

## Case study

### The Design of Hazard Analysis Critical Control Point (HACCP) Plan for chicken nugget Plant

Comment [a1]: Implementation

#### Abstract

Hazard Analysis Critical Control Point or HACCP is a protective approach alarmed with not only food manufacturing but also storage safety. Now-a-days this system has become vital tool for dealings involving different types and kinds of foodstuffs. This perseverance was to established exact HACCP proposal for Bangladeshi chicken nugget manufacturing plant in a current poultry processing plant in Kishoreganj, Dhaka. A precise broad HACCP model was established to develop consumption security and quality of chicken nugget processed in this manufacturing plant. This study was based on genuine circumstances in the chicken nugget manufacturing plant, HACCP's seven principles and several current general models such as Bangladesh Standards & Testing Institution (BSTI), HALAL, ISO 9001:2015, and ISO 22000, YUM Quality Systems Audit of HACCP utilize through investigation which is also known as qualitative methodology. Under taking the consideration all factors of HACCP such as flow-chart, corrective action, verification procedures, Critical control point monitoring requirements and record-keeping were originated, a HACCP team established in the factory. Three Critical control points (CCP) were acknowledged in the manufacture of chicken nugget in this processing plant. The most important identified CCPs were Supply of ingredients and raw material; packaging material; Proper temperature and time for oil frying and proper examination during packing for foreign and unwanted materials of final product. Therefore, HACCP system should be established in each and every poultry processing facilities, recommended by author.

Comment [a2]: (HACCP)

#### Introduction

Chicken nugget is a nutritious, high protein content, easy-to-carry, long shelf life, and not very easy-to-store food product. Chicken nugget normally soft and dry, low temperature and survives rough handling which can be stored without damaging for whole years if it is kept dry and low temperature (Sulieman, Siddeg and Salih 2013). Chicken nuggets are made from HALAL chicken meat with the accumulation of all other compounds such as spices, salt, sugar, soya protein, bread crumbs and flavoring agents. Chicken nuggets enrich with high protein content which can be utilize as feeding programs for any emergency. However, the acceptance of chicken nuggets depends on their macro-nutritional, micro-nutritional and organoleptic qualities and mainly cost of production.

Comment [a3]: How long is the shelf life and at the same time not very easy to store? Please remove the conflict

Comment [a4]: Sulieman et al. 2013

Comment [a5]: utilizing

HACCP has been familiar with an effective and coherent means of convincing food safety from primary and further production through ultimate consumption, using a “farm to table” methodology. In the 1960s HACCP was developed by Pillsbury Company along with the help of the national aeronautics and space administration (NASA). HACCP was originally established for microbiological safety system as well as food preservation to guarantee food safety for astronauts. In this 60s era most food are test after the manufacturer, which is prove an ineffective method due to product discarded. Therefore, a prevention system was needed to give an extraordinary level of food safety for general purpose (Bardic 2001), (Bennet and Steed 1999), (Sulieman, Siddeg and Salih 2013). HACCP is useful to think as a preventive food safety method, and not customary quality control or assurance inspection system. HACCP did not ensure "zero risk" and does not reduce the option of any hazard getting into the food products. HACCP tries to reduce that prospect to a satisfactory level. The most successful way to active food safety is to concentration on prevention of potential hazards and to develop the process flow (Bardic 2001), (Sulieman, Siddeg and Salih 2013).

**Comment [a6]:** Please note that the reference is written in numbers according to the method used in the journal

**Comment [a7]:** Sulieman et al. 2013

**Comment [a8]:** Sulieman et al. 2013

Hazard Analysis Critical Control Points is an organized method that assists as the base for convincing food safety in the recent era. The HACCP system is aimed to be used to avoid the existence of food-borne hazards such as physical, chemical and biological hazards from manufacture through manufacturing, packing and distribution of a food products.

**Comment [a9]:** of a food product

The promise of proper manufacturing and the supply of sufficiently harmless and healthy various types of foodstuffs perform to be the key targets of the any food industry. These goals can be accrued by adopting a methodical and organizational constitution, controlling actions, procedures, monitoring and resources according to the standards which constitute the basis for total quality systems, including ISO 9000 and ISO 22000 series and the Hazards Analysis Critical Control Points (HACCP) (Rabi, et al. 2004).

Human resources and financial safety are preliminary quality demanded by HACCP. Staff training, machineries and other technical supports requires to establish HACCP as an initial input (Motarjemi and Fritz 1999).

## Materials and Methods

### Study Area

This study was implemented in a poultry processing plant in Ramadi, Kishoreganj district, Dhaka division, Bangladesh. The plant raw materials the local markets in Dhaka division and other Bangladesh states. The plant has about two hundred employees working in one shift to produce different processed poultry products. The plant has a capability to produce around fourteen thousand kilograms of raw poultry meat and five thousand processed poultry products which are ready-to-eat and ready-to-fry products per day.

**Comment [a10]:** Please rewrite correctly and give the requested meaning

**Comment [a11]:** Fourteen

The authors spent two years in the poultry processing plant in order to observe all the to final product, the employees and operators and monitor quality controlling order to design a brief HACCP plan based on the location and processing in this plant to advance the quality of processed products.

Production related data were gathered during chicken nuggets processing monitoring and verification of every steps and stages of manufacturing such as different raw materials receiving, slaughtering, and deboning, processing, storage and distribution of finished products in various selling points and stores, including all existing measures. Additional evidence was achieved from data provided by factory management and staff and food processing and engineering laboratory at Chittagong Veterinary and Animal Science University analyses records.

### **Research Method**

The determination of this study was to plan a HACCP model for conceivable performance in a concrete condition. The study coordinated a qualitative method because it provides depth and careful study of the program current situation. The study was also observed management review committee members and plant staffs behavior which was also verified such as Dealings, employee relationship and organizational behavior. It gives the interrelated details of different singularities that are difficult to carry with quantitative research methods, which is investigative and appropriate to this HACCP model study (Patton 1987).

Comment [a12]: ????

### **Study Approach**

The researchers premeditated a described HACCP plan built on the setting and manufacturing in this poultry processing plant in order to improve the quality of different poultry product. Based on the principle and several existing generic model of HACCP, the documentation and recordkeeping forms of the model in this study were planned in the following manner where it included; prerequisite program, location, premises and rooms, equipment's, product descriptions, list of product components and incoming raw materials, descript process flow diagram, hazard identification, critical control points determination and HACCP control chart.

## **Results and discussion**

### **Prerequisite Programs**

All the perquisite programs of the HACCP are considered for this study and all of them followed a common direction to achieve zero defects and ensure no health hazard occurs with the final products. Several quality control and quality assurance programs have been utilized in the plant based in food hygiene, good manufacturing practices (GMP) and total quality management (TQM).

Comment [a13]: HACCP system

### **Location**

The chicken nugget processing plant is positioned at the Kishoreganj. In Kishoreganj, there is zero risk to food security. It is far away from environmentally contaminated areas and other industrial activities. Kishoreganj has sufficient safeguard against all kinds of natural disasters.

**Comment [a14]:** located in

**Comment [a15]:** Please write the city and country name

**Comment [a16]:** food safety

### Design and layout of the processing plant

There are no sloped in the plant building or store area and all building including store warehouse are well drained to remove stagnant water which also remove waste and debris. Good manufacturing practice ensure hygiene practices which prevents cross contamination in any stages of processing. Water proof and pest proof walls are assured not only processing building but also store house and workshop. To avoid cross-contamination, facilitate easy cleaning and avoid accidents all wall and pillar angles, junctions and corners are properly sealed and rounded by aluminum and soft plastics. To drain out waters and others liquid a well-established drainage system placed in this processing plant which is surrounded all over the production floor and covered. All glass doors are well netted and auto-closing system with air-cutter are placed for every door. The floor drains are six inch deep and Effluent Treatment Plant (ETP) connects with them directly. For easily clean and sanitize certain height of walls and floors are completely covered with tiles. The plant has good lighting and ventilation systems. The doors and windows are finished with glass and well netted which covered with finished aluminum structure and several exhaust fans and air-conditioned maintain fresh and clean airflow which diminish heated vapor and thus maintain temperature and relative humidity. Qualified technician routinely

**Comment [a17]:** practice ensures

**Comment [a18]:** water and pest resistance walls

cleaned, sanitized and it checked by exist quality control team. The floor is cleaned after a fixed period of time including daily before and after production.

**Comment [a19]:** ??????

Hand washing and sanitization stations are at appropriate locations with washing and sanitizing materials. Washing room are situated in the plant building (near the processing area, handling and resting areas), and this can be create a big source of cross contamination.

The plant area has one quality control laboratory. Ante-mortem and postmortem of the chicken are performed in this laboratory including other experiments. The tests included inspection of poultry birds.

### Equipment

The equipment are made of stainless steel, plastic and all other materials that are appropriate for food industries and design structure is simply maintainable. Half yearly preventive maintenance ensures a charming running system of all equipment and cracks, rust and dents free.

**Comment [a20]:** is

### Personal Hygiene

Personal hygiene was properly established according to Good manufacturing practice and all employees strict to follow the personal hygiene instructions in a proper way according to

**Comment [a21]:** You can write the shortcut GMP directly and never repeat typing the words every time

standards of procedure (SOP). Although employees must be wear the uniform, gloves and use hairnet to cover their fingers and hair. So these cannot create a source of cross contamination of the products.

**Comment [a22]:** Please remove

The proper employee personal hygiene covers that the employees must avoid doing from placing fingers in any part of the body such as mouth, nose, and ears.

Eating or chewing foods, spitting and smoking during food handling operation also strictly prohibited. A quality control supervisor look after and keep documentation that all employees must wash and sanitize hand before start of work and when reentering their work area after visiting the washing rooms.

### **Water Supply for processing plant**

The processing plant has particular underground water supply arrangement and storage system to provide acceptable potable water for the chicken nugget processing after treatment. Portable and treated water is tested at every hour and also complied with the national water quality standard of Bangladesh legislations.

**Comment [a23]:** What are the most important tests carried out on the water to ensure its safety?

### **Storage and Transportation for finished product**

All the cold storage rooms are properly cleaned, sanitized, temperature and humidity controlled and all of them air conditioned expect civil engineering store room. Temperature and humidity of all cold storage room is monitored hourly and verified by digital thermometer and hygrometer. Several inspections of the cold storage conditions confirmed a consistent environment which is help to avoid the hazards and help produced better quality finish products. Well established transportation facilities are available. During transportation of raw materials and finished products, separation of raw and finished products and nonfood stuffs are properly monitored.

**Comment [a24]:** all cold storage rooms are

### **Sanitation Program**

A sanitary and cultural friendly environment, essential for the storing raw materials in warehousing and distribution of safe and legal final products. The sanitation program in the poultry processing plant has been accomplished properly, clean in place (CIP) for machines, equipment and tools is done accurately, so these equipment cannot be a source of cross contamination.

### **Pest Control management**

The pest control management was to remove from various types of pest and insects such as dogs, frog, rodent, insects and birds. Pest control management programs need more than traditional various insecticide spraying and traps techniques to remove pests. Now-s-days modern pest management programs are applied to control pest. This is practiced in the plant every month by the plant employees and contract service provider named "Scorpion".

**Comment [a25]:** The pest control management was carried out to

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**Comment [a28]:** rodents

### Waste management facilities for processing plant

The processing plant has its individual waste treatment facilities along with appropriate drainage, storage and dumping system. Pond, Effluent treatment plant (ETP), incineration and landfills are combined to utilize to facilities waste management system. Different specification and standards of procedure (SOP) based on international standards of ingoing waste and discharging waste water is checked and tested weekly.

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### Traceability management

Lot identification number & Batch code, incoming date of raw materials in store warehouse, production date of chicken nuggets, raw materials mixing date etc. are correctly sustained for appropriate identification and maintain traceability. All raw and packaging materials in store warehouse maintained by First in First out (FIFO).

Comment [a30]: All raw and packaging materials in store warehouse were maintained

### Training program for workers and officers

Periodic workers and officers training conducted by quality control officers for all employee an interval of two weeks. The workers and officers training covers good manufacturing practices which includes personal hygiene, work-related health and safety issues, organizational regulations, production procedures and food safety issues.

Comment [a31]: programs

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Comment [a33]: Please make sure of this two-weeks period as it is a very short period between training programs

### Product description for chicken nuggets

Product description of chicken nuggets covers complete explanation of the finished product counting relevant different safety information such as compositions of raw materials, chemical and physical structure of ingredients, microbial treatment, packaging materials, shelf-life of raw and finished products, storage condition of raw and finished products, method of distribution, material safety data sheet, it includes ingredients intended utilization (SCV, 2006). Detailed product explanation for chicken nuggets is presented in Table 01.

Comment [a34]: What is meant by that. Please clarify

Table 01. Product explanation of chicken nuggets

Comment [a35]: description

Sl. no.	Names	Conditions
01	Product name	Chicken nuggets
02	Product portrayal	A precooked small (eighteen to nineteen grams) pieces, cubic box shaped product prepared from chicken meat, sugar, soya protein, salt, spice, bread crumbs etc
03	Preparation procedure	Ready to eat, but heat ten to twelve minutes, Turn the nuggets over halfway through heating time or two minutes in micro oven is recommended
04	Packaging condition	Poly bag, Vacuum sealed
05	Shelf life of chicken nuggets	Six months
06	Selling place	Mega shop, retail store

Comment [a36]: shape

Comment [a37]: spices

Comment [a38]: The storage conditions of the product in terms of the freezing temperature shall be clarified throughout this long period

07	Distribution condition	Keep under 4°C
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### Production procedure of chicken nuggets

The incoming slaughtered and dressed whole chicken is washed by chilled chlorinated water and stored in grading bin after grading with tube ice in chilled room that maintain the temperature of the chicken at zero to four degree Celsius. The chickens are then deboned manually with knife. The room temperature must be maintained below fifteen degree Celsius and keeping the deboned meat on flake ice. The deboned meat of chicken is mechanically ground at four mm. After grinding, all meat transfer in a mixer and salt, sugar, spices, soya protein, food starch and food conditioner are added in the mixer with grinding meat. The mixing paste then formed in cubic box shaped by a filling and forming machine and drop in a conveyor belt which is carry this cubic box shaped raw nuggets in the shower of tempura and bread crumbs. Then these raw nuggets fried in the fryer for ten minutes at 100°C. The chicken nuggets are air cooled in a cold room. Vacuum packed utilized by high density color package and stored in the chilling room at chilling temperature (0 - 4°C) in a chilling room. Finally, finished products are distributed in the shops thorough refrigerated delivery van after storing the chicken nuggets for three days in the processing plant chilling room. The process flow diagram is shown in Figure 01.

**Comment [a39]:** Container

**Comment [a40]:** (0 - 4°C)

**Comment [a41]:** °C

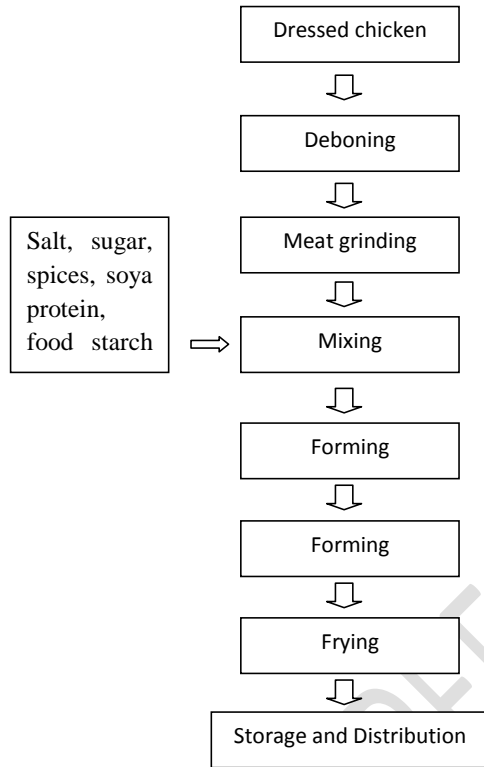
**Comment [a42]:** chickens slaughters

**Comment [a43]:** 15 °C

**Comment [a44]:** Please write in detail the grinding method

**Comment [a45]:** What is the frying method used and what type of oil is used for frying?

Figure 01. Process flow diagram of chicken nuggets



**Hazards Identification**

A hazard can be defined properly which could cause a finished product can be unhealthy eventually unsafe for human consumption (KOK 2009), (Khaliduzzaman 2005). Hazard can be classified as physical hazards (PH), chemical hazards (CH) or biological hazards (BH). Hazard identification is a two-step process for the chicken nuggets which are observe and identify the threats which can be harmful for human health by raw meat and poultry products. The hazards accompanying with all raw ingredients and incoming raw materials and chicken nuggets processing line for chicken nuggets production are shown in Table 02 and 03.

Table 02. Hazards in process ingredient and incoming raw material analysis map.

Raw Ingredients & Materials	Hazards		Preventive Measure
Raw Chicken Meat	*BH *CH	BH - <i>Escherichia coli</i> , Salmonella spp.,	Store at chilled temperature under 4°C,

**Comment [a46]:** biological hazards (BH), chemical hazards (CH) and physical hazards (PH).

**Comment [a47]:** observed

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	*PH	Salmonella aureus,., Listeria monocytogenes CH - Allergen, antibiotic residue PH - Bones >7 mm	Sanitize equipment and machine Properly, Ensured personal hygiene and handling
Salt	*PH	PH - any foreign materials	Quality: Quality Assurance assured, Store temperature: Strictly maintain below 20°C, Maintain first in first out
sugar	*PH	PH - any foreign materials	Quality: Quality Assurance assured, Store temperature: Strictly maintain below 20°C, Maintain first in first out
Soya protein	*PH	PH - any foreign materials	Quality: Quality Assurance assured, Store temperature: Strictly maintain below 20°C, Maintain first in first out
Food starch	*PH	PH - any foreign materials	Quality: Quality Assurance assured, Store temperature: Strictly maintain below 20°C, Maintain first in first out
Spice powder	*BH *CH *PH	BH - Pathogens CH - Adulterants, allergen PH - Foreign particles	Quality: Quality Assurance assured, Store temperature: Strictly maintain below 20°C, Maintain first in first out Ensured personal hygiene and handling
Na- benzoate	*CH *PH	CH - adulterants PH -any foreign materials	Quality: Quality Assurance assured, Store temperature: Strictly maintain below 20°C, Maintain first in first out Ensured personal hygiene and materials handling
Ice		No hazard as drinkable water is utilized for ice creation and processing	Ice & Water: Treated water from underground Ensured personal hygiene and handling
Bread crumbs	*BH *CH *PH	BH - Pathogens CH - Adulterants, allergen PH - Foreign particles	Quality: Quality Assurance assured, Store temperature: Strictly

Comment [a49]: Staph. aureus

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			maintain below 20°C, Maintain first in first out Ensured personal hygiene and material handling
Packaging Materials	*CH *PH	CH - ink PH -any foreign particles inside	Ink & material: Food grade, Quality: Quality Assurance assured, Store temperature: Strictly maintain below 20°C, Maintain first in first out Ensured personal hygiene and handling

\*BH = Biological hazard  
 \*CH = Chemical hazard  
 \*PH = Physical hazard

Table 03. Hazards analysis chart for chicken nuggets processing steps

Processing steps	hazards		Preventive measure
Raw Material: Slaughtered and dressed chicken store in cold storage	*BH *CH	BH - Escherichia coli, Salmonella spp., Salmonella aureus, Listeria monocytogenes CH - Allergen, antibiotic residue	Machines and equipment properly setting, clean, sanitize and dry all the transfer equipment under 4°C, Ensured personal hygiene and handling
Deboning	*BH *PH	BH - Pathogen by contamination: Salmonella aureus PH - Bone	Clean, sanitize and dry associated equipment below 12 °C, Ensured personal hygiene

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			and handling
Grinding	*BH *CH *PH	BH - Pathogen from grinder CH - Sanitizer, cleaning agent PH - Bone	Clean, sanitize and dry associated equipment below 12 °C, Ensured personal hygiene and handling
Mixing	*BH *CH *PH	BH - Pathogen from grinder CH - Sanitizer, cleaning agent PH - Bone	Clean, sanitize and dry associated equipment below 12 °C, Ensured personal hygiene and handling
Forming	*BH *PH	BH - Pathogen from former CH - Sanitizer, cleaning agent	Ensured personal hygiene Clean, sanitize and dry associated equipment
Frying	*BH	BH - Pathogen if not killed	Frying temperature above 100°C, Cooking time: 10 min
Cooling		No hazard	Cooling Procedure: Air Cooling Using clean, sanitized and dry equipment
Packing	*PH	PH - Any foreign particle enter	Proper packer machine setting, Sanitize and dry the container, scale and tools, Proper personal hygiene and handling
Cold storage & Distribution	*BH	BH - Growth of pathogen	Storage condition: Clean and under 4 °C, Distribution: delivery truck should be clean and maintain below 4 °C

### Critical Control Point (CCP) Determination

Critical Control Point is a major step at which it is important that a particular control measure is functional to eliminate or prevent a food safety hazard which is reduce the risk to a satisfactory level (Khaliduzzaman 2005). The frying temperature taken as a Critical Control Point (CCP) as core temperature of product verify the suitability of the cook (Khaliduzzaman 2005) (Alimentarius 2005). From figure 01 we found the decision tree which is utilize to categorize the Critical Control points (CCPs) for raw ingredients which is shown in Table 04. From figure 02

**Comment [a58]:** verifies

we have the decision tree which is utilized to identify CCPs for processing steps which is discussed Table 05.

Critical Control Point identification instruction:

Question 01: Raw materials associated with any kinds of hazards?

If answer is No, then it is not a CCP, if answer is Yes, proceed to Question 02.

Question 02: Are any kind's hazards going to process?

If answer is No, CCP, if Yes, proceed for Question 03.

Question 03: Any risk of cross-contamination to the facility or to other products which cannot be controlled?

If answer is No, not a CCP, if answer is Yes, then it will be a Critical Control point (CCP).

Table 04. Chicken nuggets ingredients Decision Matrix

Raw material and hazards	Kinds of Hazard	Question 01	Question 02	Question 03	Critical Control point	Remarks
Chicken Raw Meat						
BH	Pathogen	Yes	Yes	No	No	Microbial hazards eliminate by steam cooking
CH	Antibodies	Yes	Yes	No	No	Proper chlorine washing, underground water quality
PH	Foreign Materials	No	-	-	No	Proper Physical Inspection, Personal Hygiene and good manufacturing practice
Salt						
PH	Insect fragment, hair etc	Yes	Yes	No	No	Pest control management, Personal hygiene, Physical inspection
Sugar						
PH	Insect fragment, hair etc	Yes	Yes	No	No	Pest control management, Personal hygiene, Physical inspection
Soya protein						
PH	Insect fragment, hair etc	Yes	Yes	No	No	Pest control management, Personal hygiene, Physical inspection
Food starch						
PH	Insect	Yes	Yes	No	No	Pest control

	fragment, hair etc					management, Personal hygiene, Physical inspection
Spice powder						
BH	Pathogen	Yes	Yes	No	No	final cooking process, Personal Hygiene, good manufacturing practice and food storage
CH	Adulterants	Yes	No	-	Yes	Quality Product supply can be critical
PH	Foreign Materials	Yes	No	-	Yes	Quality Product supply can be critical
Na- benzoate						
CH	Adulterants	Yes	No	-	Yes	Quality Product supply can be critical
PH	Foreign Materials	Yes	Yes	No	No	Personal hygiene, Physical inspection
Bread crumbs						
BH	Pathogen	Yes	Yes	No	No	Final cooking process, Personal Hygiene, good manufacturing practice and food storage
CH	Adulterants	Yes	No	-	Yes	Quality Product supply can be critical
PH	Foreign Materials	Yes	No	-	Yes	Quality Product supply can be critical
Packaging Materials						
CH	Adulterants	Yes	No	-	Yes	Quality Product supply can be critical
PH	Foreign Materials	Yes	No	-	Yes	Quality Product supply can be critical

Instructions for identification of critical control points:

Question 01: Does this step include a hazard of adequate risk and sternness to warrant its control?

If answer is Yes, proceed for Q2, if answer is No, not a CCP.

Question 02: any preventive measure can be hazard exist in this step? If answer is Yes, Proceed for Q3, if answer is No, proceed for Q2a.

Question 02a: Safety is control at this step necessary? If answer is Yes, modify the step, process or product, if answer is No, not a CCP.

Question 03: Prevent the risk to the safety level of the hazard to consumers is necessary?

If answer is Yes, CCP, if answer is No, not a CCP.

Table 05. Hazards in chicken nuggets Processing and CCP decision matrix chat analysis

Process step	Kinds of hazards	Question 01	Question 02	Question 03	Critical control Point	Remarks
Raw meat storage						
BH	Pathogen	Yes	Yes	Yes	Yes	Storage time critical. Temperature is critical, Personal Hygiene
CH	Antibiotics, Sanitizer and Cleaner	No			No	Prerequisite program: Water quality, Sanitation system
PH	Foreign particles	Yes	Yes	No	No	Prerequisite program: Personal Hygiene, pest control management
Deboning						
BH	Pathogen	Yes	Yes	Yes	Yes	Proper Temperature hinder the bacterial and fungal growth
CH	Antibiotics, Sanitizer and Cleaner	No			No	Prerequisite program: Preventive maintenance & cleaning, Sanitation system.
PH	Foreign particles	Yes	Yes	No	No	Prerequisite program: Pest control management, Personal Hygiene.
Grinding						
BH	Pathogen	Yes	Yes	No	No	Proper Temperature prevent the bacterial and fungal growth
CH	Sanitizer and Cleaner	N			No	Prerequisite program: Preventive maintenance & cleaning, Sanitation system.
PH	Foreign particles	Yes	Yes	No	No	Prerequisite program: Pest control management, Personal Hygiene.
Mixing						
BH	Pathogen	Yes	Yes	No	No	Personal Hygiene, pest control, maintenance & cleaning
CH	Sanitizer and	No			No	Prerequisite program: Preventive maintenance &

	Cleaner					cleaning, Sanitation system.
PH	Foreign particles	Yes	Yes	No	No	Prerequisite program: Pest control management, Personal Hygiene.
Forming						
BH	Pathogen	Yes	Yes	No	No	Prerequisite program: Sanitation system
PH	Foreign particles	Yes	Yes	No	No	Prerequisite program: Pest control management, Personal Hygiene.
Frying						
BH	Pathogen	Yes	Yes	Yes	Yes	Correct frying temperature is critical, Correct frying time is critical, Prerequisite program: Treated water quality
Packing						
BH	Pathogen	No			No	Prerequisite program: Personal Hygiene & Sanitation system
PH	Foreign particles	Yes	Yes	Yes	Yes	Foreign materials presence is critical
Storage & Distribution						
BH	Pathogen	Yes	Yes	Yes	Yes	Storage & Distribution: Temperature is critical, Time is critical

Na- benzoate, packaging materials and spice powders is account as critical because this products contain are heat sensible chemical particles and components which is very common adulteration in Bangladesh. Physical hazard in packaging material and spice powder and microbial hazard in packaging material are considered as critical. Microbial growth in raw meat which result off – flavor and off – color is very important and a critical point for storage temperature. The time and temperature of frying, core temperature is very critical point for cooked chicken nuggets due to destroying of pathogens. To maintain product color and prevention of microbial growth, vacuum packaging is very useful. Metal detection system eliminates the presence of foreign and metal materials. Storage and distribution temperature is critical to acceptance with customer acceptability and shelf-life.

#### **HACCP Control Chart**

Table 06 shows all the potential critical hazards such as physical, chemical and microbial hazards that can occur during the manufacturing steps in this chicken nuggets plant which is

named as HACCP control chart. This chart includes number not only critical control point but also control point, critical limits for each control, monitoring procedure for critical points and frequency, preventive and corrective action for various critical points, records and responsible person in the desired points. The potential identified control points of the hazards can be seemed in raw material and the process. From previous study, we found hazard description associated to the product, critical limit for each critical control point, observation procedure, responsible person for control points, monitoring procedure and corrective actions for critical control points in the HACCP control chart (Khaliduzzaman 2005), (Gandhi 2009). Codex Alimentarius Commission also gave significance to include monitoring procedure and documentation of different parameters in HACCP plan for meat and meat related products (Khaliduzzaman 2005). Three Critical Control Points (CCPs) and two Control Points (CPs) were identified for this chicken plant such as qualified and assured supply of raw material and primary packaging material, Correct storage temperature and time for raw deboning meat, Proper temperature and time for frying of chicken nuggets, Proper inspection and metal detection during packing for foreign and metal materials and Proper storage temperature and distribution temperature and time of finished chicken nuggets.

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Table 06. HACCP control chart for chicken nuggets production

Process Step; CCP No	Hazards	Critical Limits	Monitoring Procedure	Frequency	Preventive measure	Corrective action	Record	Responsible person
Raw ingredients & Packaging Material ; CCP#1	Microbial Chemical & Physical Contaminations	Pure product to be used	Apply supply quality control or assurance	Each supply from supplier	Test raw material supply; Checked MSDS; Approved Supplier List and review; Specification of the material	Change supplier or brand in interval; Employee Training for raw material testing	Materials Receiving & testing report	Assigned receiver (QC/QA)
Raw Meat Storage; CP#1	Microbial growth	Under 4°C Max. Four days	Temperature log is properly monitor	Routinely (Every hour)	Proper storage temperature and time	Reject the raw Meat and incinerate	Temperature log sheet; Destroy	Assigned executive (QC/QA)



Frying; CCP#2	Survival of Pathogens	Cooking temperature 100°C	Check the Cooking Time and core temperature; Follow up the time and temperature and record keeping	Each Batch	Check The Core Temperature of product	Adjust the temperature and time by setting the equipment; Call the Maintenance team to repair	Time and Core Temperature of product log; Maintenance register	Assigned executive (QC/QA)
Packing; CCP#3	Physical contamination	No foreign material ; No leakage	Metal detection system; Visual Inspection by packing Supervisor	Each Pack	Personal hygiene and physical inspection	Retain, rework or discard based foreign material identified	Metal detection system report, Inspection Report	Assigned executive (QC/QA)
Storage & Distribution; CP#2	Microbial Growth	Under 4°C Max. Shelf- life six months	Check the storage temperature and shelf- life and record keeping	Every day	Check the time and temperature	Retain or reject based on product testing by panelist	Temperature log; Delivery report	Assigned executive (QC/QA)

### Conclusions

To achieve and improve product safety and qualified product, this qualitative study helps to design and verify a HACCP appropriate model for chicken nuggets. The seven principles and the objectives of HACCP is utilized to establish the chicken nuggets model. Simplify the HACCP plan, the prerequisite program such as location, equipment, water supply etc. was ensured to

minimize hazards earlier the production. In this study, utilizing product description to alert the purchaser and supplier to the potential hazards in the finished products. Then, the probable identified control points of the hazards may be emerged in the raw material besides the procedure along with various prevention steps and measures. In decision trees, answering the questions, critical control points were identified. Finally, including all components of HACCP principles we establish a HACCP control chart. In this study three CCPs were identified and found in the manufacture in this chicken nuggets in plant, which was Supply of various raw material and primary packaging material; proper time and temperature for oil frying and proper observation and inspection during packing for foreign and metal materials of final product.

#### COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

#### References

Alimentarius, Codex. *HACCP. CODE OF HYGIENIC PRACTICE FOR MEAT*. CAC/RCP 58, Codex Alimentarius, 2005.

Bardic, A. "HACCP ready." *Dairy Field* 184 (2001): 6.

Bennet, L, and L Steed. "An integrated approach to food safety." *Quality Programme* 32 (1999): 37-42.

Gandhi, A. P. "Development of HACCP protocols for the production of soy milk." *Asian Journal of Food and Agro-Industry* 2, no. 3 (2009): 262-279.

Khaliduzzaman, Alin. "The design of HACCP plan for chicken ball plant in Bangladesh." *Journal of Hygienic Design and Engineering*, 2005.

KOK, M. SAMIL. "Application of Food Safety Management Systems (ISO 22000/HACCP) in the Turkish Poultry Industry: A Comparison Based on Enterprise Size." *Journal of Food Protection* 72, no. 10 (2009): 2221-2225.

Motarjemi, Yasmine, and K. Käferstein Fritz. "Food safety hazard analysis critical control points and the increase in foodborne diseases: A Paradox?" *Food Control* 10, no. 4-5 (1999): 325-333.

**Comment [a61]:** References must be written in a correct and unified manner for all according to the system used in the journal

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**Comment [a63]:** Journal data and page numbers not found

Patton, MQ. *How to use qualitative methods in evaluation*. Newbury Park, California: SAGE Publications, Inc., 1987.

Rabi, A., A. Banat, R. R. Shaker, and S. A. Ibrahi. "Implementation of HACCP system to large scale processing line of plain set yogurt." *Italian Food and Beverage Technology* 35 (2004): 12-17.

Sulieman, Abdul Moneim E, Helba M. Siddeg, and Zakaria A. Salih. "The design of Hazard Analysis Critical Control Point (HACCP) plan for biscuit plant." *Food and Public Health*, 2013: 240-246.

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