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# PLC Programming for HACCP in Food Processing Unit

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**Abstract-** Hotels and food processing unit's deals with foods frequently, the food safety is considered to be a primary role to establish for precautions,especially the organization's involved in production of food, handling, storing and distributing. Hazard Analysis and Critical Control Points (HACCP), is a standardized methods of taking precautions in order to prevent hazards through biological, chemical, and physical approach, some food and beverage production processes can become unsafeif they are not treated properly and also with the finished product if not stored in right temperatures, a high attention is required while making preventive measures to reduce these risks.A well programmed PLC with the HACCP canreduce risk in evolving food safety issues. Food that are not managed or treated badly will give illness or even result in death of a consumer.The aim of this article is toprogram a PLC with HACCP standards to establish food safety in making Food and beverages, secondly it focuses on HACCP program which controls the whole production unit with CCP'sto avoid health hazards. The application of HACCP standards by programming it with PLC can assure the quality food products by reducing the risk of microorganisms in food.

**Keywords**: PLC Programming, HACCP, Food Pathogens, Food processing.

## 1. INTRODUCTION

HACCP acts as a powerful tool in ensuring food safety and preventing foodborne disease, mutually framed by WHO and the Industry Council for Development, Food safety is a major task for the food producers and the manufactures of processed food products. Food is a basic commodity and there is a great responsibility goes to food production companies or units for being concerned towards food safety, if it is not followed properly, then it may lead to health implications of a consumer or may also lead to severe illness[1]. Furthermore, when there is lack of attention in food production or storage will have harmful results to company name that may lead to stop the production process or to close the whole unit itself. PLC is an integral source for controlling the unit with a set of instruction for automation [2], this can be done by programming PLC using Ladder logic [3]. It is a programming language that create a graphical design based on circuit diagrams, this logical controls should be created by using HACCP to identify and avoid the potential hazards which may be associated with food during manufacturing, processing and storing.

### 1.1 *PLC Programming for HACCP*

There are many devices are used for PLC programming, one of that may be a handheld and PLC based device. In the handheld programming device method, a dedicated device is connected to PLC through a connecting cable RS-232 or RS-422. There are a set of keys that is used to enter, edit and feed the code into the PLC [3], mostly a Personal Computer (PC) is used for programming the PLC that is recommended. By using this PC we can run the program in either online or offline mode, and also easy to edit, monitor, diagnose and troubleshoot the program of the PLC with ladder logic. Ladder logic is a programming language represented by a circuit diagram [4] it will be used to program the PLC with HACCP principles in regard with food safety. HACCP principles are mainly focused to identify and analyze the potential health risks for the consumer in consumption of food which is not maintained or prepared properly, it may be due to food production method or by the temperature maintained at the time of storage. Food safety can be assured by applying the HACCP principles in food production unit[5], by programming the PLC with HACCP standards to discriminate risks associated with ingredients used in preparing food and the processing procedures during the time of food production, or by the storage of food in a food processing unit.

### 1.2 *HACCP Principles*

HACCP principles are the remedial action to avoid Food borne illness or injury, with a standardized steps in ensuring food safety by knowing and identifying the food

safety hazards in order to control and evaluate the process [5]. Hazard analysis helps in identifying proper control measures required for food production and it is mandatory to monitor the ingredients and raw materials added during the food production process [6]. To control the hazards occurs in food safety, critical control points are analyzed [7]. Critical control points can be located at any point where hazards could be prevented, eliminated, or reduced to the accepted level by programming PLC with thermal, radioactive, level and biosensors [8]. Food need to be processed with additional care because there are chances for microbial pathogens present in food and that can be destroyed with a specific temperature or heat treatment using CCP, on keeping control measures which is associated with critical limits. These critical limits will be applicable on Cooking Time, Temperature, Water level, Moisture, Preservatives, and on the Quantities of Ingredients added to the product. HACCP steps acts as a shield to stop, control or reduce the food safety hazards.

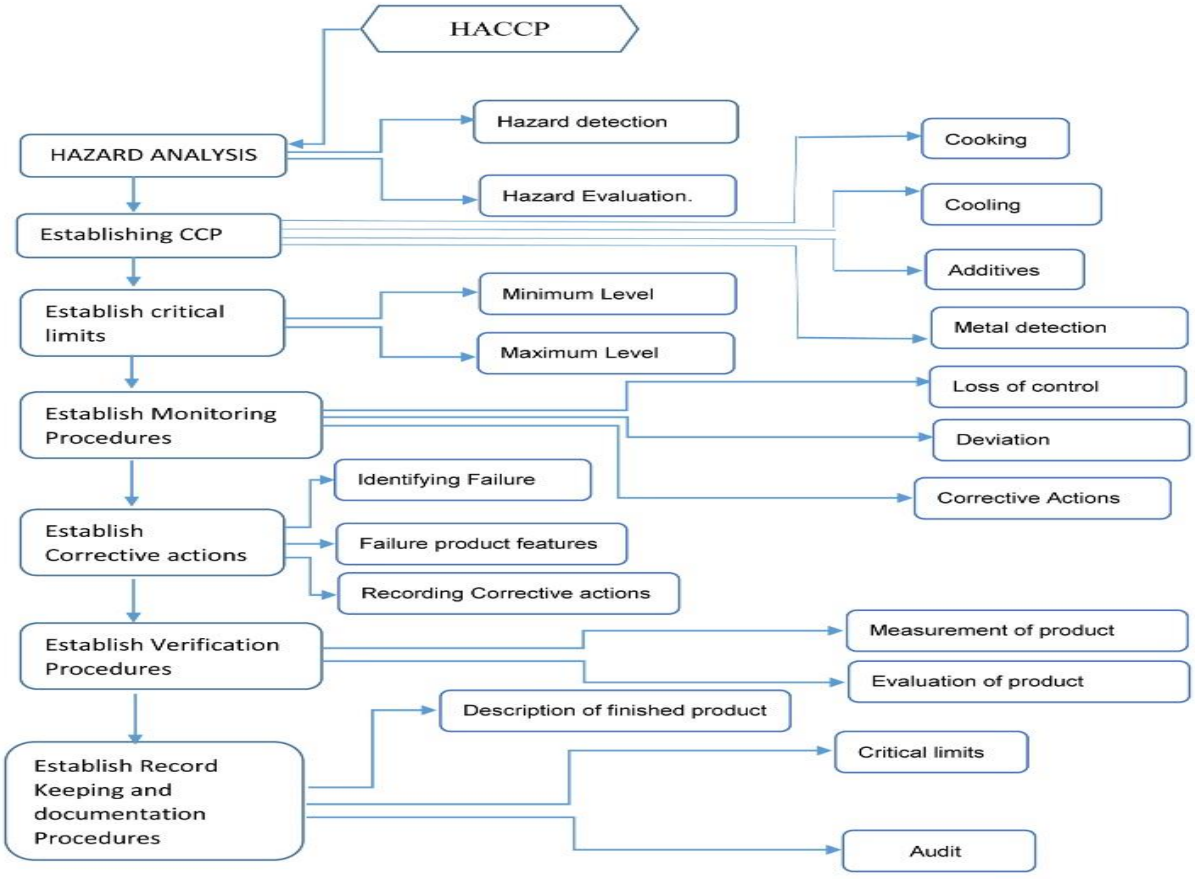


Figure 1. HACCP Chart [1]

### 1.3 *Processing Food Production with HACCP Standards*

HACCP has become an international standard in food safety assurance. Recommended or mandatory use of HACCP is found in the regulations of several countries, and governments, industries, and consumers are showing growing acceptance of the system. There are possibilities of Harmful germs present in grains like *Escherichia coli* that can spoil the wheat grain at field or during the steps in grinding flour [10]. The bacteria are killed when food made with flour is cooked. The pathogen E. coli infections linked to raw flour made and lead many to fall sick. Flour products have long shelf lives for long time even though, some perishable foods like meat and milk need to be handled carefully [11] and there is a huge possibilities of microbial organisms available in these foods when food production turn into big volume at production units and it can be controlled by automation using PLC with HACCP standards. The right temperature must be given to kill the pathogens and that can be programmed in PLC with the help of thermal sensors [12].

### 1.4 *Sensors Connected to PLC with HACCP Standards*

There are digital infrared thermal sensors are available which is used to measure the temperature of food, these digital Infrared thermal sensors has a non-contact temperature measurement component like Infra-red sensitive detector chip that can convert thermal energy in to electrical energy and also with an integrated conditioning chip to give signals [9]. This helps in monitoring the correct temperature of the food while cooking, In addition this can be programmed with a PLC to cook at the desired temperature to kill the pathogen which will be present in the ingredient of a Food. The bio sensors can identify the microbial enzymes which is produced by pathogens and acts as a defense mechanism to detect and eliminate.

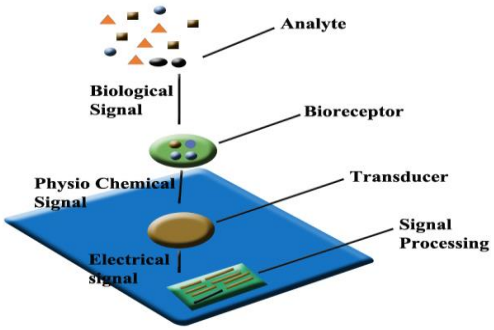


Figure 2. Biosensor Structure [13]

## 2. RESEARCH METHOD

### 2. 1 *Collection of E. coli O157:H7*

The E. coli O157:H7 iscollected from of microbiology department of VISTAS in order to conduct a test with microorganisms. E. coli O157:H7 (1258) ispreferred to carry the authentic genetic variant to typtone soy agar (TSA) by a gradual increase of 180 ppm. The rifampin emulsion 18,000 ppm is prepared by dissolving 1g rifampin in 100 mL of methanol.

### 2.2 *Preparation of Dough and storage*

The analysis is conducted to identify a serotype bacterial tissue E. coli O157:H7 present in wheat dough, and the defending mechanism of antibody rifampin withE. coli O157:H7. The prepared rifampin solution is measured with a water activitymeter 4TE (Aqua Lab Technologist, Pullman, WA). For each pathogen, around 40g of wheat dough is placed in a sterile 3500ml stomacher bag, the inoculated wheat dough is then mixed well and the stomacher 3500ml bag containing wheat dough is sealed and it is stored under 5°C and -10°C, the storage conditions recommended for a wheat dough.

### 2.3 *Statistical Analysis*

An analysis is conducted by using SAS 9.4 to measure the available data collected from the survival test of E. coli O157:H7 in wheat dough. The multiple comparisons methods were used in this program to determine the level and implication of pathogen survival under the various freezing temperatures of 5°C to -10°C in a refrigerator. The level of confidence is identified by statistical analysis is $\alpha$=0.04.

## 3. RESULTS AND DISCUSSION

To test the hypothesis that E. coli O157:H7 would survive in wheat dough and be affected by storage temperatures, which is individually inoculated with these pathogens were stored under 5°C and -10°C. The wheat dough is prepared and placed in a bag during the 24$^{th}$day testing time. The pathogen was listed by plate counting after the Survival results from plate counting is listed and found that a slow reduction in counts of E - coli is identified after addition of temperatures. The anticipation found to be correct even after the reasonable high concentrations of cells survived even after 3 weeks of storage.

The E. coli O157:H7, approximately 3.0 log10 CFU/g decrease is identified at 5°C and 2.7 log10 CFU/g reductions at -10°C. The results determines that, once the pathogen is found into wheat dough, they can able to survive in different temperatures like in low storage temperatures. Finally the survival test, approximate 3 log10 CFU/g of pathogens found after 3weeks of storage under both refrigeration and freezing temperature. This shows that the foodborne pathogens can able to survive in longer duration of time with the uncooked wheat dough.

The results of this study recommend that the ideal storage temperatures for a wheat dough but there is a little change in survival of pathogens in wheat dough after a period of time. There is reasonable large amount of E. coli O157:H7 remained even after 3 weeks of storage time, it determines that the pathogens will able to survive even in longer periods of storage, In order to eliminate them a biosensors can be used to identify and control for an appropriate cooking process.

## 4. CONCLUSION

In this study it is identified that the raw wheat dough carries microorganisms E. coli O157:H7 and that can able to survive in lower temperatures (5°C to -10°C ), this will be destroyed in specified high temperatures, due to the development of current technology that has created a broader approach in expansion and growth number of food production units and there is a huge responsibility for providing quality food products without any harmful effects after consumption, thus HACCP guides in accomplishing the objectives. The implementation of thermal and biosensors in connection with PLCs will integrates the higher possibilities to reduce physical checks in food products with available CCPs for foods a PLC can be programmed to produce a quality food product by detecting and destroying enzymes produced by microbial organisms or pathogens found in food, this will assist the food production units to deliver food with HACCP standards.

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