A Model HACCP Plan for Small Scale Production of Baby Food

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Abstract

The development and quality evaluation of brown rice and vegetables based baby food will be intended as complementary infant food for children aged between the first 6 months and one year of life. Local indigenous raw materials such as brown rice, red lentils, orange-fleshed sweet potatoes and spinach leaves were used in the formulation of baby food powder. The main aim of this research is to design a Hazard Analysis and Critical Control Point (HACCP) plan for baby food powder production. A hazard analysis system was adopted and critical control points in each processing step were determined. A sample generic HACCP plan was recommended. Three Critical Control Points (CCPs) in the processing; cold storage of raw materials; pressure cooking and packaging were identified. A HACCP plan was completed with perquisite programs dealing with the identified hazards.

keywords: Indigenous raw materials, HACCP, Critical control points

Introduction

Baby foods are generally formulated to meet the nutritional requirements of the growing baby, and the amounts are adjusted based on the baby's weight and age (Majid, 2012). The nutritive value of infant food deeply depends on the composition of what raw materials are used and what proportions of fruit or vegetable content because they have a high growth velocity, high energy and nutrient needs (Shankar *et al*., 2018). The introduction of solid food is an important role in the development of eating behavior and oral motor skills, including eating, chewing, swallowing, and speaking (Majid, 2012). Infant foods produced from fruits and vegetables are significantly helpful in promoting the health of infants. They are natural supplements of vitamins and minerals which are essential for promoting growth, the generation of red blood cells and the retention of nutrients (Kalpalathika *et al*., 1988).

Hazard analysis and critical control point (HACCP) is a preventive method that is used to control food processing procedures by identifying the hazards of food production and to ensure food safety by controlling the hazards and reducing the risks. Hazard analysis and critical control point (HACCP) is also a systematic approach, the aim of which is to determine the hazards related to food, to identify critical control points (CCP), and to put them under control. For the food industry, the HACCP program is currently recognized as the best approach to controlling food safety. Food safety is of increasing importance in the food industry. The main reasons are the susceptibility of the products to microbiological, physical, and chemical hazards (Codex,1993 and FAO,2001). HACCP is a systematic methodology for analyzing food processing and identifying undesirable or hazardous inclusion of chemical, physical, or biological agents into foods. HACCP was introduced as a system to manage safety when manufacturing products, rather than testing finished products to detect problems. This new system is based on designing systems that assess hazards or risks specific to a particular product or process and control them. The process identifies specific points that can control the risk (FAO, 2009). HACCP is complemented by other programs such as GMPs, SOPs, and SSOPs Good Manufacturing Practices (GMPs), Standard Operating Procedures (SOPs), and Sanitation Standard Operating Procedures (SSOPs) (Bennet, 2010).

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Materials and Methods

Raw Materials

The raw materials such as brown rice powder, red lentil powder, orange fleshed sweet potato powder, spinach leaf powder, and skimmed milk powder were used for the preparation of infant food formulations. The brown rice of Paw-San-Hmwe (Oryza Sativa *L*) was purchased from Hledan Center, Kamaryut Township, Yangon. Red lentil, orange-fleshed sweet potato, and spinach leaves were available from the organic farm, Insein Road, Gyogon Yangon.

Preparation of Baby Food

About 100 g of brown rice was washed with water, and the washed brown rice was mixed with 800ml of water and then pressure cooking at 121°C for 45 minutes. The cooked rice was cooled to room temperature and ground with a blender, and put on the tray, and then dried in a hot air oven at 70°C for (9) hours. The obtained dried flakes of brown rice were ground with pulverizer and sieved with a mesh no.60 screen to obtain brown rice powder.

The 100 g of red lentils were cleaned with water and soaked for about 5 hours and then cooked with a pressure cooker for about 30 minutes at 121°C. The cooled, cooked red lentils were blended, put on the tray, and then dried in a hot air oven at 70°C for 7 hour. The dried flakes of red lentil were ground with a grinder and sieved with a mesh no.60 screen to obtain red lentil powder.

200 g of orange fleshed sweet potato was washed with water to remove earth particles. After cleaning, the sweet potato was peeled, sliced, and steamed at 121 °C for 15 minutes. They were allowed to cool at room temperature, then blended, put on the tray and dried in a hot air oven at 70°C for 9 hours. The orange-fleshed sweet potato powder was obtained by grinding the dried flakes and sieving with a mesh no.60 screen.

About 200 g of spinach (*Spinacia oleracea* L.) were thoroughly cleaned with water to remove dirt, coarse parts and longer leaves. After cleaning, the leaves were blanched, cut into desirable forms and packed loosely in the basket until the water was filtered. The spinach (*Spinacia oleracea* L.) was spread lightly on the drying trays and dried in the sun for about 8 hours and the spinach leaves were turned once and twice during drying. The obtained dried spinach leaves were ground with a grinder to produce spinach leaf powder with a mesh size of 60mm.

The powder of brown rice, red lentil, orange fleshed sweet potato and spinach leaves were mixed with proper composition to obtain baby food powder relevant with codex guideline.

Methodology

The proper identification of CCPs is a key issue in HACCP, because the major efforts in process control will be directed towards these steps. This study did not use quantitative research. The main purpose of this study was to design a HACCP model, not to implement it in the actual situation, so there is no statistical data. This study contests a qualitative approach and provides the intricate details of phenomena that are difficult to convey with quantitative methods. Qualitative research is exploratory and open-minded, which is applicable to this study (Patton, 1997).

For the practical application of the HACCP concept according to Codex Alimentarius (FAO/ WHO 1997), 7 rules have to be followed which are laid down in 7 main principles and

constitute the basis for the establishment of a HACCP plan (S. Mortimore and C. Wallace, 1995). For the application of HACCP, there are 5 steps:

• Step 1: the gathering of the HACCP team

• Step 2: the product description

• Step 3: identification of its intended use

• Steps 4 and 5: The drawing and confirmation of a flow diagram. This makes documentation more accessible and makes it easier to introduce changes. The CCPs are determined by going through the decision tree of the method (D.A. Corlett, Jr. 1998). Codex provides this decision tree to assist with a logical procedure for this, but the use of this decision tree is not mandatory (FAO/ WHO 1997). The HACCP plan includes the process steps of the production, the identified hazards, the preventative measures, the determined critical control points, a monitoring system, the critical limits of CCPs' monitoring parameters, and the necessary corrective actions.

Results and Discussion

The aim of the implementation of a food safety system, which is required during the process of baby food, is to ensure product safety. The HACCP model was designed to suit baby food processing. The identified the Critical Control points (CCPs) for baby food production process are shown in Table (1). At all stages of the processing, hazards (biological, chemical, and physical) may occur during washing, cutting, cooking, blending, drying, grinding, sieving, and storage.

The raw materials received, such as brown rice, red lentil, and orange-fleshed sweet potato, in the hazard may be controlled by standard operating procedure (SOP). In the raw material, there were microbiological hazards that will be controlled in the process of infant food, e.g., blanching; chemical hazards (heavy metals) that can be controlled through good agriculture practice (GAP) and physical hazards, which have a very small chance of appearing in raw material and can be controlled with SSOPs in all processing steps. So, the receiving of raw material is not a CCP.

In the drying of spinach leaves with the solar dryer, the biological and chemical contaminations are controlled by SOP's, but the growth of microbial contamination will occur because of the change in temperature. Therefore, the drying of spinach leaves is a CCP. In the grinding step, the ground flakes could be recontaminated by equipment due to poor cleaning. However, sanitation of equipment can be controlled by SSOP, and pathogens can be killed in subsequent steps (redrying to ensure below 8%w/w moisture content). So, grinding is not a CCP. The presence of microbial contamination is critical due to the reduction of the shelf-life of infant food for processing. The physical and microbial hazard in seasoning and the chemical hazard in packaging material are also critical. The vacuum packaging system has advantages due to the retention of the product's colour, flavour and shelf-life. Therefore, packaging is also a CCP. Recontamination and growth of pathogens due to the high temperature and humidity in storage may happen, but they can be controlled by GMP. Therefore, storage is not a CCP.

The HACCP control chart Table (2) shows all the potential critical hazards that can occur during the processing steps in a baby food plant along with a number of critical control point, critical limits, monitoring procedures and frequency, preventive and corrective action, records, responsible person and verification. The potential control points of the hazards appeared both raw material and processing. Three critical control points (CCPs), i.e., pressure cooking, drying, and packaging were found in the processing of infant food.

Process layout plan, organization of HACCP team, product description, the description of process flow diagram, hazards in process and CCP decision matrix chart analysis, HACCP control chart and labelling are used to accomplish food safety management plan. The layout plan for the infant food powder factory is designed according to the HACCP plan and shown in Figure (2). The plant is specifically designed for hygiene and good manufacturing practice to establish basic conditions that are suitable for the production and handling of safe food at all stages of the food chain (SCV, 2006).

There are two pathways in this factory layout (1) for the employees and (2) for the processing line. All employees of production, packaging and storage areas need to wear on apron, hand gloves, mask, head covering and footwear. Hand washing is needed before starting their activities. They change their clothes in the primary changing room. The personal cleanliness is monitored on regular basis before entering into the secondary changing room.

After applying the instructions, they pass through the buffer room and go to their respective areas. For the processing line, 'In (1)' and 'In (2)' indicate raw vegetables' storage incoming, raw materials incoming, respectively. 'Out (1)' and 'Out (2)' indicate the amount of waste disposed.

The temperature of the raw material storage room is 4-6 °C. The vegetable spinach leaves were washed and cut in the vegetable pretreatment room and then dried. The dried spinach leaves were ground, and sieved to obtain the green powder. In the raw material pretreatment room, brown rice, red lentils and orange-fleshed sweet potatoes were thoroughly cleaned with water, peeled and cut.

Brown rice, red lentils were pressure cooked at 121°C, 15 psia for 45min, and orange-fleshed sweet potatoes were pressure cooked 121°C, 15 psia for 15 min, respectively, in the pressure cooking and blending room. After pressure cooking, the resultant pastes were blended by using blender and the blended pastes were moved to the drying room, placed on the trays, dried by hot air oven at 70° C and brown rice paste for 9 hr, red lentils paste for 7 hr and orange-fleshed sweet potato for 9 hr. The dried flakes of brown rice, red lentil, and orange-fleshed sweet potato were ground in the grinding room, sieved and obtained the dried powders.

The brown rice powder, red lentil powder, orange-fleshed sweet potato powder and spinach leaf powder were mixed in the mixing room. The obtained infant food was packed in the packaging room. In a factory, a maintenance room or mechanical room must be designed with adequate space and clearances around equipment to accommodate maintenance from the floor and replacement of items.

The air system is passed through from the finished product area to the raw material incoming area for the ventilation system of this factory. The wastes from processing were disposed of every day, and some of the wastes were used for the production of organic fertilizers and animal feed.

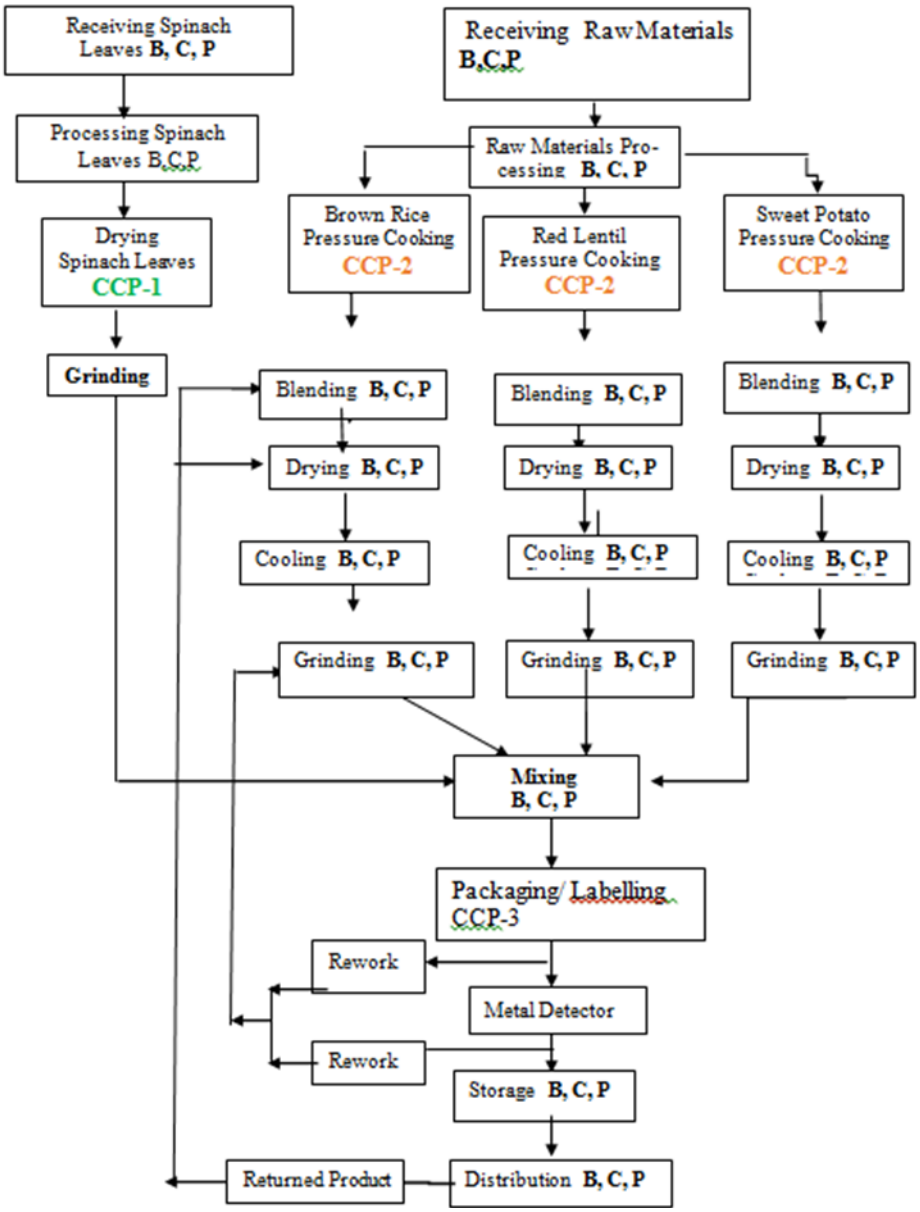

Figure (1) Process Flow Diagram for the Production of Baby Food Powder

Table (1) Hazards in Process and CCP Decision Matrix Chart Analysis

No.	Process Step	Hazard		Control Measures (SOP's or work instructions)	Q-1: Do control preventative measure (s) exist?	Q-2: Is the step specifically designed to eliminate or reduce the likely occurrence of a hazard to an acceptable level?	Q-3: Could contamination with identified hazard(s) occur in excess of Acceptable level(s)?	Q-4:Will a subsequent step eliminate identified hazard(s) ?	CCP
1.	Raw material Processing Brown rice, Red lentil, orange Fleshed sweet Potato	B	No	Standard operating procedure (SOP) for raw materials.	No	-	-	-	Not a CCP
		C	No						
		P	No						
2.	Raw material processing Drying (Spinach Leaves)	B	Microbial growth due temperature	Standard operating procedure (SOP) for raw vegetables.	-Yes	Yes-	-	-	CCP
		C	No						
		P	Foreign particle						
3.	Pressure cooking	B	Microbial growth due temperature and pressure changes.	Temperature and pressure will be controlled	Yes	Yes	-	-	CCP

		C	No	during cooking.					
		P	Foreign particle						
4.	Grinding	B	No	-	-	-	-		Not a CCP
		C	No						
		P	No						
5.	Mixing	B	Microbial growth due to leakage and moisture absorption from surrounding	Moisture test, moisture control by ensuring temperature and humidity-controlled room. Personel Hygiene Procedure, Self Inspection	No	-	-	-	Not a CCP
		P	Foreign particles present during weighing and Forming						
6.	Packaging	B	Microbial growth due to leakage and moisture absorption from surrounding	Leak test, moisture test, moisture control by ensuring	Yes	Yes	-	-	CCP

		C	Chemical hazard from foil pack	temperature and humidity controlled room. Foil pack test. Personnel Hygiene Procedure, CIP for packaging machine and weighing machine. Temperature and humidity					
		P	Foreign particle present during weighing and Forming						

Table (2) HACCP Control Chart

Sr. No.	Process Step	Hazard	Control Measure	Critical Limit	How	Who (Responsible)	Frequency	Monitoring Procedure	Corrective Action	Verification
1.	Pressure cooking **(CCP1)**	Biological hazard and physical hazard	Control temperature	Cooking temperature range (121±5°C).Cooking pressure range (15±5 psi)	Suitable temperature and pressure management	QC & production department	Each batch, Every 30 minutes	Monitor and record the temperature every 30min	Reserve another electric source if the current electric source is off	Review per batch, Auditing
2.	Raw materials processing Spinach (Solar Drying) **(CCP2)**	Biological hazard, physical hazard	Use of modern dryer and proper cleaning of containers and covers.	Storage temperature range 32 F to 39°F	Fixed temperature	Quality Assurance	Each batch	Monitor and record the temperature hourly	Drying to ensure moisture content below 10%.	Review per batch, Auditing
3.	Packaging (**CCP3)**	Biological hazard, chemical hazard, physical hazard	Control temperature and humidity. Leak test.	Recontamination during the packaging and growth of pathogens due to the high temperature during Storage. So, Control temperature and humidity of packaging room (<30°Cand<60%).	Auto packing and control of leakage under temperature controlled room.	Packing operator & Quality Control Assurance department, Personnel	Each pack (checks, temperature & humidity)	Leak test report	Product will be retained or reworked or discarded.	Production Manager

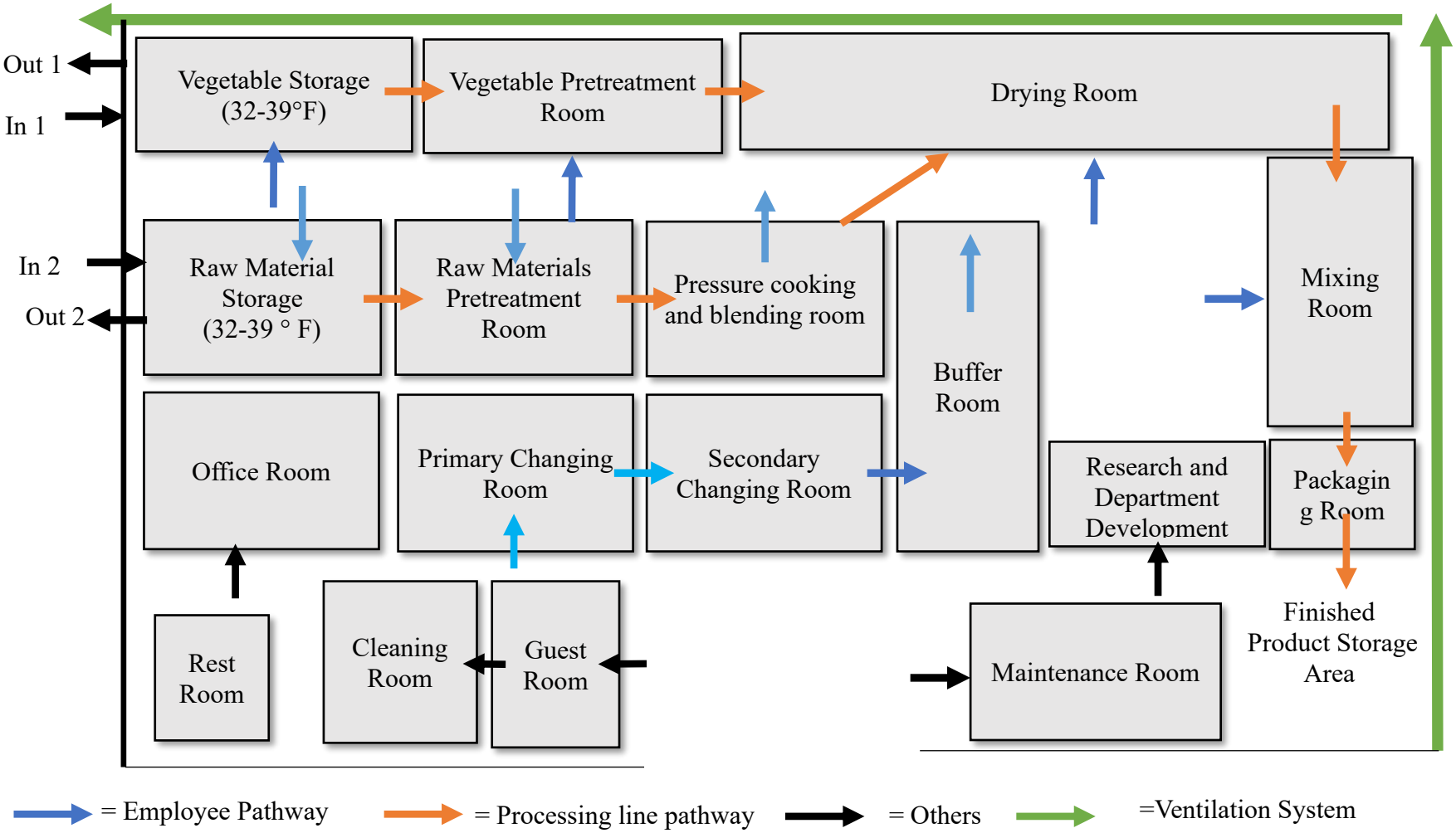

Figure (2) Layout Process for Infant Food Factory

CONCLUSION

To develop the safety and quality of baby food powder, this study designed a HACCP plan model for a baby food powder plant, and the model is built up step-by-step based on the seven principles and twelve procedures of the HACCP system. The factory layout was developed with GMP guidelines, and the product description was used to help the consumer understand the potential hazards in the final products. Then, the appearance of potential hazards was controlled with the prevention measures for the whole process, and the critical control points were determined by applying the questions in the decision trees. Finally, the HACCP control chart was built to contain components of several HACCP principles, which are control measures, critical limits, corrective action, and verification. This study reveals that three critical control points for safety were pressure cooking of brown rice, red lentil, and orange-fleshed sweet potato, drying of spinach leaves, and packaging of the product. The GMP at all steps of production must be strengthened, and an effective control HACCP system for the products must be established. The infant food product can have high safety and quality if all the critical control points (CCPs) and quality control points (QCPs) in the processing are under control.

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