA BUTTER

Cocoa butter is essentially the natural fat of the cocoa bean. Cocoa butter obtained by hydraulic expression of cocoa nib is light yellow fat. The completely liquid fat displays a marked tendency to super cool, a fact that must be taken in to account in the processes of chocolate enrobing and molding. Cocoa butter is composed of a number of glycerides of stearic, palmitic and oleic fatty acids with a small proportion of linoleic.

Cocoa butter has the valuable property of contraction on solidification, which enables the molding of chocolate blocks and bars in to the attractive confections displayed in shops.

2.1.4 MILK PRODUCTS

Whole milk powder and non-fat milk powder are the primary milk products used. In confectionery, sweet condensed milk and concentrated milk are used extensively. Whey products are finding increased use. Butterfat is derived from unsalted dairy butter by dehydration and removing of curd. It is used in conjunction with nonfat milk powder to make less expensive milk chocolate.

It is also used as an antibloom agent in dark chocolate and occasionally to replace some of the cocoa butter constituent of either dark or milk chocolate when butterfat is cheaper than cocoa butter. (Minifie, 1989)

2.1.5 EMULSIFIERS

The most popular emulsifier is Lecithin, used to reduce viscosity and save cocoa butter. Soya lecithin has been used to aid the wetting of cocoa powder but this is subjected to the development of off flavors It has had a great impact on the food industry particularly in the manufacture of chocolate It occurs naturally in all living matter animal and vegetable, with the highest content in egg yolk

Because of its molecular structure, commercial lecithin exhibits both lipoplilic and hydrophilic properties, and this is responsible for its exceptional value as an emulsifier and wetting agent. (Minifie, 1989)

2.1.6 OTHER FATS

Some countries now permit the addition of small quantities of other fats with the understanding that it can still be called chocolate Such fats are called equivalent fats and should have the same chemical and physical properties as cocoa butter, except for flavor

2.1.7 FLAVOURS

Flavors also may be added, including vanillin, cinnamon, cassia oil, and essential oils of Almond, Lemon and orange as well as manufactured combination flavors (Beckett, 1994)

2.2 CHOCOLATE PROCESS

Manufacturing process, whether for dark or milk chocolate involve certain basic operations. Preparation of ingredients, mixing of ingredients, refining of the mixture, pasting or partial liquefaction of the refined mixture and adjustment of viscosity and flavoring.

2.2.1 PREPARATION OF INGREDIENTS

The two main ingredients, cocoa nibs and sugar, must be pulverized either before mixing or by using a machine with a combined grinding and mixing action. Cocoa butter and other fats are liquefied and care must be taken to see that they are not over heated when melting and are not stored as liquids for long periods, particularly butterfat.

Milk powders should not be stored in open hoppers and should be used as soon as possible after delivery. Moisture content should not exceed 3 percent .In some cases, milk powder. And cocoa powder may be further dried before mixing, but this is more likely with compound coatings (Minifie, 1989)

2.2.2 MIXING

In most chocolate plants the basic ingredients are dispensed by automatic methods, which deliver the correct quantities according to any given formula. In some instance, the ingredients are metered and mixed continuously, in other; they are fed in to batch mixers. The mixing process prior to refining should produce a chocolate paste of somewhat rough texture and plastic consistency

2.2.3 REFINING

The refining of chocolate paste is an important operation and produces the smooth texture so desirable in modern chocolate confectionery. Exactly what constitutes smoothness is debatable, as it is clear that if refining is carried to an extreme, producing chocolate with maximum particle sizes of less than 0010 in, the texture becomes slimy, particularly with milk chocolate (Minifie,1989)

2.3 PRODUCTION METHODS OF CHOCOLATE

The methods of manufacturing of bulk chocolate have been described and there is certain well-defined process for using chocolate to produce a variety of confections.

2.3.1 MOLDING

This is the casting of liquid chocolate in to molds followed by cooling and demolding. The finished chocolate may be a solid block. This chocolate mixture is deposited in to molds as solid pieces. These molding machines are consisting of the temperer, the depositor, the mold cycle carrier, the cooling tunnel, and the packing belt. (Minife, 1989)

2.3.2 ENROBING

This is the mechanical method of coating confectionery centers with chocolate by putting them through a certain of liquid chocolate followed by cooling. The confectionery centers to be covered with chocolate are placed on a conveyor belt. From the canvas belt the centers are transferred to a wire net specially designed for enrobers, which first passes over a bottom-coating device

2.3.3 PANNING

This process, sometimes called the Volvo process, employs a rotating pan in which the centers rotate and cascade over one another. In this manner, layers of chocolate are built up around the center to any desired thickness and the shape of the final article approximates that of the center and is quite smooth. (Beckett, 1994)

2.3.4 TEMPERING

This process is necessary as a preliminary to all the other chocolate processes. It ensures that the cocoa butter constituent is seeded and that the chocolate will set in a stable condition with a good permanent color and gloss

2.3.5 CONCHING

Conching may be regarded as the last process in the manufacture of bulk chocolate, whether dark or milk. It is certainly an essential process for the development of the final texture and flavor (Beckett, 1994)

2.4 ESTABLISHING SANITARY PRACTISES

Management is responsible for establishing and maintaining sanitary practices in food plants. This is more than a responsibility: It is both a duty to protect the public health.

And a necessity to promote consumer good will. The problem of establishing as well as applying and maintaining sanitary practices within food industries is essentially the problem of the sanitarian or the food technologist in charge of sanitation. Management is concerned with the control of quality through production. The sanitarian must make certain that the practice he seeks to establish are, first of all, essential to public health and economical operation. He is both the guardian of public health and the counselor to management in quality control as influenced by sanitary practice. (Gould, 1994)

2.4.1 STRATEGY FOR ESTABLISHMENT OF SANITARY PRACTICE

A large food processing company should have a separate sanitation department in the general office on the same level as production or research that is in charge of all operating plants, with the chief sanitation administrator directly responsible to the top management. A sanitation department should exist in each plant on a level with other plant departments. In a large organization, sanitation maintenance should be separated from production and mechanical maintenance, an arrangement that will enable the sanitation department to exercise company-wide surveillance of sanitary practices and thus maintain of high level of sanitation. Production practice, quality control, and sanitary practice do not always appear compatible when subjected to the administration of a single department or individual, however, all of these functions are complementary, and are best performed when properly coordinated and synchronized. Although production deserves major consideration, the proper application of sanitary practices is essential to ensure efficient and effective production

Ideally, an organization should have a full-time sanitarian with assistants, but this is not always practical. Instead, a trained individual who was originally employed as a quality control technician, a production foreman, or a superintendent or some other individual experienced in production can be charged with the responsibility of the sanitation operation. This situation is fairly common and usually effective. But unless the sanitarium has an assistant to take care of some of the routine tasks and is given sufficient time for proper attention to sanitary details, the program may not succeed.

A planned sanitation maintenance program is essential to meet legal requirements, to protect brand and product reputation, and to ensure product safety, quality, and freedom from contamination. All phases of food production and plant sanitation should be included in the program to supplement the cleaning and sanitizing procedures for equipment and floors. A sanitation program should start with surveying and monitoring the raw materials that enter the facility because these items are potential contamination sources.

The sanitation survey should be comprehensive and critical. As each item is considered, the ideal solution should be noted, irrespective of cost Aesthetic sanitary practices should not be adopted without clear evidence of their ability to pay dividends in increased sales or because they are necessary to meet competitive sales pressure.

2.4.2 SANITATION AND SANITARY REGULATIONS

During the past decade, as the food industry has become larger and more diversified, sanitary practices in this industry have changed and become more complex. Added mechanization and larger volume operations of food processing and preparation have increased the need for workers to understand sanitary practices and how to attain and maintain hygienic conditions Workers who comprehend the reasoning and biological basis behind these practices will become more effective sanitation workers (Gould, 1994)

2.4.3 IMORTANCE OF SANITATION

Today, more processing is conducted at plants near the area of production, a trend that should continue Many of these food plants are hygienically designed, nevertheless, foods can be contaminated with spoilage microorganisms or microbes that cause food borne illness if proper sanitary practices are not followed If effective hygienic practices are conducted, clean and safe foods can be produced, even in older plants with less than ideal sanitary features The caliber of the sanitary practices can be equally or even more important to the wholesomeness and safety of food than the chart Anstech of the physical plant
Scientific advance in food processing, preparation, and packaging during the past century have contributed to improve food acceptability and to more economical prices With increased

productivity, however, convenience foods and other processed foods remain vulnerable to problems created through advanced technology. The major problems have been food contamination and waste disposal.

Many food processing and food service operators offer excuses for not implementing a sanitation program in their establishments. Yet, the reason for not establishing such programs are more compelling, because they deal with the bottom line of the profit and loss statement. A sanitation program is "a planned way of practicing sanitation". It results in a number of crucial benefits for both the public and the business conducting the program.

Obviously, most owners or managers of food operation want a clean operation. But, frequently unsanitary operations result from a lack of understanding of the principles of sanitation and of the benefits that effective sanitation will provide.

2.4.4 Benefits of sanitation

1. An effective sanitation program increases the chance of complying with regulatory requirements. The general perception is that inspection is becoming more stringent because inspectors are relying more on modern methods of microbial and chemical determination to establish compliance. Thus, an effective sanitation program is essential.
2. Catastrophic outcomes resulting from ineffective sanitation, while posing a significant risk, do not occur frequently.
3. The more common problems are food spoilage and resultant off-odor and flavor. Spoiled foods are not acceptable to consumers and cause reduced sales and increased claims. Off condition products convey the lack of a firm's commitment to an effective sanitation program and a compromise of compliance with regulatory requirements.
4. A superior sanitation program enhances product quality and shelf life because the microbial population can be suppressed. A major national supermarket chain has found that the increased labor, time loss, and packaging cost due to poor sanitation can account for a decrease of 5-10% profitability of their meat operations. A rigid sanitation program can facilitate an effective quality assurance program by increasing the acceptability and storage life of food.

5. An effective sanitation program that includes regular cleaning and sanitizing of heating, air condition, and refrigeration equipment reduces energy and maintenance costs. Dirty, clogged coils harbor microorganisms, blowers and fans spread these floras throughout the establishment. Furthermore, insurance carries may reduce their rates for a clean establishment because fewer slips and falls on greasy floors reduce accidents.

6 Various, less tangible benefits of an effective sanitation program include: product acceptability, increased product stability, improved customer relations, reduced public health risks, increased trust of compliance agencies and inspectors, decreased product salvaging, and improved employee morale.

2.5 HACCP (Hazard Analysis Critical Control Point)

HACCP should be applied as a systematic approach to hazard identification, risk assessment and hazard control throughout any procedure/process/packaging line at a manufacturing site, and includes the distribution system The likely abuse of the product should also be considered. Each stage of the process should be considered as an entity as well as in relation to other stages

2.5.1 HACCP DEFINITIONS

The terms used within the HACCP system need to be defined before consideration is given to the way in which the system is applied This is not quite as simple as it may seem, and while it may be tedious, it is essential However, with the HACCP system 'hazard' and 'risk' have their own separate and distinct meaning, and they must be defined and used precisely if the analysis's to be of real use Similarly, the other terms must be understood and used correctly by everyone who is working with the HACCP team (Shapton&Shapton, 1998)

HAZARD

Hazard is the potential to cause harm to the safety aspect or to the product –the spoilage or quality aspect and is present at any stage in the life of the product where unacceptable microbiological contamination or where growth or survival of unwanted microorganisms may occur The term is used in this way in this manner and can be applied to foreign material and chemical reduces as appropriate (Shapton&Shapton 1998)

RISK

Risk is the probability that a hazard will be realized or will happen In principle, risk may be quantified mechanically, but most microbiological safety failures are anticipated to occur at such low probabilities that mathematical probabilities may not be helpful because of inadequate data Therefore, risk may well be ranked as low medium or high, based on judgment or experience

CRITICAL CONTROL POINTS (CCPs)

These are points in the location, process, or product formulation, which minimize or prevent safety hazards being realized Have chosen to discuss critical control points (CCP) according to a typical product flow from

- Production, growing or procurement of raw materials,
- Ingredient receiving and handling,
- Processing,
- Packaging,
- Distribution, and
- Handling at retail, foodservice or in the home.

At each of these stages we will consider a number of CCPs for representative physical, chemical biological hazards Obviously, not every specific hazard and its CCP can be discussed (Pierson, 1992)

2.5.2 REPRESENTATIVE CCPs

2.5.2.1 GROWING

All types of hazards-physical, chemical and biological-are potentially associated with the growing of animals and plants Often antibiotics are used to treat diseases in animals Only approved antibiotics can be used and often they cannot be administrated within a certain period before slaughter This CCP is necessary to protect consumers who are sensitive to specific antibiotics and to reduce chances for evolution of antibiotic resistant pathogens in the human population The application of pesticides to crop is another CCP Only approved pesticides can be applied and then in the amounts specified by regulation or by the manufacture (Pierson, 1992)

2.5.2.2 INGREDIENT RECEIVING

Food ingredients should be shipped only in vehicles, which are clean and sanitary Nonfood chemicals such as pesticides cannot be permitted in the same shipment with food-grade materials Bulk shipment n particular must be locked and sealed to assure that contamination or tampering cannot occur during shipment Temperature control of perishable raw material is essential and will be a CCP

Sensitive ingredients must be quarantined and tested before being released to production. Often tests are performed before the shipment is unloaded The ingredients must either be quarantined during this time or pre shipment arrangements need to have been made with the supplier to provide the necessary assurance that the material is contaminant free. (Pierson, 1992)

2.5.2.3 INGREDIENT HANDLING

The food processor must establish and maintain CCPs for ingredient handling, both for bulk and packed ingredients Most of these CCPs are necessary to detect and contain potential physical hazards All bulk receiving lines should be locked to protect against accidental or premature unloading, tampering, and infestation. The outlet of each bulk system needs to be protected by a physical control device such as a sifter, magnet or filter. (Pierson, 1992)

2.5.3 PRINCIPLES OF STEPWISE ANALYSIS

- Prepare a flow diagram of the process, from ingredients through to the customer. The full details of ingredient specifications, the packaging system, the product formulation and processing must be known.

- Identify the hazards then assess the severity of these hazards and the accompanying risk and level of concern for each stage of the process, including 'bought in processed' as well as raw ingredients.

- Determine/identify the critical control points (CCPs) at which the hazards can be controlled Then, select the control option, which must be in place at each CCP

- Specify the criteria that indicate whether an operation is under control for each CCP Thus, if heat is the control option, the exact temperature and time of heating must be specified and the tolerances, which can be allowed must be set

- Establish and implement procedures that monitor each CCP to check that it is under control The procedures should measure accurately the chosen factors which control a CCP, should be simple and give a quick result Appropriate records are needed as part of a positive assurance of safety

- Specify and record what corrective action is necessary when the monitoring result shows that a CCP is not in control.

- Verify that the HACCP system is working, by use of supplementary information. This is where microbiological examination of product during and/or after processing and packaging has its place the HACCP system.

(Shapton&Shapton, 1998)

2.6 GMP (Good Manufacturing Practices)

A key issue for product safety is the risk of cross contamination occurring during the process from the internal factory environment. Cross contamination could arise from a wide range of sources and the inherent risks in a particular processing area must be understood. Most of these issues are managed through adherence to good manufacturing practices (GMP)
It covers following topics

- Adequate premises and space
- Correct and adequately maintained equipment
- Appropriate trained people
- Correct raw materials
- Packaging materials
- Appropriate storage facilities
- Written operational procedures
- Cleaning schedule
- Transport facilities
- Appropriate management and supervision

2.6.1 Adequate premises and space

Lay out

The facility layout should be considered carefully to minimize the cross contamination risks. This should include adequate segregation of raw materials and finished products. Depending on the type of operation, full segregation between raw materials and finished product may be required, and in most facilities the outer packaging stages, both for raw materials and finished products, will need to be kept separate from the main processing area. If you do not have the standards you require already in place, then layout upgrade and /or segregation can be timetabled in to your project plan for HACCP development and implementation.

Availability of the required services and facilities for manufacture of the product should also be considered This will include the availability of portable water, and adequate cleaning facilities for plant, equipment and environment, along with the connection of all required services in the correct area

The number of holding stages and associated times should also be considered at this stage as it is important that there is adequate space for holding the required amount of product at each stage without causing a cross contamination risk, and that the appropriate temperature controlled facilities are available (Gould, 1994)

2.6.2 BUILDINGS

The fabric of the building itself could pose a hazard or safety risk to the product, through harborage of pests and other contamination, or through physical contamination due to poor design and maintenance Surfaces should be non-porous and easy to keep clean, with all cracks filled and sealed, and overhead services should be kept to a minimum All buildings should be well maintained to prevent physical hazards falling into the product, and drains should be designed and serviced so that the flow is always away from production areas, with no chance of back flow or seepage Adequate pest proofing and cleaning schedules should be drawn up for all facility buildings All food manufacturing areas should be constructed such that issues are managed

Construction of new and expanded processing plants must reflect hygienic design because most of today's plants are volume oriented High volume plants operate under the principal that pushing more materials through a larger capacity production pipeline attains greater capacity High volume processing plants by design operate with longer production periods and much greater product volume flow than lower volume plants. There is much more microbial buildup in the plant because of the longer dwell time and larger volume output. To reduce the microbial buildup, safe levels should be set by a saturation device that senses the buildup, stops production, and triggers an automatic cleaning procedure.

Sanitary design features are necessary to minimize downtime for cleaning and sterilizing. The need for maximum utilization of equipment and facilities and minimum discharge of sewage has mandated that the minimum effective cleaning approach to a process cycle is minimal cleaning time and less effluent discharge from cleaning. (Gould, 1994)

2.6.3 APPROPRIATELY TRAINED PEOPLE

Food handlers and other personnel with access to the food processing area could cross contaminate the product with microbiological, chemical or physical hazards. The process layout and movement patterns should be considered in order to minimize the risk, along with the appropriate training programs. All personnel in a food plant should be trained in good hygiene practice.

2.6.4 CLEANING SCHEDULES

There must be sufficient facilities for the cleaning of equipment, people, plant and buildings, and these should be situated to enable their convenient use. Cleaning areas should not cause a cross-contamination risk to the process. Cleaning schedules should be prepared for all areas and staff must be adequately trained to carry out cleaning activities effectively.

2.6.5 CORRECT RAW MATERIALS

Raw materials can act as cross-contaminants if they gain access to the wrong product, or if they are added in excess quantities. This can have serious consequences in the case of allergenic raw materials entering a product where they are not labeled. Handling areas for raw materials must be carefully planned, and areas used for more than one type of ingredient may require thorough cleaning between uses. (Gould, 1994)

2.6.6 APPROPRIATE STORAGE FACILITIES

Storage areas must be properly planned to minimize damage and cross-contamination issues Consider whether you have adequate segregation, temperature and humidity control, and ensure that all storage areas are properly pests proofed. All materials should be stored off the floor and in sealed bags or containers. Part-used containers must be resealed after each use, and strict stock rotation should be employed.

CHAPTER III

Materials and methods

3.1 materials

Conical flasks
Boiling tube
1%Phloroglucinol
Concentrated Hydrochloric acid
Test tubes
Autoclave
Incubator
Durham tubes
Brilliant green solution
Sodium hydroxide solution

3.2 Method of testing rancidity

1g of phloroglucinol and 100ml of ether were taken and 1%solution was made 1ml of oil and concentrated HCl were taken in to a test tube and mixed thoroughly. Then 1ml of 1% of phloroglucinol solution was added in to the test tube along the test tube wall. If a red ring appears after approximately 30 seconds the sample is rancid and it is unsatisfactory. If no ring appears the sample is satisfactory

3.3 Method of testing *Salmonella*

100g of chocolate was weighted in to sterile container and added about 300ml from 1 liter of sterile reconstituted non -fat dry milk (100g of non-fat dry milk+1000 ml Of distilled water) It was blended for 2 minutes and transfereed3 to remaining portion (about 700ml) of sterile non-fat dry milk solution 2 ml of brilliant green solution was added and it was mixed well. It was incubated at 37°C for 24 hours

3.4 Studying the process of chocolate manufacture

Studied the chocolate manufacturing process included with preparation of ingredients, mixing and refining.

3.5 Identification of the good manufacturing practices

Identified good manufacturing practices such as adequate premises, correct raw materials, correct maintained equipment, packaging materials, storage facilities and cleaning schedule

3.6 Identified the current factory good manufacturing practices and sanitary conditions

This was to assure the safety aspects of chocolate and HACCP system was simply introduced.

3.7 Identification of the scope of the HACCP system.

3.8 The process flow diagram.

The flow diagram was drawn in a way that it contains all details from the start to the end of the Production process

3.9 Identified of Product description

The product was described with respects to its features regarding its safety In that case product name, it's ingredients, it's shelf time, packaging materials and some other parameters were considered in production process

3.10 Review of incoming materials

For this activity the product description and the list of product ingredients and the incoming materials were used Information of the product description and the list of product ingredient and the incoming materials were used

3.11 Evaluation of the processing steps

This step was followed to identify all possible hazards related to each processing operation. This was accomplished by reviewing the process flow - diagram

3.12 Determination of the critical control points

3.13 Establishment of critical limits.

3.14 Establishment of monitoring and verification procedures

3.15 Documentation procedures

CHAPTER IV

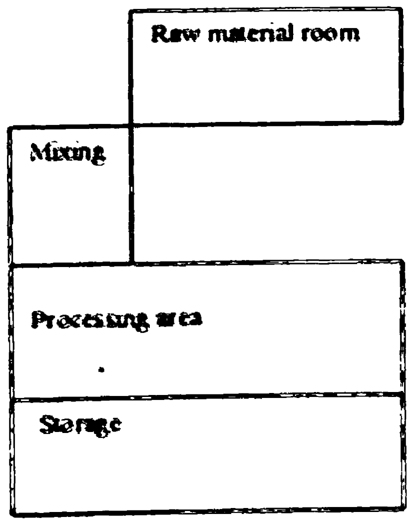
RESULTS AND DISCUSSION

4.1 GOOD MANUFACTURING PRACTICES OF CHOCOLATE

4.1.1ADEQUATE PREMISES

Establishment should be constructed to prevent hazards. Internal structures were designed to improve good hygiene practices. Each section was separated from each other in this establishment. Hence that cross contamination was reduced. Three processing lines were operated in processing area Two enrobing processes and molding process were taken place In processing plant debris accumulation areas were reduced by controlling recessed corners and uneven surfaces and hollows. Unfilled edges were avoided to reduce soil accumulation of debris and subsequent microbial contamination. Rodent control system was introduced. Pests entrances were minimized by using doors, which had self-closing mechanism.

Figure 4.1 Plant lay out



4.1.2 CORRECT AND ADEQUATELY MAINTAINED EQUIPMENT

MacIntyre (raw material mixing), Enrobing, Molding, Tempering, Packaging machines were mainly used in chocolate manufacture. Equipments were designed so that all surfaces in contact with the product can be readily disassembled for manual cleaning. Exterior surfaces were constructed to prevent harboring of soil, pests and microorganisms on the equipment. Equipments were constructed to minimize external contamination. All surfaces in contact with chocolate were inerted to reaction with chocolate. Enrobing machine feeding area was nonporous to prevent accumulation of tiny particles.

Equipments were designed internally with a minimum number of crevices and pocket where some particles may collect. Nontoxic sealants were used to seal equipments to the floor. All machines should be properly cleaned before starting the production.

4.1.3 CORRECT RAW MATERIALS

Cocoa powder, full cream milk powder, sugar, fat and lecithin were mainly used in chocolate manufacture. Raw materials were placed in separate specific places to prevent cross contamination. Normally fats (kemfat 38) were placed on racks. Raw materials were carefully inspected to insure its quality and safety. Raw materials were imported from well-known suppliers.

Some of raw materials such as cocoa powder, fat and lecithin were highly susceptible to contamination. Lecithin was stored in well-covered plastic bottles. Sugar was not subjected to easy contamination. There was an enough space in raw material room. Raw materials were fulfilled some specifications.

Certificate of analysis was obtained for batches of raw materials to confirm that they had been sampled for certain criteria and providing the analytical result. Those certificates of analysis were prepared only by laboratories that were competent to carry out the tests and provide accurate results.

4.1.4 PACKAGING MATERIALS

In the chocolate industry there were packaging of every type. Paper was the most widely used packaging material and there were many types in industry. The protective quality of the wrap was become important. Protection could mean either preservation of the condition of the unit inside the wrap such as prevention of drying out or action as a barrier against exterior contaminants. The second was probably the more important for the following reasons.

i. It was excluded light.
ii. It was prevented access of water vapor, oxygen and contaminating odors.
iii. It was kept out insects.

Metal foil was used as a packing material due to some advantages. It was very attractive and still carried with it an image of quality of the product wrap in it. It was odorless, tasteless, non-toxic, easily printed and not troublesome. It was a very good barrier against moisture, gases and light.

4.1.5 APPROPRIATE STORAGE FACILITIES

There was an enough storing room. The boxes with chocolates were stored in this area manually. Pest entrance was successfully controlled. Where chocolates have been wrapped or boxed different effects appear. Obviously an impervious heat- sealed wrap was given full protection. But overlap wraps or boxes with waxed linings allow penetration at the corners.

4.1.6 CLEANING SCHDULE

Appropriate and well-planned cleaning schedules were very important. Machines (enrobing, molding) were cleaned by following same procedure. Firstly hot water was used to clean molding machine. By rinsing attached particles were removed. Isopropyl alcohol was used after the process. Wire brush was used to clean the enrobing machine. After that piece of cloth was utilized to cleaning process of enrobing machine. Chocolate collecting area should be well cleaned and free from foreign matters. To clean that area, some parts can be disassembled. Normally it was done once a month. Using hot water cleaned these parts and air-dried all cleaned parts before reassembling. Ethanol was used for the cleaning and rinsing of conveyor belt surfaces. It was done before starting the process.

There should be sufficient facilities for the cleaning of equipment, People, plant and buildings, and these should be situated to enable their convenient use. Cleaning areas should not cause a cross-contamination risk to the process. General -Purpose-cleaning compounds are mildly alkaline and are effective for removal of soil from floors, walls, ceilings and most equipment and utensils

These preparation steps can be followed for effective cleaning

1 Remove all large debris in the area to be cleaned.
2 Dismantle equipment to be cleaned as much as possible.
3. Cover all electrical connections with a plastic film.
4 Disconnect lines where possible or open cutouts to avoid washing debris on other equipment that has been cleaned.
5. Remove large waste particles from equipment by use of an air hose, broom, shovel, or other appropriate tool.

4.1.7 written operational procedures

Operational procedures were very important in chocolate industry. In chocolate plant below mentioned procedures were activated.

- Procedures for inspection and test

  All incoming materials shall be tested prior to use to evaluate whether they confirm to company standards

  Using samples checked FFA (Free fatty acid) value, Fat content, rancidity and some other parameters.

  For non conformances,

  If in process inspection and test found non-conformities it shall be recorded in the process control sheets by the quality checker and informed operator and shift manager for immediate corrective actions

  Any product if found suspicious, as defective in the finished goods stores such material shall be handled as according to relevant manual

  - Method of testing particle size of chocolate
  - Final inspection
  - In process quality control of chocolates and chocolate coated biscuits.

Following corrective actions were taken

- Back to production line for reprocessing
- Separate until a management decision
- Rejected for grinding
- Rejected totally (waste)

4.2 Hazard Analysis Critical Control Point system

The HACCP system/concept can be divided in to two parts.

1) Hazard analysis
2) Determination of critical control points

Hazard analysis requires a thorough knowledge of food microbiology, and a good knowledge of which microorganisms may potentially be present and the factors that affected their growth and survival.

Some hazards were involved with raw materials of chocolate. Those hazards were classified in to following categories.

1) Microbiological hazards
2) Chemical hazards
3) Physical hazards

When determine critical control points of chocolate, following critical limits can be applied.
Criteria most frequently utilized

For critical limits

- Time
- Temperature
- Moisture level
- pH
- Humidity
- Viscosity

4.2.1 Production flow charts

Figure 4.2 Chocolate coated biscuits

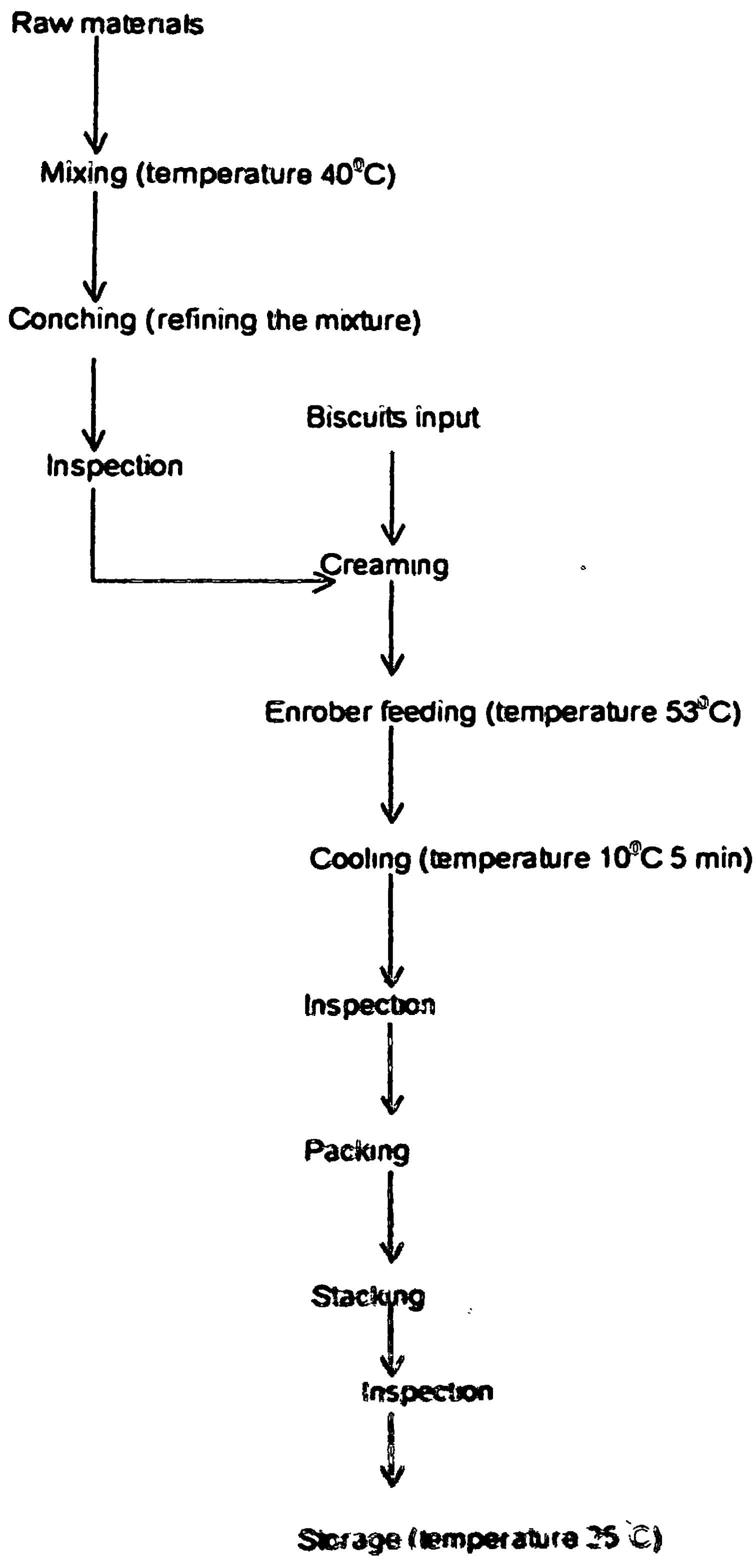


Figure 4.3 Flow chart of dark/milk chocolate

Raw materials

↓

Mixing (temperature 40°C)

↓

Refining the mixture

↓

Inspection

↓

Into storage tanks

↓

Tempering (temperature 50°C)

↓

Molding (temperature 40-45 °c)

↓

Cooling (temperature 12 C, 15 min)

↓

Inspection

↓

Packing

↓

Storage (temperature 25 °C)

4.2.2.1product description

Table 4.1 Product Descriptions

Name of the product	Ritzbury chocolate
Product ingredients	Cocoa powder Skimmed milk powder Sugar Fat Emulsifiers Flavors and colors
Packaging	Polymer coated food grade wrapping material Corrugated cartoons
Shelf time	6 months
Where the product will be sold	Retail shops
Labeling instructions	The date before which the product should be consumed The batch code Price

4.2.3 Possible hazards of chocolate process

Table 4.2 Hazards related with Chocolate Ingredients/Process

Ingredients/step	Hazards
Fat/oil	Rancidity
Sugar	Large particles
Cocoa powder	Insect fragments
Milk powder	Microbial contamination
Cocoa butter	Microbial contamination
Chocolate mixture	Changing FFA value
	Viscosity
	Fermentation
Finished product	Microbiological contamination
Refining	
Tanking	Leaks from water jackets
Rework of chocolate	Presence of residual water after washing the tanks
	Handling and storage of recycled products
	May lead to cross contamination.
Enrobing	Cross contamination
Molding	Cross contamination
Storage	Changing moisture

4.2.4 Hazard control of chocolate

Chocolate products will be safe only when all the relevant hazards are controlled In order to achieve this end, care must be taken in selection of appropriate control measures to operate at the CCPs (Critical Control Point)

Table 4.3 Hazards and Control measures

Hazard	Control measures
Hazard category -Biological Vegetative pathogens	Raw materials • Lethal heat treatment process • Evidence of control during supplier process • Temperature control of prevents growth to hazardous levels. People • Hand wash procedures • Occupational health procedures Process Control of time that ingredients, Intermediate and finished products are held within the organism growth temperature range.
-Physical Extrinsic physical contamination of raw materials	Raw material contamination Powders milk/cocoa -Magnets -Metal detectors
Hazard Physical process	Control measures
Glass	*Elimination of all glasses except lighting, which must be covered
Wood	• Exclusion of all wooden materials from exposed product area
Metal	• Avoidance of all loose metal items such as jewelry, drawing pins, nuts and small tools
Pest	• Pest control programs

4.2.4.1 CCP determination sheet

Table 4.4 Microbial Hazards related with Process

Process/ step	Category and identified hazard
Heating	Survival of pathogens due to insufficient heating of the mixture
Cooling	Growth of pathogenic spores
Enrobing	Unacceptable growth of microorganisms due to some factors
Storage	Growth of pathogenic/spoilage organisms due to increased store temperature
Chocolate rework	The movement and storage of the recycled product may lead to the possibility of cross contamination

4.2.4.2 HACCP WORKSHEET

Table 4.5 Risk assessment worksheet for microbiological food hazards

Product-Chocolate + for "yes", 0 for "no"

Raw material	A High risk	B Sensitive ingredient	C No kill step in process	D Recontamination between process	E Abusive handling	F No term. Heat process by consumer
Fat/oil	+	+	0	+	+	0
Sugar	0	0	0	0	0	0
Milk powder	0	+	0	+	0	0
Cocoa powder	+	+	0	0	0	0
Lecithin	+	+	0	+	+	0

4.2.5 Chocolate manufacture charts

Table 4.6 HACCP control chart 1

HACCP plan 001			Chocolate			
CCP No	Process Step	Hazard	Control measures	Critical limits	Monitoring	
					Procedure	Frequency
1.1	Ingredients					
	Spray dried Full cream Milk powder	Antibiotic residues	Effective Supplier assurance Certificate of analysis	Continue approved Status Maximum acceptable levels	Audit by trained auditor Check Certificate of analysis	Each delivery
	Cocoa powder	Microbial contamination	Effective Supplier Assurance		Check supplier certificate of analysis for compliance	Every batch
		Foreign matters	Supplier assurance Use metal detectors	Continue approved Status	Check supplier certificate	Annual
	Fat	Rancidity	Effective supplier assurance Control heat and light in storage time	Maximum Acceptable levels Maximum levels	Check certificate of analysis	Every batch

Table 4.7 HACCP control chart 2

HACCP plan 001			Chocolate				
CCP No	Process Step	Hazard	Control measures	Critical limits	Monitoring		Corrective action
					Procedure	Frequency	Procedure
1.1	Ingredients						
	Spray dried Full cream Milk powder	Antibiotic residues	Effective Supplier assurance Certificate of analysis	Continue approved Status Maximum acceptable levels Absent in 25 g	Audit by trained auditor Check Certificate of analysis	Each delivery	Change supplier
	Cocoa powder	Microbial contamination	Effective Supplier Assurance	Maximum Acceptable levels	Check supplier certificate of analysis for compliance	Every batch	Change supplier
		Foreign matters	Supplier assurance Use metal detectors		Check supplier certificate	Annual	
	Fat	Rancidity	Effective supplier assurance Control heat and light in storage time	Maximum levels	Check certificate of analysis	Every batch	Change supplier

4.2.6 Monitoring procedures

CCP – Raw material receiving.

Frequency – Each consignment.

Procedure – An analysis report of samples of the respective consignment is obtained from laboratory. Tests are carried out according to Sri Lanka standard methods. The report will be compared with Sri Lanka standard values to check whether it agrees with Sri Lanka standards.

Responsibility – Quality assurance manager.

Record – Raw material file.

Corrective action – Reject the consignment.

CCP – Mixing.

Responsibility – The shift manager.

Frequency – Each batch.

Critical limit – 40⁰C.

Operational limit - 45⁰C.

Procedure – Read the mixing temperature.

CCP – Molding.

Responsibility – The shift manager.

Frequency – Continuous type.

Critical limit - 40⁰C.

Operational limit - 45⁰C.

Procedure – Read the molding temperature.

CCP – Cooling.

Frequency – Continuous type.

Responsibility – The shift manager

Critical limit – 12⁰C – 15 minutes.

Monitoring procedure – The mix out temperature should be read from the control panel and the responsible person should sign in the chart recorder for cooling

4.2.7 Verification procedures for critical control points of raw materials.

CCP –RAW MATERIALS

Responsibility- quality assurance manager

Procedures- laboratory analysis of raw material samples by Sri Lanka standards Institution The test report is obtained

Frequency-Each consignment

Records-raw material verification file

Verification procedures for packaging materials

CCP-Packaging materials

Responsibility – quality assurance manager

Procedure-Audit the supplier manufacturing process

Records-Raw material records

Verification procedures for critical control points of the process

CCP- heating/Mixing
Responsibility- the shift manager
Procedure-calibration of the digital thermometers
Frequency-once every 6 months
Records-process steps verification file

CCP-Molding
Responsibility- the shift manager
Frequency-once every 6 months
Procedure-calibration of the digital thermometers cooling
Records-process steps verification file

4.2.8 DOCUMENTATION PROCEDURE

Effective record keeping procedures must be established to document the HACCP system.

Types of HACCP pan together with the data collected during its creations

- Process flow diagram
- HACCP control chart
- Hazard analysis information

CCP monitoring record
Corrective action taken
Training record
Audit record
Calibration records
HACCP system procedure
History of amend mends to the plan

Discussion

High sensitive ingredients such as skimmed milk powder, cocoa powder and lecithin were highly susceptible to microbial contamination. Milk powder sometimes can be contains *salmonella* or any other food borne pathogens therefore it was consider as a special critical control point. In addition, foreign matters were considered as a hazard due to its adverse effects. Due to rancidity quality of chocolate can be spoiled. To prevent rancidity temperature and light were controlled.

Supplier quality assurance can be used to certified raw materials standards

Third party inspection was applied in testing of some metal ions

By controlling of time and temperature some microbial contamination can be reduced in processing steps

HACCP is a team approach and alone can't assure the safety of the products. Accurate practicing of good manufacturing practices, management supervision and employs dedication cause to assured product safety.

CHAPTER.v

CONCLUSION AND RECOMMANDATIONS

5.1 Conclusion

Knowing of the manufacturing process was very important in sanitary practices Good manufacturing practices were carried out to some extent in this establishment In plant facilities were helped to maintain sanitary practices Acid cleaning compounds were used in cleaning the molding and enrobing machine Cleaning schedules were properly functioned. Personnel hygiene also was in a certain standard Raw material handling was not in a highly satisfactory level. Because highly sensitive ingredients were easily contaminated by microorganisms due to bed handling practices.

The control measures applied to hazards associated with ingredients and process steps such as cooling, enrobing and finished product storage were found to be the critical control points

Supplier quality assurance was the main element of controlling hazards, which are associated with raw materials

Most process step monitoring was designed in a way that it requires only time and temperature measurement to be made

By accurate implementing the HACCP system the factory will be able to assure the safety of its products

Recommendations

When Chocolate reworking it should be processed in a separate area for bacteriological reasons A sanitation program must be evaluated to determine the effectiveness of cleaning and sanitation Therefore well-qualified sanitation committee should be introduced Sanitary records should be correctly kept

Chocolate rework risk management

Pasteurization might be able to be introduced in to the manufacturing process Add up to 2% of water and heat the product to 75-80^{0}c for 12 hours The product must be analyzed after this process. Otherwise effective measures must be taken to protect rework materials against recontamination.

If pasteurization is used check the time /temperature/moisture by bacteriological measurements

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