Internet Journal of Food Safety, Vol.13, 2011, p.98-106

Internet Journal of Food Safety

Establishment of Hazard Analysis Critical Control Points (HACCP) System for the Soft Drink Beverage Powder manufacturing

Kohilavani[1], Noor Ariefandie Febrianto[1], Wan Nadiah Wan Abdullah[2], Tajul Aris Yang[1*]

1 School of Industrial Technology, Food Technology Division, Universiti Sains Malaysia, Penang 11800, Malaysia

2 School of Industrial Technology, Bioprocess Division, Universiti Sains Malaysia, Penang 11800, Malaysia.

Abstract

HACCP implementation is a preventive oriented approach to ensure that the potential risks are assessed and reduced to acceptable level. A Case study was conducted in a chocolate malted beverage powder drink manufacturing in Malaysia. Risk based approach was adopted and implemented from Raw material assessment until the end product distribution. 3 legged application concepts that is Good Manufacturing Practice, Suitable standard sanitation operation procedure and HACCP were implemented and verified on the effectiveness of the food safety system..

Keywords: Powder beverage drink, HACCP. Hazard Analysis, Critical Control Points

Introduction

Today's soft drink companies manufacture and also distribute an increasingly large and diverse line of beverages. Along with the proliferation in these product categories, consumer demands too have driven an increase in the number of available product and packaging in respective types and sizes.

Besides that Instant beverage powder business as become one of the leading food segment in food product manufacturing world. Besides tapping the health factor of the local and oversea market, safe food production equally become important to ensure the beverage pre-mixture is safe to be consumed. With the development of current food processing technology and method the hazard risk assessment requires continues checking and evaluation. Rotaru et. al. (2001) also stated that continues evolvement of complex food processing in food chain indeed require specific measures to ensure and acceptable level of food safety.

The hazard analysis and critical control point (HACCP) system is a preventative measure that assesses biological, chemical and physical hazards, estimates risks and establishes specific control measures that emphasize preventative activity rather than reliance on end product testing (ILSI, 1993).

Pre-mix powder is normally categorized under low risk and high care products. However the ingredients as well as the work environment play a vital role in determining the risk exposure level. Normally cross contamination issues become one of the leading problems in most of the industries and clearly evident with the increasing recall notices especially for the ready to eat food products.

Although there is a growing demand, minimal information available regarding the soft drink beverage powder process. The aim of the study is to establish the HACCP system for the instant soft drink beverage powder processing. In any system management commitment is extremely essential to establish an effective and efficient system. During the study the management of the particular industry has shown tremendous co-operation and commitment embracing the food safety culture within its food production boundaries including the relevant food chain. This paper is focus on the implementation of HACCP in beverage manufacturing plant in Malaysia..

*Corresponding author. mailing address: School of Industrial Technology, Universiti Sains Malaysia, Penang – Malaysia, Tel.: +60164274605 Fax: 6 04 6573678. Email: taris@usm.my

Materials and Methods

Development and implementation of HACCP system. The steps used to develop and implement the HACCP system as appropriate to particular industry under consideration as described by Stevenson & Bernard (1999) as follows.

Prerequisite Programs. Basic environmental and operating condition as described in the Codex Alimentations General Principles of Food Hygiene annex to CAC/RCP 1-1969, Rev.3 (1997) and food safety legislative to meet the expected food safety, wholesomeness and suitability for human consumption.

Application of HACCP seven principles and FAO (2001) recommended 12 task in development of HACCP plan for chocolate malted beverage powder processing line based on (Figure 1)

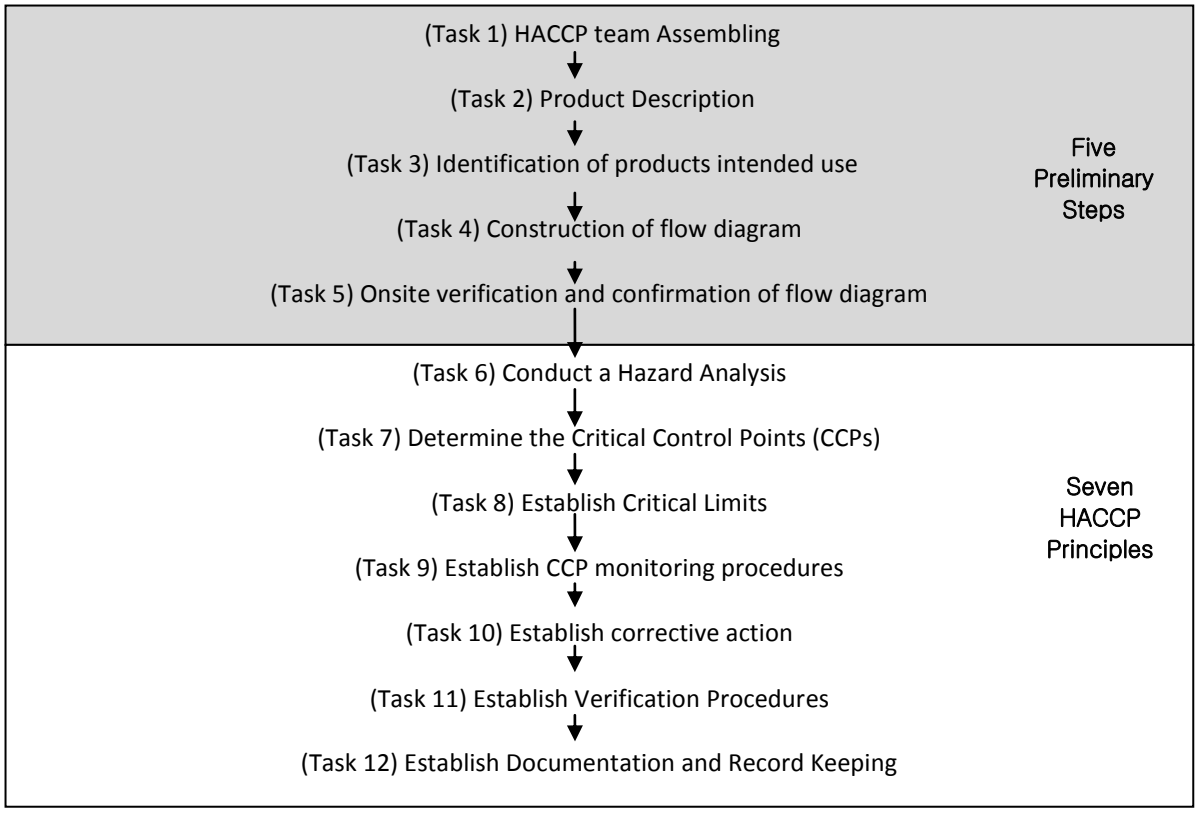

Figure 1: 12 task sequence steps for HACCP application

Table 1: Product description form for Beverage Powder, improved and upgraded version (FAO, 2001)

1. Product Description	BEVERAGE POWDER
2. Permitted Ingredients	All the powder raw material
3. Hyperactivity Advice – *"May have an adverse effect on the activity and attention in children"* If product contains any of the followings: Southampton Colours: Tartrazine (E102); Quinoline Yellow (E104); Sunset Yellow (E110); Carmoisine (E122); Ponceau 4R (E124) and Allura Red (E129) Preservative: Sodium benzoate (E211)	Nil
4. Product Characteristics (Biological, chemical and physical characteristics)	Aw (Water Activity) and Moisture Content Preservative Method - Product formulation is maintained with an Aw range of (< 0.75) and moisture content of (< 9%) and packed in a hermetically sealed primary packaging material to maintain intended end-product shelf life.
5. Intended use (Preparation and/or Handling Before Use or Processing)	Not suitable for infants. The preparation method follow as per instructed on packaging material/ Label.
6. Primary Packaging	Metalized foil PE bag and Kraft liner bags
7. Secondary Packaging	Cartons (except for Kraft bags)
8. Packing Size	Based on Customer and manufacturing desire
9. Intended Shelf Life / Storage Conditions before Consumption	18 months from date of production under ambient storage temperature and away from direct sunlight
10. Where it will be sold?	Bulk pack – Institutions Commercial pack - Retail outlets
11. Labelling instruction – Food Safety Guidance	Store in a dry place. Once opened, unfinished product shall be resealed
12. Sensitive Consumers	Non identified / Allergenic contains Milk based product
13. Methods of Distribution	Local - By normal truck under ambient temperature. Export – By Food Grade Container
14. Statutory / Regulatory Food Safety Requirements?	Malaysia Food Act 1983 Malaysia Food Regulations 1985 Importing country specific food law and regulatory requirements

Results and Discussion

1. The HACCP team (Task 1)

The first task in developing HACCP plan is to form a team consisting of individuals who have adequate knowledge and work experience on the respective process.

2. Product Description (Task 2)

Prior conducting the hazard analysis, it is essential to prepare a comprehensive description of beverage powders to be made. Intended consumer segments, customer requirement and the regulatory and legislatives were shown in table 1. The product description form was improvised and upgraded with current requirement and also can be easily revised dynamically.

3. Identify Intended Use (Task3)

The normal expected use of the food was described. With regards to possible acceptable risk level for a food safety hazard it has to be stated for which group of population the food is intended (Untermann, 1999). The intended use need to be stated or informed whether the food need to be prepared e.g by using hot or cold water prior consumption. Besides that sensitive consumers too need to alert which adequate information on allergenic ingredients if it were used to prepare the product (Table 2).

4. Construct the process flow diagram (Task 4)

The flow diagram covers all the common steps in the process of soft drink beverage powder making in general. Simple and clear diagrams with production reflective details are adequate to conduct process HACCP plan. It is important to point out that, the flow diagram is the base for any further hazard analysis and to establish the critical control points (FAO, 2001). It is, therefore generally recommended to attach a detailed description of the operations which are being carried out on the flow diagram itself, including some additional information on raw materials, additives, containers they come in, storage characteristics, as well as the activities to be performed

during the process, time/temperature profiles of the different stages, equipment and design characteristics, plan of the facilities, customer and distribution problems, etc. (Mortimore & Wallace, 2001, Martinez & Carrascosa, 2009).

Flow diagram with steps pior to and after production until it reaches the consumers required to be included (Arvanitoyannis and Hadjicostas, 2001), to establish a complete traceability procedures and also establish emergency action plan if they are any potential circumstances that might affect the safety of the product. (Figure 2)

5. Onsite confirmation and verification of process flow (Task 5)

The HACCP team shall perform onsite verification on the accuracy and completeness of the flow diagram. Besides that the team also was trained to check the conformity of flow diagram is correct for any shift pattern that normally takes place in processing plant (Slatter, 2003). The onsite assessment normally involves participation of respective responsible personnel to explain the processing nature and the operation procedure during assessment. During the assessment, any additional documentation required for on-site review was examined (Motarjemi, 2000).

Each step was checked and to ensure that all relevant information regarding potential hazards to the process and products are identified. If any modification required, it were amended immediately and documented. After the five preliminary tasks have been completed, the seven principles of HACCP are applied to construct the HACCP plan (Corlett, 1998).

6. HACCP Principle 1: Conduct a hazard analysis

Guidebook for the preparation of HACCP (USDA, 1999), have clearly stated that a hazard analysis is the identification of hazardous properties such as biological, chemical or physical properties in raw materials, processing steps and an assessment of their likely occurrence and potential to cause food to be unsafe for consumption. After the hazard identification, the risk was assessed by the team members and appropriate control measures were identified (Corlett,1998).The hazard analysis for the powder beverage drink is accomplished in two stages: Stage 1: hazard identification based on review of the origins of possible hazards and Stage 2: hazard evaluation within the frame of potential significance of each hazards were assessed by considering it's seriousness (freeing to health concern) and it is likeliness to take place based on work experience, epidemiological data and available information from the literature (Arvanitoyannis & Hadjicoastas, 2009)

6.1. Hazards Identification

The regulation defines hazards for Food safety as any biological, chemical or physical properties that may cause a food to be unsafe for human consumption (USDA, 1997). There are three major groups of hazards that are considered in a HACCP plan. These are physical, chemical and biological (Table 2). Harris (1999) has stated that all types of the hazards can enter a food product at any stage during processing.

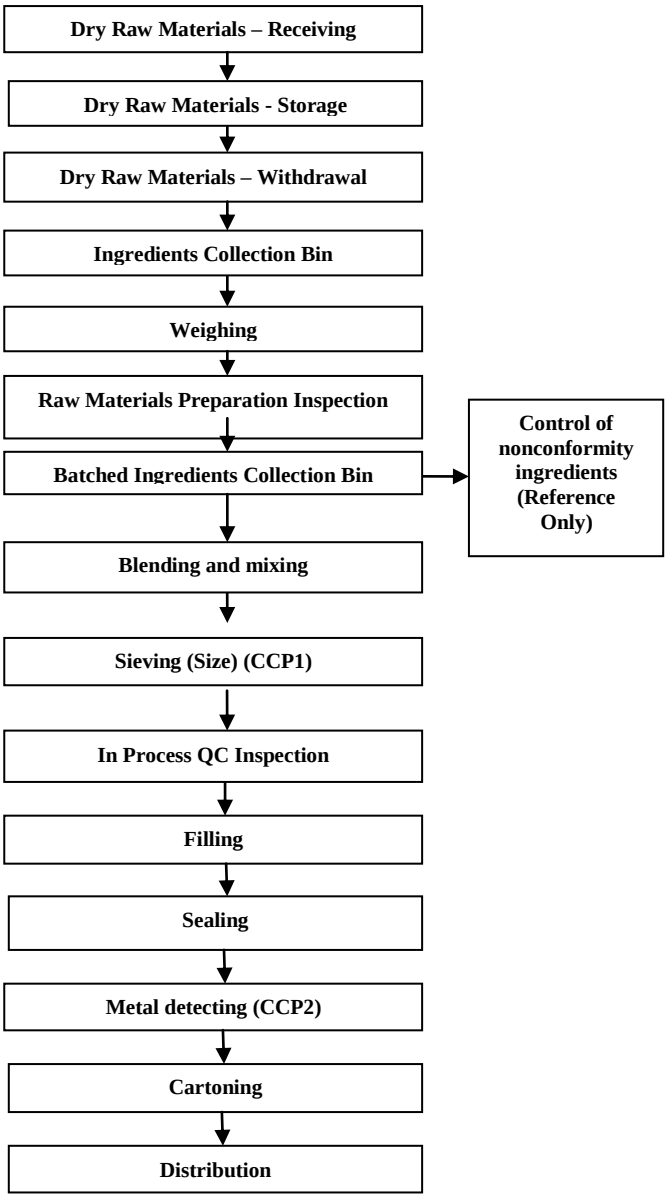

Figure 2: Generic soft drink beverage powder making flow diagram

6.1.1 Physical Hazards

Normally in powder beverage processing, highly anticipated hazards are the physical hazards. Physical hazards include glass metal, stones, wood, plastic, rubber or pests (weevils). Besides that foreign materials which cannot or do not cause illness or injury are not hazards, even though they are not aesthetically pleasing to the consumers to consider as physical hazard (USDA, 1997).

Although supplier assurances are in place, the in house process control extremely important to prevent the physical

hazards. Sieves or filters were used commonly in the powder beverage processing line to eliminate the physical hazards prior packing. The sieve size and capacity may vary from one plant to another based on the production capacity. The sieve size were chosen based on the powder partial size, production experience and also based on the manufacturer recommendations.

Besides that the operators were taught and trained to handle food safety to prevent contamination by un wanted foreign objects. McSwane (2000), also stated in that workers are not allowed to wear jewelry when involved in the production of food, except for plain wedding band. However during the implementation common instruction were given to workers to remove jewelry during working hours. This instruction was carried out firmly to avoid any conflict of interest among various practices in wearing wedding band.

There are various methods for the detection of foreign materials such as metal detectors low-energy X-rays and etc, which are used in the food industry to scan the finish product. This particular step ensures and eliminated any potential physical contamination that may take place during the processing.

6.2.1 Microbiological Hazards

Salmonella, E.coli and Bacillus cereus are the famous hazardous microbs that can able to survive although the water activity and moisture content of the powder lower than any other food products. Due to poor hygiene and mishandling the hazardous microorganism can spread from raw food materials to ready to consume food.

Aerobic colony counts, Coliform, Total plate count, Bacillus cereus, enterococci, yeast and mould enumeration are useful and most often used means of assessing overall sanitation in the environments of food service establishment.(Collins,1964; Jay,1987, Moyo and Baudi, 2004). Effective and efficient cleaning program after implementing HACCP shows impressive result when compare with before implementation environment hygiene (Table2). Sanitation program and practice is of prime importance since it not only removes gross contamination but also any residues that could support the subsequent survivals and growth of microorganisms. (Clark,1965, Ajao and Atere, 2009). Workers personal hygiene level was elevated and hygienic culture was inculcated effectively

after the implementation of the food safety system. Besides that the air quality at work environment especially at processing have improved tremendously from 4.3 $X10^4$ CFU/G to 1 $X10^1$ CFU/G

The main objectives of sanitations is to minimize the access of microorganisms in food from various sources at all stages of handling (Marriot,1958; Cords & Dychdala,1993). The objective was meeting after an effective implementation of sanitation program which was one of the vital legs in HACCP system.

6.2.2 Chemical Hazards

Chemical Hazards including pesticides, cleaning chemicals, allergens, food contact materials, additives and preservatives were considered assessed during hazard plan development for powder beverage processing. Since all the ingredients were assessed and validated for its safety prior purchasing, its created slim possibility for the hazardous chemical present in the process line. Besides that close communication with supplier and suppliers support have made the raw material assessment process easier.

New suppliers for ingredients and packaging materials are required to go thought the screening process before confirming the purchasing activity. Heavy metals test results and other relevant chemical traces in common ingredients were required to be collected and assessed by the team leader and respective personal. This systematic procedure allows the industry to stream line the required specification and produce a safe and quality product.

7. HACCP Principle 2: Determination of critical control points

Codex Alimentarius, decision tree was used to determine the (Critical Control Points) CCPs in the powder beverage process flow diagram (FAO,1997). Based on Figure 2, sieve which was used to eliminate foreign bodies which are physical hazards was identified as CCP1. The sieve sizes various based on powder practical sizes based on the produces. Table 3, clearly defines the output the decision tree in identifying the Hazard in process line.

8. HACCP Principle 3: Establish Critical Limits for each CCP

CCPs are the key steps at which control can be applied and hazards can be eliminated, prevented or reduce to acceptable (Rushing and Ward, 1999). Once the CCPs have been identified and determined, a critical limit or the amount of acceptable range were established to each CCP (Arvanitoyannis & Hadjicoastas, 2000). Corlett (1998) have stated that the critical limits for CCPs are expresses as specific parameters on water activity, pH, salt concentration, chlorine level and temperature. In Table 4, the critical limits are set for beverage powder products.

Since the metal detector was the last CCP to eliminate any potential physical contaminant, higher sensitivity normally desired to detect the smallest piece of metal in the beverage powder. The respective personal was trained on competency of using the equipment and also in recording the data in the records.

Critical limits are set for product safety and not for product quality (Arvanitoyannis & Hadjicoastas, 2000). For example in this scenario, the critical limit for sealing is suitable the temperature and will be checked by conducting bubble test or pressure test. Sealing integrity extremely important the ready to consume powder beverages to ensure the products not contaminated or oxidized. However in this case study, the sealing process step is not a CCP because is the sealing is improper the product will get lumpy and become out of specification. Unlikelihood of causing food

poisoning very slim because the product will be will be harden if the sealing integrity bridged.

Table 2: Hazard Analysis Table for Powder Beverage Process

Processing Step	Determination of hazards	Do preventive control measures exist?	Is the step specifically designed to eliminate or reduce the likely occurrence of hazard to an acceptable level?	Could contamination with identified hazard(s) occur in excess of acceptable level(s) or could these increase to acceptable level (s)?	Will a subsequent step eliminate identified hazard(s) or reduce likely occurrence to acceptable levels?	Is this step a critical control point
Receiving , storage , Withdrawal	Biological :Pathogenic microorganisms (salmonella, e-coli) Chemical: Heavy metals, pesticide residue, preservatives Physical: metal, foreign particles	No	No	NO	Yes	cp
Ingredient collection	Biological : Surviving pathogen from improperly cleaned inside. Salmonella Chemical: Excessive sanitizer residual or pest control chemicals Physical: Brittle broken plastic fragment due to collection bin's wear and tear	No	No	NO	Yes	cp
Weighing,	Biological : None identified Chemical: None identified Physical: None identified	No	No	NO	Yes	cp
Raw material Preparation Inspection , batched ingredient collection bin	Biological : From unhygienic sampling techniques by personnel during sample collection or inspection Chemical: Excessive sanitizer residual or pest control chemicals Physical: Brittle broken plastic fragment due to collection bin's wear and tear	No	No	NO	Yes	cp
Blending , Mixing	Biological : Contamination from improperly sanitized homogenizing rod and arms Chemical: None identified Physical Loose metal parts due to wear and tear of equipment and homogenizing arms, and other non-ferrous foreign particles	No	No	NO	Yes	cp

Source: Real time production implementation

- CP : Critical Points
- CCP: Critical Control Points

Table 2: Hazard Analysis Table for Powder Beverage Process (Continue)

Processing Step	Determination of hazards	Do preventive control measures exist?	Is the step specifically designed to eliminate or reduce the likely occurrence of hazard to an acceptable level?	Could contamination with identified hazard(s) occur in excess of acceptable level(s) or could these increase to acceptable level (s)?	Will a subsequent step eliminate identified hazard(s) or reduce likely occurrence to acceptable levels?	Is this step a critical control point
Sieving	Biological : None identified Chemical: None identified Physical: Loose metal parts due to wear and tear of equipment including other non-ferrous foreign particles	Yes	No	Yes	Yes	CCP1
In process QC Checking	Biological : None identified Chemical: None identified Physical None identified	No	No	NO	Yes	cp
Filling , Sealing	Biological : Form micro organisms if filling tank has not been properly cleaned and sanitized in between production batches Chemical: None identified Physical :Foreign particles from environmental impact if fully processed batches are not properly protected prior to filling and packing	No	No	NO	Yes	cp
Metal Detecting	Biological : None identified Chemical: None identified Physical :Loose metal parts due to wear and tear of equipment	Yes	No	Yes	Yes	CCP2
Cartoning and Transportation	Biological : None identified Chemical: None identified Physical: None identified	No	No	NO	Yes	cp

9. HACCP Principles 4: Establish a monitoring procedure

After establishing the critical limits for CCPs, the monitoring activity consists of observation and measurements taken to ensure it to be under control. Hulebak and Schlosser (2002), also highlighted that monitoring is used to determine when a deviation occurs at a CCP and, if it is not continuous, need to be conducted at sufficient frequency to ensure that the CCP under control. There are 3 basic requirements for developing monitoring procedure for the HACCP plan. Monitoring procedure to be defined accurately and suitability, then the frequency of monitoring and person responsible need to be stated to ensure the implementation and monitoring effectively carried out.

10. HACCP Principles 5 : Establish Corrective Actions

When deviation occurs from the set limit, the procedure to be followed is the corrective action (USDA, 1997). The corrective action that required to be conducted were clearly spelled out in the Table 4. The purpose of the corrective action is to adjust the process to maintain control or prevent deviation. The Critical limit need to be re- established to control the process and the CCP. The effected products disposition and maintaining the records of corrective action also required in the corrective action (Table 3).

If the raw materials and process activity are defined accurately the possibility of occurrence of deviation can be eliminated from earlier stages. Corrective action is required to be conducted immediately without any procrastination and the root cause of the event to advice to be investigated to prevent the reoccurrence of similar deviation (Table 3).

11. HACCP Principles 6: Verify the HACCP plan

Verification is a application of methods, procedures, test and other evaluations, in addition to determine compliance with the HACCP plan (FAO, 2001). The verification typically consists of two levels. Respectively, verification that the critical limits established for CCPs will prevents, eliminate or reduce hazards to acceptable limits and that the overall HACCP plan effectively functional (Arvanitoyannis & Hadjicoastas, 2000).

Random sample collection, analysis and visual inspection of food production operations to determine that CCPs are under control are apart of verification activity conducted to confirm the conformity of the HACCP plan. Overall review of HACCP plan, CCP records, process flow, onsite review and corrective action are review through the audit activity (Martinez & Carrascosa, 2009).

12. HCCP Principles 7: Record Keeping

Record keeping and documentation system required to be customized to meet the need of the company and adequate demonstrate the food safety program in place effectively. Keeping records is an important part of application in the HACCP plans to evident the demon- stration of monitoring and corrective action. Besides that with adequate traceability system from raw material to distribution gives a strong traceability system and confidence for the HACCP implemented industry.

Table 3: Comparisons of hazardous microbiological load before and after implementation of HACCP system.

Microbiological Validation	Microorganism	Test Result **BEFORE** implementing HACCP System and applying sanitizer *	Test Result **AFTER** Implementing HACCP System and applying sanitizer*
End Product (Beverage Powder)	Total Plate Count	4.5 X 10^5 CFU/G	1.2 x 10^2 CFU/G
	Coliform	1.0 X 10^3 CFU /G	Absent
	Salmonella	2.3 X 10^3 CFU/G	Absent
	Bacillus Cereus	<10	Absent
Environment Quality (Air)	Yeast and Mould	4.3 X10^4 CFU/G	1 X10^1 CFU/G
Water Quality	Pseudomonas	<1.1	Absent
Personal Hygiene Swab	Total Plate Count	3.8 X 10^6 CFU/G	2.1 X 10^2 CFU/G
	Salmonella	4.1 X 10^4 CFU/G	Absent
	Coliform	3.4 X 10^3 CFU /G	<1
Equipment Hygiene Swab	Total Plate Count	2.1X 10^4 CFU/G	1X 10^2 CFU/G
	Salmonella	3.5 X 10^4CFU/G	Absent
	Coliform	2.0 X 10^4CFU /G	Absent
**The results were obtained from 3rd party laboratory test (ISO 17025)*			

Conclusion

Soft Drink Beverage manufacturing industries have demonstrated commitments and responsibility to improve and meet the food safety requirements for the business development. Besides the HACCP implementation successfully benefit the manufacture, consumer and government in establishing elevated level of confidence and additional leverage completing safety assessment for new type of soft beverage drinks.

Acknowledgements

This work has been supported by the beverage manufacturing companies in Malaysia.

References

Ajao, AT, and Atere, TG. 2009. Bacteriological assessment and hygiene standard of food canteens in Kwara State Polytechnic, Ilorin, Nigeria. African Scientist 10(3): 173-180.

Arvanitoyannis, IS, and Hadjicoastas, E. 2001. Quality assurance and safety guide for the food and drink industry. Mediterranean Agronomic Institute, pp. 73-83.

Clark, DS. 1965. Method of Estimating the Bacteria population of surfaces. Canadian J. Microbiol. 11:407-13

Collins, CH. 1964. Microbial methods. Butter worth and company. London

Cords BR, and Dychdala GR. 1971. Sanitizer: halogens surface active agents and peroxide. in : Davidson, PM, and Branen AL. (Eds). Antimicrobial in foods. New York : Marcel. Dekker. pp. 36-52

Corlett, DA. 1998. Environmental and Quality System Integration. New York: Lewis Publishers.

FAO. 2001 Codex Alimentarius- Food Hygiene – Basic Text, 2nd ed. Rome. Italy.

Harris, LJ. 1999. HACCP 101 Part 11- Principle 1. Hazard Analysis. Perishables Quarterly 98

ILSI. 1993. A Simple Guide to understanding and applying the hazards analysis critical control point concept. Washington DC. International Life Science Institute.

Jay, MJ. 1987. Modern Food Technology Microbiology. New-York. Van Nostrand Company

Marriot NG. 1958. Principles of food sanitation. New York. Van Nostrand Reinhold. Pp 71,101.

Martínez-Rodríguez, AJ., and Carrascosa AV. 2009. HACCP to control microbial safety hazards during winemaking. Food Control. 20: 469-475

Mortimore. S, and Wallace C. 2001. Food Industry Briefing Series: HACCP. Blackwell Publishing Ltd

Motarjemi, Y. 2000. Regulatory Assesmnet of HACCP: A FAO/WHO consultation on the role of government agencies in assessing HACCP. Food Control, 11 (5): 341-344.

Moyo, DZ and Baudi, I. 2004. A Bacteriological Assessment of the cleaning and Disinfection efficacy at the Midland State University Canteen, Zimbabwe, Pak. J. Biol. Sci. 7(11): 1996-2001.

Rotaru G, Borda D, Sava N. 2001. Implementing Quality Management Programmes, Ed. Academica, Galati, pp. 82-90.

Slatter. J. 2003. Hazard Analysis Critical Control Point. Encylopedia of Food Science and Nutrition pp. 3023-3028.

Stevenson KE and Bernard DT. 1999. HACCP, a systematic approach to food safety : a comprehensive manual for developing and implementing a hazard analysis and critical control point plan. Washington, D.C. Food Processors Institute

Unterman, F. 1999. Food Safety management and misinterpretation of HACCP, Food Control 10: 161-167

USDA. 1997. Guidebook for the Preparation of HACCP plan. Washington DC. USDA

CAC/RPC. 1997. Hazards Analysis and Critical Control Point (HACCP) System and Guideline for its Application. Codex Alimentarius Commision CAC/RPC 1-1967, Rev. 3. Annex to CAC/RC1-1969, Rev 3.

McSwane, D. 2000. Essentials of Food Safety and Sanitation, 2nd ed. New Jersey: Prentice Hall.

Rushing, J.E. and Ward, D.R. 1999. HACCP Principles. Food Safety FSE 99-21, N.C. State University Cooperative.

Hulebak, K.L and Schlosser,W. 2002. Hazard Analysis and Critical Control Point (HACCP) history and conceptual overview. Risk Analysis, 22(3): 547-552.