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Annals of Food Processing and Preservation

Review Article

Hazard Analysis and Critical Control Point (HACCP) Plan for Carbonated Soft Drinks Plant

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Submitted: 08 August 2022

Accepted: 19 September 2022

Published: 21 September 2022

ISSN: 2573-1033

OPEN ACCESS

Keywords

- HACCP
- CSD
- Soft drinks plant
- CCP
- Food Safety

Abstract

Carbonated soft drinks are amongst the most consumable drinks around the world. The objective of this study was to design Hazard Analysis and Critical Control Point (HACCP) plan for soft drink production plant based on real time conditions in the beverage industry located in Faisalabad, Punjab, Pakistan. The model was developed to ensure the food safety of whole plant using the seven principles of HACCP and other generic models of HACCP using different approaches. Eight-member HACCP team was involved and HACCP chart, verification procedures and record-keeping were initiated. Only one CCP was identified during the production of carbonated soft drink. This research didn't include the overview of production setup. Based on the results of this study, the authors recommend implementation of HACCP system in all food facilities.

INTRODUCTION

HACCP is a short form for the Hazard Analysis Critical Control Point [1]. This system was developed to ensure pathogen-free foods. It provides accurate control measures & precautions to be followed for each step during whole process. The first portion of this system deals with the principles of the Hazard Analysis and Critical Control Point (HACCP) adopted by the Codex Alimentarius Commission. The guidance for application of the system are provided in second portion keeping in view that the details of application may vary depending on the circumstances of the food operation [2]. The researchers and specialists from The Pillsbury Company, The Natick Research Laboratories, and the National Aeronautics and Space Administration in USA were the pioneers to develop HACCP in late 1950s [3].

In modern era, food quality & food safety is compulsory for every industry and HACCP has made progress toward becoming synonymous with food safety [4]. HACCP is a tool that can be used for reducing the risks of food safety failure. All types of possible hazards are consider as a part of HACCP system, these include Biological, Physical and Chemical hazards [5]. The HACCP program ensures safety of products because potential hazards that may occur at any stage of processing are anticipated, evaluated, controlled and prevented. Processing plants are required to have a HACCP plan for each product [6]. HACCP framework requests a high initial investment just to get it implemented. The basis of this system requires additional resources for staff training, gear and additional provisions, as well as technical support [7].

Beverage industry is one of the renowned industry of modern era. Soft drinks are consumed a lot in every part of world. Due to high demand, the technology to produce soft drink also demanded a lot. Currently the several business groups are going to develop and invest in this field due to high demand.

Microbial hazards within soft drinks can be: (1) spoilage, done by general micro-organisms; (2) food poisoning done by pathogens [8]. The main ingredients and composition of soft drinks consists of water, fruit materials, sweeteners, flavorings, colorings, preservatives as well as other components [9]. Many micro-organisms are present in soft drinks due to contaminants, but few can survive within the acidic and low oxygen environment. Yeasts are the significant groups associated with spoilage of soft drink. Spoilage can occur as the metabolic by-products grow, for example, CO_2, acid, and tainting compounds [10]. The objective of this study was to develop a comprehensive, long term HACCP plan for beverages plant. So, by implementing the best plan in real time conditions at beverages plant can reduce the occurrence of hazards. This will identify health hazards and establish strategies to prevent, eliminate, or reduce the occurrence of physical, biological, or chemical hazards.

MATERIALS AND METHODS

This study was conducted at PepsiCo registered as name of

Punjab Beverages Private Company Ltd. in Faisalabad, Punjab, Pakistan. This plant is categorized as large-scale plant for its production capacity. This plant has 700 workers, working in three shifts to produce average of 50,000 carbonated soft drink bottles per day. The objective of reforms was to expand company's market. For that purpose, company planned effective quality system to ensure safe, healthy and best quality products.

The researchers spent four weeks in carbonated soft drink plant to observe and made hypothesis of final product. Employees and operators monitored the quality control in order to develop brief HACCP plan according to setup and processing in plant.

Collected Data of each step was analyzed during whole process which include raw material, packing until dispatch from plant, including all other procedures. Rest of the data was collected from tests, laboratory analysis records and from management.

Research Method

The research didn't base on quantitative approach. The objective of this research was to develop HACCP plan for possible implementation in real time conditions. The study coordinated the qualitative approach that suggest inductive process directed by conceptual framework, driven more by itself hence there is no statistical data [11]. Subjective research was exploratory and open minded which was pertinent to this investigation [12].

Research Approach

The researchers developed a HACCP plan for carbonated soft drink based on the setup and processing in plant in order to enhance the quality of finished product. The HACCP plan was based on seven principles. These principles include risk analysis, CCP identification, setting critical limits, monitoring protocols, corrective actions, verification techniques, record-keeping, and documentation. In this study, models [13,14], guidelines [15,16], requirements [17] and record keeping related to HACCP was studied and designed.. This model was developed from NACMCF [18] that was adopted August 14, 1997 worldwide (FOODS).

The decision matrix tree is utilized to recognize Critical Control Point (CCP) for procedure [19].

RESULTS

This HACCP plan was designed on basics of seven principles of HACCP and by interpreting several models, to suit real time conditions of carbonated soft drink plant.

Prerequisite Program

The first step to design a HACCP plan was to bring all current essential prerequisite programs under the roof of HACCP and provide them a typical guidance about accomplishing zero deformities in finished product to guarantee that there was no health concern in the finished product. All prerequisite programs executed according to codex general principles of food hygiene and good manufacturing practices to bring hygienic food by establishing the essential condition during production.

Structure and Layout of Plant

The premises were designed in well manner structure that allow GMP, good food hygiene practices and prevent from accumulation of water. The design of building was in such a way that it mainly focused to prevent cross contamination. The base of building was sloped and drained. Although the corners and joints of the building were not well in form and it's difficult to clean them. In some areas of the plant there were neither slope nor draining system, the water accumulated there. The walls of the plant were dust, Incest & rodent free. Although there were few cracks and gaps in some parts of wall that made it unsafe, it could be habitat for insects and rodents.

The glass covered doors and windows with aluminum finish are used throughout the plant. The air curtains were used specially on testing laboratories. The exhaust fans were used for proper air flow and prevent the building from heat accumulation and maintain relative humidity. The professional cleaners cleaned the plant on daily basis, the water accumulation and floor was cleaned after every shift.

Personal Hygiene

Personal hygiene has vital importance in every industry, it plays the role of back bone for production of finished safe food. The personal hygiene was followed properly by staff, but labor's personal hygiene was improper. Although labor wore uniform but didn't use net caps and gloves that might be source of contamination.

Equipment

The food grade material was used for equipment, such as stainless steel that could easily cleaned and maintainable. Each equipment checked after each shift to ensure proper working, smooth running, free of cracks and dents.

Pest Control

Pest control exercises were done through the professional teams available in state. In this modern era the pest control activities are carried out to prevent and control the pest, rather than to prevent pest as in traditional manners. This eliminated a huge risk of insects and rodent from spoiling the product.

Water supply

The best quality treated water was supplied for carbonated soft drink plant at desired temperature and parameters to ensure the good taste of drink.

Storage

The specific temperature was not required to store soft drinks. The storage was done at room temperature, but chilling before consumption was highly recommended.

Sanitation

The cleaning of area and drainage of water from warehouse were done on regular basis to ensure the safe and healthy finished product.

APPLICATION OF HACCP

Product Description

Product description defines the product completely with

respect to applicable safety information such as: composition, intrinsic attributes, physical/chemical structure (including A_w, pH, etc.), shelf life, target market, and storage conditions and method of distribution [2] (Table 1).

Characteristics (Table 2)

Intended Use (Table 3)

Flow Diagram

Hazards Analysis and Critical Control Point (CCP) Determination (Tables 4-7)

Operations Pre-Requisite Program for Carbonated Soft Drinks (Table 8)

CCP DETERMINATION FOR CARBONATED SOFT DRINK (TABLE 9)

Instructions [20]

Q-1 :Do Preventive approach Exist For BCP If Yes (Y), proceed for Q2, if No (N),Is control compulsory? If No, not a CCP.

Q2: Does This Step Eliminate/Reduce The Likely Occurrence Of BCP Hazard To An Acceptable Lev1el? If No, Proceed for Q3, if Yes, that is CCP.

Q3: Could Unacceptable BCP Contamination Occur? If Yes, proceed for Q4, process or product, if No, not a CCP.

Q4: Will Subsequent Step Eliminate BCP Hazard? If No, CCP, if Yes, not a CCP.

Table 1: Carbonated soft drink product description.

Product Description:	**Carbonated Soft Drink-Cold Processing**
Product Name(s) or SKU:	Pepsi, 7up, Mirinda, Mirinda Green Cream Mountain Dew, Sting Berry Blast. Pepsi Diet, 7up Free, 7up Diet,7up mint RGB (Returnable Glass Bottle): 250 ml & 240 ml CAN: 250ml, 300ml PET:300ml, 345ml, 500ml, 1000ml, 1500ml, 1750ml, 2250ml.
Intrinsic Product Attributes: (Food Safety Characteristics) - Including Ingredients	Treated Water, CO_2, Sugar-Sucrose Syrup, Sodium Benzoate, Citric Acid, Caffeine, PI flavors (Pepsi, 7up, Mirinda, Mountain Dew, Sting Berry Blast, Pepsi Diet, 7up Free, 7up Diet,7up Mint, Mirinda Green Cream) (Acidic)
Customer/Consumer Use:	Ready to use No cooking/processing required
Target Market:	Teenagers and Adults
Vulnerable Consumer:	Diabetic Patients (except 7up free, Pepsi Free and Diet Products like 7up Diet and Pepsi Diet), Carrying mothers (Sting, Dew, Pepsi Only)
Special Distribution & Storage Control:	Storage at Ambient temperature, under shed, protect from direct sunlight.
Shelf Life: (If Applicable)	PET = 6 months Sugar Free (7up & Pepsi) = 6 months Glass = 9 months Can = 6 months Can Diet = 6 months Can Sting BB = 1 year
Label Instructions:	Product Name, Brand Name, Name and Address of the Manufacturer, Net Content, Nutritional facts, Caloric Contents of Products, Ingredients, Serving instructions, Storage Instructions, Production Date and Expiry Date
Method of Distribution:	Delivery in Clean Covered vehicles having cover on it.

Table 2: Characteristics relevant to food safety.

Characteristics Relevant to Food Safety	**Carbonated Soft Drink**
Physio	**7up:** As is brix:10.65± 0.2, CO_2 PET:3.25-4.24, CO_2 RGB:3.45-3.94, TA:22.36-24.70 **Pepsi:** As is brix:10.45± 0.2, CO_2 PET:3.15-4.42, CO_2 RGB;3.35-3.84, TA:10.90 **Mountain Dew:** As is brix:11.85± 0.2, CO_2 PET:2.75-3.84, CO_2 RGB;2.95-3.45, TA:18.91-21.02 **Mirinda Orange:** As is brix:12.95± 0.2, CO_2 PET:1.35-2.44, CO_2 RGB:1.5-2.05, TA:26.53-29.12 **Mirinda Green Cream:** As is brix:10.50± 0.2, CO_2 PET:2.80-3.10, TA:6.94-7.36 **7up Mint:** As is brix:11.05± 0.2, CO_2 PET:2.80-3.20, CO_2 CAN:2.40-2.80 TA:38.18-40.54 **Sting Berry Blast**: As is brix:15.15± 0.2, CO_2 PET:2.80-3.38, CO_2 RGB:2.35-2.85, TA:50.35-53.04 **7up Free :**As is brix:0, CO_2 PET:3.25-4.24, CO_2 RGB;3.45-3.94, TA:25.50 **Pepsi Diet :**As is brix:0, CO_2 PET:3.15-4.42, CO_2 RGB;3.35-3.84, TA:13
Chemical	N/A
Microbiological	Yeast ≤ 15/100mL, Mold ≤ 15/100mL, Aciduric Bacteria < 30/100mL TPC < 100 cfu/ml Coliform < 10 cfu/ml

Table 3: Intended use of carbonated soft drinks.

Queries related to product use	Carbonated Soft Drink
Will the product be cooked or heated by the consumer?	No
Will the product need specific storage until consumed?	Yes, Stored at ambient temperature at covered places away from direct sunlight.
Is the product likely to be mishandled by the consumer?	Yes, Poor handling can result in cross contamination.
Are there any vulnerable groups in the target market?	Yes, sugar and caffeine based CSD, kids carrying mothers and diabetic patients
Are there any specific allergens?	No
Are there any allergen claims made?	No

Table 4: Severity determination level of hazards and effect of hazards.

Severity Determination		
Severity If control fails:	**Effect of severity if hazard occurs**	**Multiplier**
Little Damage	Consumer disappointed.	1
Damage	Illness at home. Medical treatment not necessary.	2
Serious Damage	Minor medical treatment may be necessary (for example a broken tooth).	3
Very Serious Damage	Illness at home with medical treatment necessary.	4
Disaster serious illnes	Hospitilization Require	5
Catastrophic	Death	6

Table 5: Probability of risk determination level of hazard.

Risk/Likelihood Determination		
Probability of hazard occurring under current conditions	**Likelihood That Hazard Could Occur**	**Multiplier**
Almost Impossible/Improbable	No history of it occurring in facility or across the food and beverage industry	1
Un-Likely/Remote	Very occasional, has been known to occur in the facility or in a similar industry	2
Small Risk/Possible	Could be an isolated event that results after manual operations – would expect to happen occasionally in a year	3
Likely/Probable	Product or operational factors that can be expected to be present – could happen a number of times in the year	4
Certain/Frequent	Product or operational factors that are always present that the process is expected to control – occurs repeatedly	5

Table 6: Severity determination of hazard.

Risk/Severity determination	
Risk Score	**Risk Level Description**
1 – 5	Low risk - Probably controlled by a Prerequisite Program. Check nature of problem against existing pre-requisite programs.
6 – 9	Some risk. Control by a Prerequisite Program.
10 – 16	Elevated Risk. Use Codex decision tree for hazards. Definitely a Prerequisite Program, may be a CCP.
16 +	Significant risk! Likely to be a Critical Control Point (CCP). Use Codex decision tree for hazards. Initiate special HACCP review.

Table 7: Hazard Identification and analysis for CSDs.

Operations	Type of Hazard	Cause of Hazard	Significance of Hazard				Justification for Decision	Control Measure
			Severity of Hazard	Likelihood of Hazard Occurring	Risk	Significant Hazard (Yes or No)		
1.1 Source Water	Physical: Sand, Mud etc.	Occurrence in ground water	2	3	6	No	Water Treatment Process In Place	Water Treatment System as Per PEPSICO guidelines and annual testing through external Lab

	Chemical: Heavy Metals	Carried with ground water	2	2	4	No	Water Treatment Process In Place	Water Treatment System as Per PEPSICO guidelines and annual testing through external Lab
	Biological: Presence of Total Coliform, E.coli	Carried with ground water	4	2	8	No	Water Treatment Process In Place	Water Treatment System as Per PEPSICO guidelines and annual testing through external Lab
1.2 Sugar	Biological: Presence of TC, Mold, yeast	From supplier process	6	1	6	No	Controlled by supplier. Certificate of analysis on delivery and RM tested.	Supplier Quality Assurance Program.
	Physical: Presence of FB e.g. metal filings.	From Supplier drier process.	3	1	3	No	Controlled by supplier. CoA on delivery and RM tested. RM specifications in place. Filtration step later in process will address hazard.	Supplier Quality Assurance Program, Filtration.
	Chemical: Heavy Metals	From supplier process	3	1	3	No	Controlled by supplier. Certificate of analysis on delivery.	Supplier Quality Assurance Program.
1.3 Concentrate	Biological: Presence of TC, Mold, yeast	From supplier process.	6	1	6	No	Controlled by supplier (Pepsico). RM specifications in place. pH too low to sustain pathogen growth.	Pepsico Quality Assurance Program.
	Physical: Presence of FB e.g. metal filings.	From supplier process.	3	1	3	No	Controlled by supplier (Pepsico). RM specifications in place. Filtration step later in process will address hazard.	Pepsico Quality Assurance Program.
	Chemical: Presence of industrial grade components e.g. citric acid.	From supplier process.	4	1	4	No	Controlled by supplier (Pepsico). All components are food grade. RM specifications in place.	Pepsico Quality Assurance Program.
1.4 Preforms	Biological: Presence of mold, TC	Unhygienic handling in supplier process.	1	1	1	No	Controlled by supplier. Fully automated system with hygiene standards in place. RM specifications in place. Approved supplier.	Supplier Quality Assurance Program.
	Physical: Presence of FB e.g. metal filings.	From supplier process.	1	1	1	No	Controlled by supplier. RM specifications in place. Approved supplier.	Supplier Quality Assurance Program.
	Chemical: Presence of toxic chemicals.	From supplier process.	1	1	1	No	Food grade certificate. RM specification in place. Approved supplier.	Supplier Quality Assurance Program.
1.5 Caps	Biological: Presence of mold, TC	Unhygienic handling in supplier process.	6	1	6	No	Controlled by supplier. Fully automated system. RM specifications in place.	Supplier Quality Assurance Program.
	Physical: Presence of FB e.g. hair.	From supplier process.	1	1	1	No	Controlled by supplier. Fully automated system with hygiene standards in place. RM specifications in place.	Supplier Quality Assurance Program.

	Chemical: Presence of toxic chemicals.	From supplier process.	1	1	1	No	Food grade certificate. RM specification in place.	Supplier Quality Assurance Program.
1.6 Labels	Biological: NILL		-	-	-	No	Secondary Packaging. No hazard Exist	
	Physical: NILL		-	-	-	No	Secondary Packaging. No hazard Exist	
	Chemical: NILL		-	-	-	No	Secondary Packaging. No hazard Exist	
1.7 Empty Cans and Ends	Biological: NILL		-	-	-	No	No hazard Exist	Supplier Quality Assurance Program
	Physical: Dust	Due To damage secondary packaging damage	1	1	1	No	Not likely to occur	
	Chemical: NILL		-	-	-	No	No hazard Exist	
1.8 Shrink Wrap Film	Biological: NILL		-	-	-	No	No hazard Exist	
	Physical: NILL		-	-	-	No	No hazard Exist	
	Chemical: NILL		-	-	-	No	No hazard Exist	
1.9 CO_2	Biological: NILL		-	-	-	No	No hazard Exist	
	Physical: NILL		-	-	-	No	No hazard Exist	
	Chemical: Presence of toxic impurities.	From supplier process.	3	1	3	No	Approved supplier used, food grade CO2, purity tested on delivery, ingredient specification available, CoA on delivery.	Supplier Quality Assurance Program.
2.1 CO_2 purity	Biological: NILL		-	-	-	No	No hazard Exist	
	Physical: NILL		-	-	-	No	No hazard Exist	
	Chemicals: Presence of adulterating chemicals.	From supplier process.	4	1	4	No	Controlled by supplier. CoA on delivery and CO_2 tested for purity. RM specifications in place.	Supplier Quality Assurance Program.
2.2 CO_2 unloading	Biological: NILL		-	-	-	No	No hazard during unloading	
	Physical: Foreign Matter	During connecting pipeline with tank line	1	1	1	No	Not likely to be occurred	CO_2 Filtration
	Chemical: NILL	-	-	-	No	No		
3.0 Storage	Biological: Growth of vegetative pathogens.	Cross contamination from damaged packaging.	2	1	6	No	Good warehouse practices in place. Staff well trained and GMP being followed.	GMP, training.
	Physical: introduction of FB.	From environment through damaged packaging.	3	1	3	No	Good warehouse practices in place. Staff well trained and GMP and cleaning schedule being followed.	GMP, GHP, training.
	Chemicals: Introduction of excrements from pests.	Cross contamination from pests through damaged packaging.	4	1	4	No	Integrated pest management system being followed. Good warehouse practices in place. Staff well trained and GMP and cleaning schedule being followed.	Pest control, GMP, GHP, training.

4. Cl_2 Dosing	Physical: Foreign Particle	From Incoming Bag	2	2	4	No	Manage through PRP	Incoming inspection program
	Chemical: Cl_2	Chemical Contamination due to over dosing of Cl_2.Impurities in Cl_2	3	2	6	No	Manage through PRP	Carbon Purifier
	Biological: NILL		-	-	-	No	No biological hazard exist	
4.1 - Raw Water Reservoir	Physical: NILL	Present in potable water	1	1	1	No	Not likely to occur	Filtration through Sand and micron filtration
	Chemical: Cl_2	Overdosing of Cl_2	3	2	6	No	Manage through PRP	Carbon Purifier in next program
	Biological: E. coli Coliform	Low dosage of Cl_2	3	2	6	No	Manage through PRP	UV
4. 2 Brine Solution	Physical: Foreign Matter	Incoming material and handling	1	2	2	No	Not significant hazard	Incoming material inspection
	Chemical:		-	-	-	No	No significant hazard occurred	
	Biological: Total Coliform	Micro Contamination during annual maintenance from air, area & personal handling.	2	2	4	No	Manage through PRP	Micro analysis of water
4.3 Softener	Physical: Foreign Matter	Probably present in treated water	1	2	2	No	No likelihoods	Back washing of softener and changing at defined frequency
	Chemical: NILL		-	-	-	No	No biological hazard exists	
	Biological: Total Coliform	Micro Contamination during annual maintenance from air,	2	2	4	No	Manage through PRP	Micro analysis of water
4.4 Chemical Dosing	Physical: Foreign Particles	From Incoming Bag	2	2	4	No	Manage through PRP	Testing at defined frequency
	Chemical: Ferrous and Lime	Contamination due to over dosing of chemical	2	2	4	No	Manage through PRP	Testing at defined frequency
	Biological		-	-	-	No	No biological hazard exists	
4.5 Buffer Tank	Physical:		0	0	0	No	No significant hazard occurred	
	Chemical: High Chlorine concentration	Overdosing	3	2	6	No	Manage through PRP	▪ Chlorine concentration is maintaining through water analysis as per defined frequency (>1 ppm) ▪ Removal of total chlorine through Carbon Filter
	Biological: E.coli	Contamination improper dosing	3	3	9	No	Manage through PRP	▪ Chlorination (6-8ppm) is maintained in buffer tank. ▪ Microbiological monitoring at plant's laboratory. ▪ Hygienic conditions of area and personnel are being followed.

4.6 Carbon Purifier	Physical: Foreign Particles, carbon particles		2	2	4	No	Manage through PRP	Follow Backwash frequency, Use Potable water
	Chemical: Cl_2	Improper Back washing	4	3	12		As there is no other step for removal of chlorine and Likelihood is lower	OPRP-1
	Biological: Total Coliform	Micro Contamination during annual maintenance from air, area & personal handling.	2	2	4	No	Manage through PRP	Follow Sanitation frequency, Use Potable Water
4.7 Polisher	Physical: Foreign Matter	Probably present in treated water or person	4	3	12		There is no filter this is a last point but likelihood is lower	OPRP-2
	Chemical: NILL Biological: Total Coliform	Micro Contamination during annual maintenance from air, area & personal handling.	- 2	- 2	- 4	No No	No biological hazard exist Manage through PRP	Hygienic conditions of area and personnel are being followed. Disinfection of filters before installation.
4.8 UV	Physical: NILL		-	-	-	No	No biological hazard exist	
	Chemical: NILL		-	-	-	No	No biological hazard exist	
	Biological: Total bacteria, coliform	Present in portable water	4	3	12		High acidic product. Likelihood is lower	Lamp replacement at defined frequency and micro testing at defined frequency (OPRP-3)
5.0 Sugar Dumping	Physical: Foreign matter, threads, stones	Sugar Bags	2	2	4	No	Manage through PRP	Filtration of syrup in next steps
	Biological: Contamination of Sugar from personals	Unhygienic condition	2	2	4	No	Manage through PRP	Area GMP and Personnel Hygiene
	Chemical: NILL					No	Not likely to be occurred	Chemical control program
5.1 Steam	Physical: NILL		-	-	-	No	Not likely to be occurred	No direct contact
	Chemical: Boiler chemical	Non-Food grade chemical	2	2	4	No	Manage through PRP	No Chemicals Used
	Biological: Microorganism	From water due to inappropriate Filter	1	2	2	No	Manage through PRP	Micro analysis of soft water
5.2 Filtration	Physical: Suspended particle	Cross Contamination	3	2	6	No	Manage through PRP	Visual inspection of simple syrup after each filtration.
	Biological: yeast, mold total count	Filter Chocking	4	2	8	No	Not likely to be occurred	Cleaning and Sanitation program
	Chemical: NILL		-	-	-	No	Not likely to be occurred	Close circuit, Cleaning and Sanitation program
5.3 Cooling through Heat Exchanger	Physical: NILL		-	-	-	No	Not likely to be occurred	
	Chemical: Coolant Contamination	Leakage	3	1	3	No	No direct contact	Simple syrup inspection, maintenance program
	Biological: NILL		-	-	-	No	Not likely to be occurred	Cleaning and Sanitation program

5.4 Concentrate Components	Physical: Foreign Particles, paper, tape and polythene pieces	Present in Cartons	2	2	4	No	Manage through PRP	Filtration of final syrup
	Biological: NILL		-	-	-	No	Not likely to be occurred	
	Chemical: NILL		-	-	-	No	Not likely to be occurred	
5.5 Mixing Tank	Physical: Foreign Particles, paper, tape and polythene pieces	During Mixing of Ingredients	2	2	4	No	Manage through PRP	Filtration of final syrup
	Biological: Yeast, Mold & Total Coliform	Air borne micro contamination & non-appropriate cleaning and sanitation of mixing tank.	2	2	4	No	Manage through PRP	*Cleaning and sanitation of mixing tank. (PRP) * Personal Hygiene and area GMP (PRP)
	Chemical: NILL		-	-	-	No	Not likely to be occurred	Cleaning and Sanitation program
6.1 CO_2 Filtration	Physical: NILL		-	-	-	No	Not likely to be occurred	
	Chemical: Impurities	From Supplier	3	2	6	No	CO_2 From Approved Suppler	Annual Lab Analysis From Approved Supplier TOA for each delivery
	Biological: NILL		-	-	-	No	Not likely to be occurred	Close circuit
6.2 De-aeration	Physical: NILL		-	-	-	No	Not likely to be occurred	Close circuit
	Chemical: NILL		-	-	-	No	Not likely to be occurred	Close circuit
	Biological: NILL		-	-	-	No	Not likely to be occurred	Close circuit
6.3 Final Syrup Mesh Filtration	Physical: Foreign Particles, paper, tape and polythene pieces, Pump Rubber	Escape of item due to inappropriate filtration	4	4	16		This is last step for filtration	Daily 100 mesh strainer inspection
	Chemical: NILL		-	-	-	No	Not likely to be occurred	
	Biological: Micro organism Yeast & Mold	Micro contamination during maintenance of pump from personal contact and from area.	2	2	4	No	Manage Through PRP	Area and Personnel Hygiene
6.4 Syrup receiving & Proportioning	Physical: Foreign Particles, paper, tape and polythene pieces, Pump Rubber Seals	From Syrup and water	2	2	4	No	Filtration	100 mesh strainer at syrup lines and 5 micron filter on air
	Chemical: Residue	Contamination from residue from Changeover or sanitation	2	2	4	No	Verification after each CIP	CIP SOP and Changeover Matrix
	Biological: NILL	Yeast, Mold	2	2	4	No	Not likely to occur	CIP SOP and Changeover Matrix
6.5 Carbonation	Physical: Foreign matter	From supply lines and tanks	2	2	4	No	Filter are in place	Purging of line, Filter maintenance
	Chemical: Impurities	From Supplier	2	2	4	No	Incoming COA/COC TOA on each delivery	Annual lab Analysis of CO2
	Biological: NILL		-	-	-	No	Not likely to be occurred	

6.6 Mixer Product Tank	Physical: NILL		-	-	-	No	Not likely to be occurred	
	Chemical: NILL		-	-	-	No	Not likely to be occurred	
	Biological: Yeast, Mold	Ineffective sanitation	2	1	2	No	Not likely to be occurred	Sanitation and Micro Sampling
7.1 Washer	Physical: Cemented Bottles, Chipped bottles, Cracked Bottles & Bottles containing foreign matters (with sharp edges, stones, glass pieces), Other brand bottles	Contaminated Container and improper pre wash inspection	2	2	4	No	Control Measures in place and effective	Sorting of all such bottles by trained visual inspectors at first light & final light. Washing through washer
	Chemical: chemical residue	Carryover along contamination	2	2	4	No	Control Measures in place and effective	▪ Visual inspection of jets for alignment. ▪ Maintain required rinsing conditions including: •Pressure of jets >1.5 bar •Accurate alignment of jets. •Maintained pH 7-8 •Concentration of caustic >2.0 % •Contact Time: 7 minutes
	Biological: Survival of E. coli, Salmonella & Salmonella & another mold.	From storage and handling	3	3	9	No	Control Measures in place and effective	▪ Bottles are thoroughly washed & sanitized to ensure elimination of pathogens. Following conditions are maintained for cleaning sanitation of containers ▪ Visual inspection of jets for alignment •Temperature of water: 60-70 °C •Concentration of caustic solution >2.0 % •Contact Time of caustic with container : 7 minutes •Additives •Microbiological analysis as per defined frequency •Mold test of washed container after washing
7.2 Hopper Filling	Chemical: NILL	No food safety hazards were identified.	-	-	-	No	No Significant Hazard Occur	
	Biological: NILL	Pest activity while feeding the hopper cover is open	3	1	3	No	GMP	Pest control program implementation
	Physical: NILL	Dust (uncleaned surface) + Packing Remains	1	1	1	No	GMP	GMP and regular inspection
7.3 Preform Lift conveyor	Chemical: NILL		-	-	-	No	No Significant Hazard Occur	
	Biological: Mold, Yeast	Pest activity while the cover is open	3	1	3	No	GMP	Pest control program implementation
	Physical: Foreign Matters	Dust (uncleaned surface)	1	1	1	No	Control Measures in place and effective	GMP and regular inspection
7.4 Preform Neck Camera Inspection	Chemical NILL		-	-	-	No	No Significant Hazard Occur	
	Biological: Yeast, Mold	Pest activity while the cover is open	2	1	2	No	GMP	Pest control program implementation

	Physical: Foreign Matter	Dust (uncleaned surface)	1	1	1	No	GMP	GMP and cleaning by ionized air
7.5 Compressed Air	Physical: NILL		2	0	0	No	Control Measures in place and effective	Filters in Place
	Chemical: NILL	Oil Used for Lubrication	2	0	0	No	Control Measures in place and effective	Oil free compressors are in use
	Microbiological: Yeast and Mold	Environment	2	1	2	No	Control Measures in place and effective	Environment and Empty PET Microbiology Testing Done
7.6 Blowing Molds	Chemical: Lubricants	Lubrication	1	1	1	No	GMP and regular cleaning	Food Grade greases are being used
	Biological: Mold, Yeast	Pest activity while the cover is open	1	1	1	No	Control Measures in place and effective	Pest control program implementation
	Physical: Foreign Matter	Dust (uncleaned surface)	1	1	1	No	Control Measures in place and effective	GMP and cleaning
7.7 Bottle Guiding Star	Chemical: Lubricants	Lubrication	1	1	1	No	Control Measures in place and effective	Food Grade greases are being used and below bottle neck
	Biological: Mold, Yeast	Pest activity while the cover is open	1	1	1	No	Control Measures in place and effective	Pest control program implementation
	Physical: Foreign Matter	Dust (uncleaned surface)/ Rust on the grippers	1	1	1	No	Control Measures in place and effective	GMP and cleaning
8.1 Air Conveyors	Chemical NILL		-	-	-	No	Not likely to be occurred	
	Biological: Yeast, Mold	Pest activity while the cover is open	1	1	1	No	GMP	Pest control program implementation
	Physical: Foreign Matter	Dust (uncleaned surface)/ Rust on the guiding strip	2	1	2	No	GMP and design	GMP and cleaning
8.2 Base Cooling	Physical: NILL					No	Not likely to be occurred	
	Chemical: NILL		-	-	-	No	Not likely to be occurred	
	Biological: NILL		-	-	-	No	Not likely to be occurred	
8.3 Labeling	Physical: NILL		-	-	-	No	Not likely to be occurred	
	Chemical: NILL		-	-	-	No	Not likely to be occurred	
	Biological: NILL					No	Not likely to be occurred	
8.4 Rinse	Physical: Dust particles	Poor rinsing	1	2	2	No	Control Measures are effective	Rinse Pressure monitoring Rinse alignment monitoring
	Chemical: Residual Water		1	2	2	No	Control Measures are effective	Residual Volume monitoring
	Biological NILL		-	-	-	No	Not likely to be occurred	
8.5 Crown/closure Debagging and transfer to hopper	Physical: NILL		-	-	-	No	Not likely to be occurred	
	Chemical: NILL		-	-	-	No	Not likely to be occurred	
	Biological: NILL		-	-	-	No	Not likely to be occurred	
8.6 Filling	**Physical**: Presence of sharp-edged glass fragments, Carrying of foreign particles from empty bottle inspection	Its due to bottles bursting, Second occurs due to untrained bottle inspectors.	3	3	9	No	Control Measures are effective	*Bottle failure Procedure *Training of bottle inspectors.

	Chemical: NILL	No significant hazard occurs	-	-	-	No	Not likely to be occurred	
	Microbiological: Microbiological contamination (mold, yeast)	Its due to Non-appropriate cleaning of containers Dirty filling equipment From air-borne micro-organisms. Personal contacts Dirty bottles due to poor inspection of bottles by untrained bottle inspectors.	3	2	6	No	Control Measures are effective	Monitoring Washer parameters. Cleaning & Sanitation of process equipment's (CIP). Area GMP and Personal Hygiene* Training of bottle inspectors.
8.7 Capping	Physical: Cap shoot particles & tap and paper pieces	Its comes from cap cartons, improper cleaning	3	2	6	No	Control Measures are effective	Cleaning & Maintenance of equipment as per schedule. Manual Cleaning of cartons before opening. *Training of filler operators.
	Chemical		-	-	-	No	Not likely to be occurred	
	Microbiological: Air borne microorganisms & Mold	Its comes from personal and second due to improper cleaning	2	2	4	No	Control Measures are effective	Area and machine GMP and personal Hygiene
8.8 Date Coding	Physical: NILL		-	-	-	No	Not likely to be occurred	
	Chemical: NILL		-	-	-	No	Not likely to be occurred	
	Biological: NILL		-	-	-	No	Not likely to be occurred	
8.9 Bottle Inspection	Physical: cracked and foreign matter	bottle and machine contact	2	2	4	No	Control Measures are effective	Bottles Inspectors training
	Chemical NILL		-	-	-	No	Not likely to be occurred	
	Biological: NILL		-	-	-	No	Not likely to be occurred	
8.10 Warmer	Physical: Bottles crack	High temperature of water	2	2	4	No	Control Measures are effective	Monitoring of Temperature
	Chemical: NILL		-	-	-	No	Not likely to be occurred	
	Microbiological: Mold, E.Coli		-	-	-	No	Not likely to be occurred	treated water used and micro sampling
8.11 Washed Containers Visual Inspections	Physical: Non-removed foreign matters, Glass particles from breakage of bottles due to thermal shock, damaged pockets, other brand bottles	Improper cleaning and not removal by EBI and Prewash inspectors	2	2	4	No	Control Measures are effective	Inspection of washed containers at light by trained & permanent visual inspectors.
	Chemical: oil, greasy, paint	From washer	2	2	4	No	Control Measures are effective	Inspection by trained visual inspectors
	Biological: air bone contamination	From Handling and improper washing	2	2	4	No	Control Measures are effective	Good cleaning and hygienic practices. Monitoring of air quality at defined frequency
9.1 Case Packing	Physical: NILL		-	-	-	No	Not likely to be occur	
	Chemical: Residual oil	From Air	-	-	-	No	Not likely to be occur	

	Biological: Mold	From sugar due to leakage of any previous product	1	1	1	No	Control Measures in place	Leak can sort out
9.2 Shrink Wrap	Physical NILL		-	-	-	No	Not likely to be occur	
	Chemical NILL		-	-	-	No	Not likely to be occur	
	Biological NILL		-	-	-	No	Not likely to be occur	
9.3 Palatizing	Physical NILL		-	-	-	No	Not likely to be occur	
	Chemical NILL		-	-	-	No	Not likely to be occur	
	Biological NILL		-	-	-	No	Not likely to be occur	
9.6 Storage	Biological: Micro Growth TC, Yeast, Mold	Cross contamination from damaged packaging.	6	1	6	No	Effective Control Measures in place	Good warehouse practices in place. Staff well trained and GMP being **followed MP**, training.
	Physical: Introduction of FB.	From environment through damaged packaging.	3	1	3	No	Effective Control Measures in place	Good warehouse practices in place. Staff well trained and GMP and cleaning schedule being **followed MP**, GHP, training.
	Chemicals: Introduction of excrements from pests.	Cross contamination from pests through damaged packaging.	4	1	4	No	Effective Control Measures in place	Integrated pest management system being followed. Good warehouse practices in place. Staff well trained and GMP and cleaning schedule being **followed MP**, GHP, training.
8.12 Seamer	Physical: Dust can enter		-	-	-	No	Not likely to be occurred	
	Chemical NILL		-	-	-	No	Not likely to be occurred	
	Biological: Air bone contamination	Due to improper sealing	2	2	4	No	Control Measures are effective	Seamer Inspection

Table 8: OPRP plan for CSDs.

OPRP Plan for CSDs Lines

OPRP # & Description	Food Safety Hazard to be controlled	Control Measure	Critical Limit	Monitoring Procedures				Correction	Corrective Actions	Responsibility & Authority (Who?)	Records Of Monitoring and Location
				What	How	Frequency	Who				
				Activity	Method to be used	How often?	Responsible for monitoring?	Activity (What?)	Activity (What)		
Activated Carbon Tank	Chemical: High Residual Chlorine	Chlorine NILL after activated Carbon Tank	NILL	Chlorine monitoring after A.C	Colorimeter	At startup and every four hours	Water Treatment operator	Hold the production from last good check to current check random samples and decide accordingly	Carry out root cause analysis and take corrective actions	Process Engineer	Water treatment quality report
5 Micron Filter	Physical: Sand/ Activated Carbon particles	Physical: Sand & Silt Particles	Pressure Drop < 5 PSI	Pressure Drop Calculation	Visual monitoring	Daily	Water Treatment operator	Hold the production from last good check to current check random samples and decide accordingly	Carry out root cause analysis and take corrective actions	Process Engineer	Filter change record Available in Water Treatment

UV	Biological: Coliform	UV monitoring and micro analysis	Intensity >70 % Operating Hours < 8000 hours Total bacteria 50/100mL, coliform bacteria (cfu) 0/100mL	Microbial Count of treated water Maintenance Log of UV	Visual monitoring/ Micro results	UV parameters monitoring once in 8hour shift and weekly micro analysis	Microbiologist Water Treatment Operator	Hold the production from last good check to current check random samples and decide accordingly	Carry out root cause analysis and take corrective actions	Process Engineer	Microbiology reports, 5 Step CIP reports, UV maintenance Log Available in Water Treatment

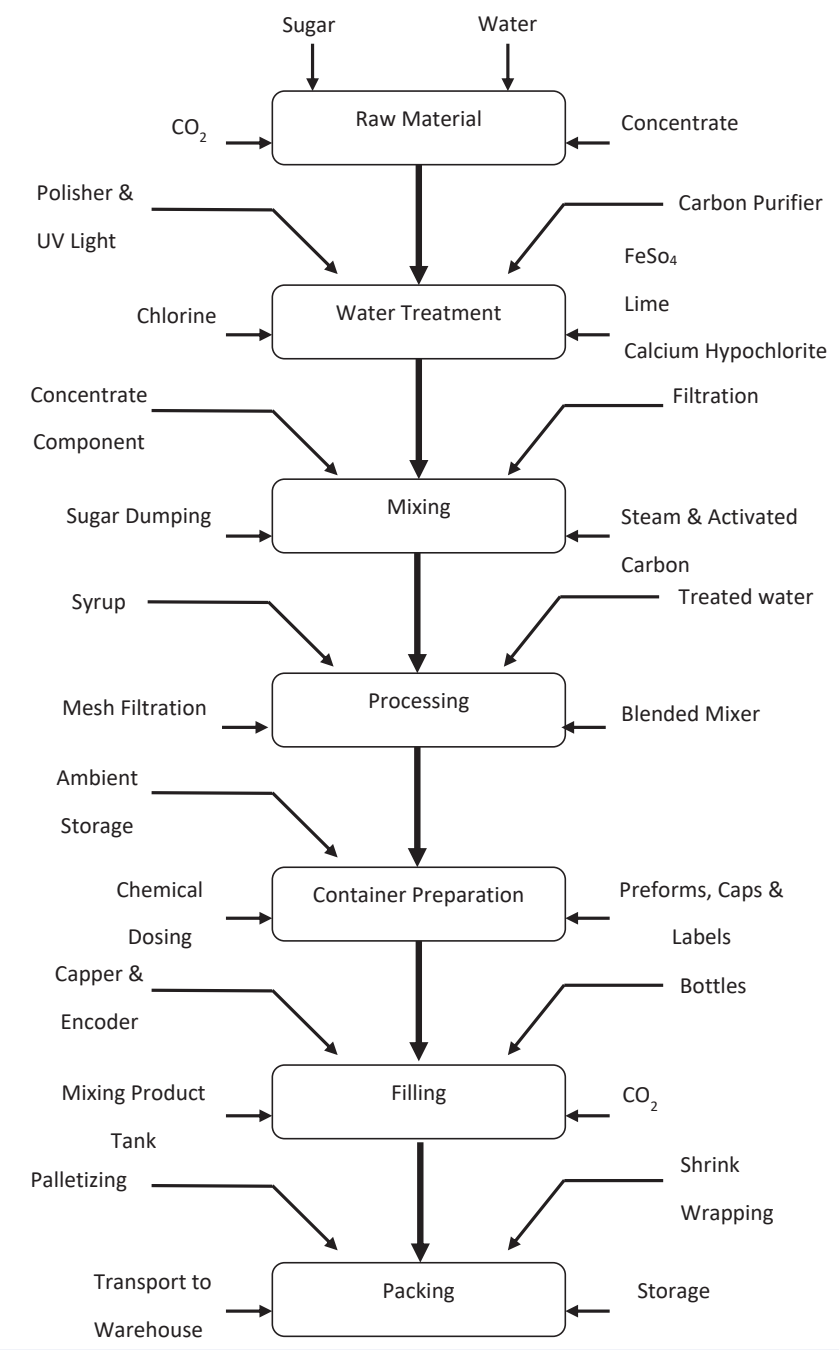

Figure 1 Flow Diagram

CCP Control Chart (Table 10)

CONCLUSION

The safe and healthy food along with wholsomeness is highly demanded in this modern era of development and improvement in food industry. For the purpose of production and distribution of safe food,the industries are implementing safety mangements systems. This HACCP model was developed to improve the safety and quality of the carbonated soft drink plant. Based on seven principles of HACCP system, this model was developed step by step. The item depiction was utilized to warn the consumer about the potential perils in the finished items.Then, during process the prevention measures elaborated together with the potential control points of the hazards. The critical control points were determined by use of decision trees. Finally, by taking in view the seven principles of HACCP the control chart, critical limits, monitoring and corrective action was developed. One CCP was found in the processing of Carbonated soft drink. That was final syrup stainer.

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Table 9: CCP determination for CSDs.

CCP Determination for Carbonated Soft Drink

Process Step	Hazard Type	Control Measure	Is the hazard completely controlled by a prerequisite program?	Decision Tree Answers				CCP (Yes/No), CCP#	Justification of Decision
				Q-1 Do preventable control measures exist?	Q-2 Is the step specifically designed to eliminate or reduce the likely occurrence of hazard to an acceptable level?	Q-3 Could contamination with identified hazard occur in excess of acceptable level or could these increase to unacceptable levels?	Q-4 Will a subsequent step eliminate identified hazard or reduce likely occurrence to acceptable level?		
Final Syrup Strainer	**Physical: Foreign Object s**	Yes Filtration with the filter of mesh size 100	NO	Yes	Yes	Yes	No	YES CCP1	The inline 100 mesh filter positioned as the last filtration step at the closest point prior to filling specifically designed to control the identified foreign object hazards. As Syrup Room is the last manual Handling Operation

Table 10: CCP control chart for CSDs.

Process Step / CCP#	CCP #	Type of Hazard	Control Measure	Critical Limits	Monitoring Procedures				Correction	Corrective Actions	Responsibility & Authority (Who?)	Records Of Monitoring and Location
					What	How	Frequency	Who				
					Activity	Method to be used	How often?	Responsible for monitoring?	Activity (What?)	Activity (What?)		
Final Syrup Strainer	CCP # 1	Physical: Presence of foreign matter	Flltration Through inline 100 mesh filter	Absent, Filter intact and free of foreign matter	Mesh filter (located prior to filling).	Visual inspection of the filter/ screen for integrity, assembled correctly and of the correct size for the product	Daily	Syrup Room Operator	1.If filter/ screen is not present, intact or the correct size during verification, check on hold, stop the process, place the machine "out of order". 2.Notify designated quality employee. 3.Conduct risk assessment to evaluate the likelihood of the hazard. 4.Replace damaged filter with a functional filter.	Carry out root cause analysis as corrective and preventive action program	Process Engineer/ Syrup Room Operator/ FSTL	Strainer Inspection Record Available in Syrup Room