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HACCP Implementantation on beer production from barley

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Abstract

The production of beer is called brewing, and beer is considered a safe beverage; however, its degree of safety may be comparable to many other food products. Many hazardous situations may arise during the production of beer. The major steps in producing malt & beer include: barley intake, cleaning & grading, drying, steeping, germination and kilning malt, roasting, milling, mashing, boiling, fermenting, maturing, filtration and packaging or bottling. These steps should be analyzed to effectively apply the HACCP method to control food safety. It is in the public interest that beer producers, especially at brewing pubs and microbreweries, develop and implement HACCP plans to ensure the safety of beer. The most effective way to active food safety is to focus on prevention of possible hazards and to improve the process. HACCP can be considered as a management tool. It is a simple but specialized method designed to prevent health hazards resulting from the consumption of contaminated food and beverages. Health hazards may originate at any point in a production process, including receipt of raw materials, food handling, storage, packaging and transportation. The knowledge of the product formula and the details of the process are basic tools necessary to apply the HACCP method. It is very important to remember that HACCP is an analytical approach to food safety, focusing on critical points or areas of a food process which may present a hazardous situation in need of control.

Keywords: HACCP Implementantation, beer production, safe beverage

Introduction

Beer is the world's most widely consumed and probably the oldest alcoholic beverage, it is the third most popular drink overall, after water and tea. The production of beer is called brewing, and beer is considered a safe beverage; however, its degree of safety may be comparable to many other food products. Many hazardous situations may arise during the production of beer. It is uncommon to hear about a beer contaminated with a pathogen, the presence of glass fragments in bottled beer, or contaminating mycotoxins in a freshly brewed beer. Although unusual, these hazards may occur and the processor should be ready to prevent these situations. Beer is a fermented beverage made in several steps from cereal grains such as malted barley. Other grains such as corn and rice are being used to aid in the final texture and flavor of the product. The primary ingredients in making beer are: malted barley, water, hops, and yeast. Each ingredient has its own function. Barley provides the starch which is converted to maltose and other sugars, and finally to alcohol and carbon dioxide. Color, flavor and body are other important functions of barley and are dependent on its roasting method. Different degrees of roasting result in a range of colored beers from very light to very dark. The major steps in producing malt & beer include: barley intake, cleaning & grading, drying, steeping, germination and kilning malt, roasting, milling, mashing, boiling, fermenting, maturing, filtration and packaging or bottling (Lewis M. J. and Young .T. W. (1995) ^[12]. These steps should be analyzed to effectively apply the HACCP method to control food safety. It is in the public interest that beer producers, especially a brew pub has been described as an establishment which brews and sells beer for consumption on the premises such as in a restaurant at brewing pubs and microbreweries (Johnson, S. (1994) ^[9]. develop and implement HACCP plans to ensure the safety of beer. This is particularly true in brew pubs and microbreweries where beer is not commonly pasteurized. World barley production reached

136 million tons in 2007 that increase 3 million tons from the previous year's results. Barley is the second most important coarse grain after maize (785 million tons in 2007) and outweighs by far sorghum (65 million tons). Three regions produce more than a half of the world's barley: the European Union (EU) (43%, mainly Spain, Germany and France with about an 8 %-share each), the Russian Federation (11%) and Canada (9%). Europe has long been a producer of malt barley. HACCP has been recognized as an effective and rational means of assuring food safety from primary production through final consumption, using a "farm to table methodology". The safety of any food and beverage, including beer can be managed and controlled by the HACCP concept. This concept is already being used across the food industry, especially in large food companies where it may be a part of their quality management program. HACCP is not difficult to adopt for small processors which includes the micro brewing industry. It is very important to remember that HACCP is an analytical approach to food safety, focusing on critical points or areas of a food process which may present a hazardous situation in need of control.

Material and Method

The detail of experimental material used and methods applied during the course of present study are described in this chapter under the various headings.

Selection of different developed varieties of barley

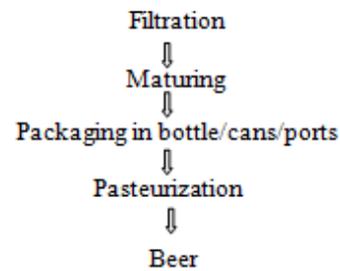
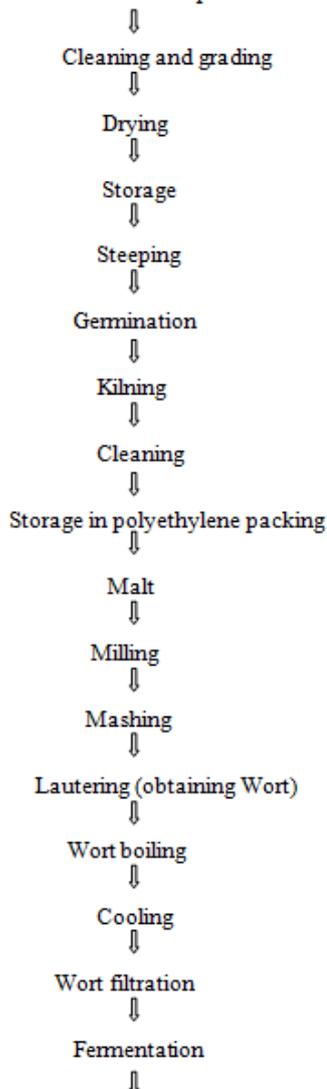


Fig 1: Beer production (grain selection to beer)

HACCP Implementation in malt and beer processing:-The HACCP system consists of the following seven principles. By applying all seven principles at every step, HACCP plan should be ready for implementation (Barron, F. H. (1994) [3].

Principle 1: Assess the potential hazards (microbiological, chemical, or physical) at every step in the beer making process.

Principle 2: Determine the critical control points (CCPs) necessary to control the hazards. The definition of a CCP will be provided later in this publication.

Principle 3: Establish the critical limits (CLs) for each CCP.

Principle 4: Establish procedures to monitor each CCP and their critical limits.

Principle 5: Establish corrective actions that need to be taken any time a deviation from critical limits occurs.

Principle 6: Establish an effective record keeping system to document the HACCP plan.

Principle 7: Establish procedures to verify that the HACCP system is working effectively.

Application of the HACCP principles: -the application of the HACCP principle consists of the following tasks as identified in the logic sequence for application of HACCP.

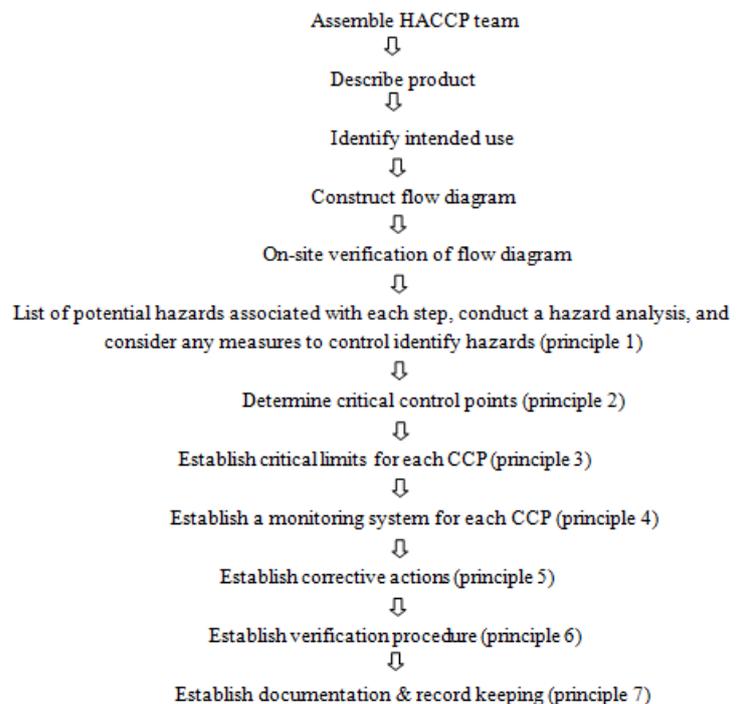


Fig 2: Application of HACCP principle

Table 1: Hazards identified in beer ingredients and their control measures

Ingredient & material	Hazards	Control measures
Barley	PCB	Received qualified grain & stored at optimum temperature
Malt	P	Received qualified product
Water	PCB	Received qualified product
Adjuncts and hops	PB	Received qualified product
Can and bottles	PC	Received proper clean & sanitary bottles/cans

Table 2: Hazards identified in beer processing steps and their control measure

Processing steps	Description	Hazards suggested	Control measures
Raw material receiving & storage	Raw material are receiving & stored for a certain period of time	PCB	Received qualified product & store at optimum temperature
Malting	Steeping, germination and kilning process	PC	Received qualified product
Milling	Obtain malted grain are milled	P	Uses different types of sieves & magnetic stirrer
Mashing	Mixing, boiling, cooling and filtration	PC	Received qualified product
Fermentation	Fermentation environment, yeast and hops	PB	Uses pure culture & proper time and temperature combination
Packaging	Cans, bottle and other ports etc.	PC	Received qualified product
Pasteurization	Time and temperature	B	proper time and temperature combination

Results and Discussion

3.1 Beer product description

Beer description on the basis of second principle of HACCP system

Description of product is in Table 3.

Table 3: Beer product description

Product characteristics	Beer
	Weight of sample – 100 ml
	Water – 90 %
	Calories – 43
	Fat – 0.00 %
	Sodium – 4 mg
	Calcium – 4 mg
	Potassium – 27 mg
	Protein – 0.5 gr.
	Alcohol – 3 to 8 %
Packaging	Glass bottle/aluminum coated cans
Shelf life	6 months
Distribution	Refrigerator conditions

3.2 Identification of intended use

The important purpose of intended beer ready to consumption categories

3.3 Construction of a flow diagram

The process flow diagram was verified to establish that the diagram accurately represents the actual activities and operations used in the manufacture of the product. This was done by observing each step of the manufacturing process.

3.4 Possibility of hazard occurrence in beer ingredients and to suggest control measures based on HACCP

This product shows the possibility of microbiological, chemical and physical hazards in the raw material for beer production. It includes the suggestive and preventive measures for the hazards in each raw material was shown in Table 4.

Table 4: Possible Hazard and control measure

Ingredient & material	Hazards	Control Measure
Barley grain	PB	Receiving qualified product. Store at clean and dry place at room temperature away from direct sunlight. Proper personal hygiene and handling.
Malt grain	P	Receiving qualified product. Store at clean and dry place at room temperature away from direct sunlight.
Adjuncts	PB	Receiving qualified product.
Malt	PCB	Receiving qualified product. Store at clean and dry place at room temperature away from direct sunlight.
Wort	PCB	Receiving qualified product store in low temperature.
Hops	PCB	Receiving qualified product store at clean and dry place at room temperature.
Water	PCB	Supply quality water
Sugar	PC	Receiving qualified product store at clean and dry place.
Yeast	B	Received qualified culture. Store at optimum temperature.

3.5 Possible hazards identified in beer processing steps and their control measures

The Suggestive control measures are provided for the hazards in each processing step. All the natural Visual check situations were set up under the requirements in beer processing to make safe and quality product as shown in Table 5.

Table 5: Possible Hazard identified in Processing Steps and Control measures

Process step	Description	Hazards	Control measures
Raw material receiving and storage	Raw materials are received and stored for a certain period of time before processing	PCB	Raw material store at optimum temperature
Sieving	Sieving the barley grain/malt grain by different size sieves.	PB	Using clean sieves which cannot be contaminated
Weighing all ingredient	Weigh all ingredients by using Weighing balance	No hazard	
Addition of other ingredient +such as adjuncts and hops	The ingredients were mixed with the required processing steps.	PCB	Utensils which was use for the mixing it should be properly clean by detergent & dried few min then it used.
Sugar	Stored at clean and dry place	PC	Before adding the wort with sugar washing the hand neatly and using the gloves
Preparation of wort	Prepared the wort to formulate according to procedure	PCB	Used clean utensils for the wort preparation
Sheeting and shaping	Sheeting of wort in barrel & gives uniform temperature by heat exchanger	P	Before of sheeting clean the barrel or utensils by using sanitizer & dry it for few min. & shaping of wort by hand slightly or through pipe.
Fermentation	Pitching the Uniform culture & give the optimum temperature	PB	Received qualified culture, not mixed any wild cells
Maturation	Stay the beer at 0 to 1 °C for 7 to 8 days	No hazard	
Filtration	After maturation/aging beer obtained from fermented tank	PB	Receive qualified beer, filtered properly.
Carbonization	Added carbon dioxide in Beer	C	Required amount of CO ₂ added.
Packaging in bottles/cans	The beer is package in glass bottle/cans automatically	PC	Packing sealed carefully without entering air in bottle/cans Pasteurized at specific time and
Pasteurization	Receive packed beer and uniformly spray the hot water	B	Temperature.
Storage	Stored the beer at refrigerant temperature.	CB	Stored at clean and safe place.

3.6: Beer HACCP control chart for monitoring

6.

Beer HACCP control chart for monitoring as shown in Table

Table 6: Beer HACCP control chart for monitoring

Process steps	Hazards to be controlled	Critical limits	Monitoring	
			Procedure	Frequency
Raw material receiving and storage	Any contamination	Nil	To identify contamination	Each trials
	Foreign bodies	Nil	Foreign bodies detection	Each trail
Milling	Foreign bodies	Nil	Foreign bodies detection	Each trail milling
	Dust	Nil	Visual check	Each trial
	Any contamination	Nil	To identify contamination	Each trail mixing
Fermentation	Any contamination	Nil	To identify contamination	Each trail
Packaging	Any contamination	Nil	Visual check	Each trail
Pasteurization	Any contamination	Nil	To identified contamination	Each trail
Storage	Any contamination	Nil	Visual check	Each trail

3.7: Beer control chart and possible corrective action during processing steps

processing steps as shown in Table 7. The result obtained agreed with result reported

Beer control chart and possible corrective action during

Table 7: Beer control chart and possible corrective action during processing steps

Raw material/ Process step	Hazards to be controlled	Critical limits	Corrective action
			Procedure
Raw material receiving and storage	Any contamination	Nil	All raw materials keeps in clean & dry place. Away from direct sunlight
	Foreign bodies	Nil	
Milling	Foreign bodies	Nil	Conduct the milling operation after washing hand & use sieves & properly clean utensils & grinder
	Any contamination Dust	Nil Nil	
Fermentation	Any contamination	Nil	Use the pure and original yeast culture
Packaging	Any contamination	Nil	Use good resistance quality of packaging material & proper sanitize.
Storage	Any contamination	Nil	Product place in clean & refrigerant temperature & place.
	Visual check	Nil	

The potential control points of the hazards appeared in the process along with the prevention measures is indicated in above Table. The HACCP control chart was developed to

include components of several HACCP principles which are critical limits, monitoring and corrective action for beer production, the most essential part of the whole HACCP plan,

is the organization analysis and documentation of the CCPs. Readings from the book *Beer in Health and Disease Prevention* indicated that beer was an intrinsically safe product that would negate the potential for pathogens to be present in the finished product (Menz, et. al., 2009) ^[14]. The column of the control chart will be filled out. The steps that contain CCPs will be emphasized during production. The production steps and the finished product introduce hurdles to microbial growth that indicated any pathogens present would be killed (Menz, et. al., 2011) ^[15]. The documentation of the HACCP plan which is suitable for the conditions in this procedure will help to prevent and eliminate those critical hazards in its production.

A. Suggestions and control measure based on HACCP

Based on the HACCP control chart, all selected varieties grain/malt grain CCPs were identified in the present study. All the grain/malt grain CCPs were determined based on the HACCP principles. These programs were crucial to determine the critical control points. Without the HACCP plan, the researchers need to consider more hazards that are possible to the product from outside the process. These CCPs include:

B. Raw material receiving and storage

The raw material was received after the personnel inspection. Then raw materials are stored at appropriate conditions in clean and dry place away from direct sun light corrugated box to keep the material off the ground. Bad quality raw material can result in product spoilage or poor quality. Bad storage condition results in material deterioration and will decrease the shelf life of the material. Raw material receiving and storage has been critical for the final product quality which can add hazards to the materials and decrease the quality.

C. Milling and Mashing

Milling step takes place when the malt grain are milled in the grinder after cleaning with the help of different size of sieves, weighing then on defined process bases. The sachets open and fall the malt grain manually or with the help of elevator into the grinder. After then add water in mashing tank, and then add adjuncts. Proper HACCP system at this step could prevent hazards and contamination to the process which will affect the quality of the final product.

D. Packaging

The finished product is automatically fill in glass bottle or cans under sanitary and hygienic conditions, and proper capping had done. This is the point or processing steps at which carbon dioxide has added in the filtered beer for increasing the sprinkling and as a preservative.

E. Product Storage

The finished product is stored at appropriate conditions in clean, refrigerant and dry place away from direct sunlight in freeze or other cooling operator to keep the product off the ground to follow and test the product quality. Storage condition is critical for developing spoilage and deterioration or poor quality of the product. Quality of the product should be monitored and the stock must be managed carefully.

Conclusion

The study concludes that the improvement of quality of malt and beer & wholesome beverage (beer) food products. As a result, during process implementation of HACCP for food safety to ensure the production of safe foods, the present

study implementation of HACCP plan for beer give possible control measure during processing steps to improve the safety and quality of products. The reduction of identified CCPs number is necessary. Current research work will be helpful for implementation of HACCP plans for malt and beer on industry/lab basis. And during the project work sanitary condition was implemented strictly, because HACCP systems are implemented in some processing steps. Such as in grain receiving, milling, mashing, fermentation, filtration, packaging and pasteurization time, these processing steps directly affected the quality of beer. The final analysis of all three variety of barley was on the basis of alcohol percentage. Highest alcohol percentage was produce from RD 2849 after then DWRB 101 and lowest alcohol percentage was produce from BH 959 variety.

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