International Scholars Journals

Global Journal of Food and Agribusiness Management ISSN 2756-343X Vol. 2 (5), pp. 001-006, May, 2011. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Comprehensive haccp strategies for reducing incidence of food poisoning (salmonella prevalence) in ready-to-eat-broiler chicken

***Joel Ndife[1], S.C. Egege,[2] and G.O. Komolafe[1]**

[1]Dept. of Food Technology, Kaduna Polytechnic, Nigeria.
[2]Dept. of Veterinary Public Health, Ahmadu Bello University, Zaria, Nigeria.

Accepted 13 April, 2011

In order to reduce the prevalence of *SALMONELLA* on ready-to-eat chicken, a number of approaches have proven useful, as there is no one stop solution available in practice. The use of the HACCP (Hazard Analysis Critical Control point) approach, based on the use of multi-functional strategies which combine the innovative use of sanitizers and modern disinfection techniques supervised by professional food handlers and food regulators with a visionary commitment by management from the production, through the processing, preservation, handling and final preparatory stages, will surely help to eliminate or reduce significantly the prevalence of salmonella and the consequent food poisoning effects in the society.

Key words: Pathogen, *Salmonella*, Broiler, Food poisoning, Hazard analysis, Hygiene.

INTRODUCTION

Meat and poultry products are sensitive to microorganism contamination by bacteria, viruses and parasites. Poultry have been recognized as an important source of human infection with salmonellas ever since they started to be intensively reared and processed on a large scale in order to provide a cheap source of meat. After becoming contaminated, meat and poultry products provide an excellent environment for growth of bacteria. Bacterial contamination and growth is a problem because it may result in foodborne illness (Corry *et al.,* 2002). *Salmonella*, a major foodborne pathogen found in poultry products, remains a serious problem for poultry processors. Over the past years, it has been recognized as an important cause of human illness. Disease surveillance data indicate that salmonella affects about 2.5 million people every year and due to the epidemiological significance of *Salmonella* food poisoning, huge funds are needed for the control of *salmonella* in poultry (CDC, 2000).

In many developing countries diarrhea is a common cause of morbidity and ready-to-eat foods have been implicated in salmonellosis (Silvia *et al.*, 1987; Bolat, 2002).). Salmonella food poisoning can occur when someone eats undercooked chicken.

Although microbial testing of food is a very important tool in ensuring food safety, such testing has the disadvantage that it takes time and it often detects problems only after they occurred.

In preventing food born diseases it is required to understand where the food borne disease originated and how food processing and storage can increase the risk of disease. Once these factors are understood, steps can be taken to ensure that such risks are minimized. Good manufacturing practice (GMP) is meant to ensure that the end product is safe, of high quality and complies with relevant standards. To improve product safety, the meat and poultry industries are adopting a process control system known as “hazard analysis critical control point,” (HACCP). The HACCP system improves product safety by anticipating and preventing health hazards before they occur. A 1985 report from the National Academy of Science Food Protection Committee suggested that HACCP was the most effective method for ensuring food safety (Bashor *et al.,* 2004). In 1996, the United States Department of Agriculture Food Safety and Inspection Service (USDA-FSIS) passed a new regulation known as

*Corresponding author E-mail: jothel2000@yahoo.com

the “FSIS Pathogen Reduction/HACCP Regulation,” which requires meat and poultry plants to use HACCP in their operations (USDA-FSIS, 2001).

This publication serves to give information on the application of HACCP strategy to eliminate the prevalence of salmonellas at all stages of poultry production from hatchery through processing to the final handling and preparatory stage. Poultry producers and processors that are already using a HACCP program will find the technical information in this publication useful as they monitor their programs and train employees on the principles and application of HACCP.

HACCP which is Hazard Analysis and Critical Control point (system) is an approach to food manufacture and storage in which raw materials and each individual step in a process is considered in detail and evaluated for its potential to contribute to the development of pathogenic microorganisms or other food hazards because they are leading causes of food borne diseases. Critical Control Point (CCP) is an operation, by which a preventive or control measure can be exercised that will eliminate, prevent, or minimize food hazards (Onuorah *et al.*, 2003).

Principles of HACCP

There is no unanimous agreement on all details of HACCP, but in general a series of principles or steps have been developed viz:

Hazards associated with growth, harvesting raw materials, ingredients, processing, manufacturing, distribution marketing, preparation and consumption are each assessed in detail. Areas of microbial, mechanical or physical contaminant are determined.

The critical control points for controlling each hazard listed above are identified. Those steps in the process which control result in an unacceptable health risk are considered as critical control points, careful control of the points must be maintained in order to ensure the safety of the product(s).

Salmonella food poisoning

Salmonella infection is a type of food infection, whereby large numbers of these bacteria are ingested when they are allowed to multiply in foods which stand for some hours in a warm room in sufficient numbers. These bacteria will develop in the food to produce symptoms when consumed thus causing Salmonellosis (Bolat, 2002).

The onset of the illness occurs usually within 6-24 hrs of eating the food. The symptoms are characterized by fever, headache and general aching of the limbs as well

as diarrhea predominantly and vomiting. Other symptoms include watery, greenish and foul smelling stool.

Even if *salmonella*-containing foods such as chicken are thoroughly cooked, any food can become contaminated during preparation if conditions and equipment for food preparation are unsanitary (Bolat, 2002).

Characteristics of salmonella

Salmonella are gram-negative, non spore-forming rods that ferment glucose but usually do not ferment lactose. They grow well at room temperature but their optimum is about 37^{O}C and they grow in low acid foods. The organisms of the salmonellae include those that cause enteric fever like *S. paratyphi* A, B and C and those that are agents of food poisoning like *Salmonella enteritidis*.

Sources of *Salmonella* include human beings and animals, but the more important food sources are poultry and their eggs. The organism may come from actual cases of the disease or from carriers. Animal feeds containing fish meal, meat meal and blood meal are the original sources into the animal/poultry foods (Ezeama, 2007).

The Detection And Enumeration

Laboratory procedures, using *Salmonella-Shigella* selective medium are employed for the detection of *Salmonella* species and in some cases the identification of the toxin and test for pathogenicity are necessary to explore the roles of the pathogen. In advanced identification, typing of bacteria is done to provide definitive proof of the causative agent (Jay, 1987; Whyte *et al.,* 2003).

Salmonella control

To reduce the prevalence of *Salmonella* on poultry carcasses during processing, intervention strategies should be initiated from the feed mill and subsequent controls put in place during the initial breeding, hatching, growing and transportation phases before the processing and preparation of the ready-to-cook chicken (Corry *et al*., 2002).

The Feed Mill

Many feed mills are sources of *salmonella* contamination, when vehicles are allowed to move beyond the boundaries designated for “clean and dirty” areas of the factory. Trucks used previously for loading raw materials could also be used in loading feed products thereby spreading the contamination. At the feed processing stage microbes can be introduced by cross-contamination from another raw agricultural product or

from infected humans handling the food (Whyte *et al.,* 2003).

Salmonella in the feed mills can be controlled by paying particular attention to dusts and raw materials, especially from animal sources such as fish meal, meat and blood meals which are potential carriers. Vectors of *Salmonella* such as rats, mice, insects, humans, pigeons and other wild birds are greater risks (Corry *et al.*, 2002). The solution lies in explaining the rules of clean and dirty demarcation principles to the staff involved and the need to work according to the rules of factory hygiene/sanitation (Scott, 2002; Whyte *et al.,* 2003).

Hatching

Some of the strategies for elimination of *Salmonella* in the hatching process would include: installing a disinfectant fogging system or electrostatic spraying system in the hatchery plenum setters and hatchers. The spraying should be done every 30 minutes, during setting and hatching to prevent cross contamination and hatchery should be cleaned and sanitized using sanitation standard operating procedures (SSOP) (Cason *et al.,* 1994).

Grow-Out

The voracious nature of growing birds could prove a disadvantage for maintaining the sanitary quality of the bird during processing. As a result of feed withdrawal prior to processing, the birds become hungry and begin to search for food on the floor which may be contaminated. This activity has increased the level of pathogenic microbes and in particular salmonella on processed carcasses (Ikeme, 1990).

Crop Disinfection

Salmonella in the crops of the birds could break out during the processing stage thus, spreading to the exterior and interior of the carcass. The suggestions for eliminating salmonella in the crop prior to processing would involve applying lactic acid to drinking water of chickens before the feed withdrawal period and ensuring that the pH of their crops, at the plant are being acidified (Scott, 2000).

Coop Disinfection

The transportation coops, must be thoroughly washed and sanitized. All dry excreta should be removed before washing if possible, if not, it could lead to a rehydration of the left over excreta, allowing salmonella to proliferate. If disinfection systems are used, they must be capable of thoroughly removing excreta prior to sanitizing the coops (Sheridan, 1998).

Sanitation

It is mandatory that all poultry and related companies operate using guidelines spelt out in their SSOP manual (Whyte *et al.,* 2003). These SSCP describe exactly how each piece of equipment and processing areas (walls and floors) should be cleaned and sanitized. Equipment surfaces should be clean and free of processing residue. New sanitation monitoring systems should replace old, out-dated and ineffective methods for determining the sanitary status of equipment in use. Traditional swabbing methods which are slow (48 hrs), expensive, inaccurate and ineffective should be replaced by more efficient modern ones (Ikeme, 1990; Corry *et al.,* 2002).

Processing Operations

Incoming Birds.

If birds coming into the plant are dirty, a brush system with a pressurized, chlorinated rinse should be installed to remove foreign materials. Excessive contamination early in the process can lead to contamination of equipment downstream (Cason *et al*, 1994). Salmonellae were frequently isolated from air samples where live-birds carrying the organisms were handled. Air must be going out of the factory as positive pressure displacement otherwise, all contaminant outside will be pulled into the plant. Other measures will be to ensure that all in-coming air is clean and at a controlled temperature (Davies *et al*, 2000).

Scalder

The scalder is one of the most important areas in the processing plant in which cross contamination occurs. The water flow must be counter-current, as opposing water flow is essential to wash the birds and remove contamination from the birds as they travel through the scalder. The rate of water flow should be high, so as to dilute the concentration of foreign material and bacteria in the scalder. The water where the birds are kept should be fairly clean. The water scalder temperature should be as high as possible without causing breast stripping (Bashor *et al*, 2004)

Feed withdrawal

Prior to evisceration carcasses should be evaluated to determine if birds have undergone proper feed

Table 1. Prevalence of potential human pathogenic bacteria in raw poultry reported by different research groups between 1971-1995 (USDA-FSIS, 2001).

MICROORGANISM	PREVALENCE (%)
Campylobacter jejuni	0-100
Clostridium perfringes	63
Clostridium botulinum	0.3
Escherichia coli	1.5
Samonella spp.	0-100
Staphylococcus aureus	7-88
Listeria monocytogenes	5-60
Yersinia enterocolitica	8

withdrawal by examining the abdominal cavity to see if it is concave, indicating small amount of faeces in the intestine or vice versa. If birds are not held off feed for less than 8 hrs, the intestines will be full of digesta, which can spill and increase contamination of the carcass processing equipment and environment. To reduce salmonella prevalence on processed carcasses, every effort must be made to reduce contamination in the field and during processing (Izat and Waldroup, 1989).

Venter/Opener/Eviscerator

If these equipments are misadjusted, nicked or cut, intestines may cause the spread of contamination. Make sure these pieces of equipment are well adjusted to prevent contamination (Corry *et al*, 2002).

Cropper-Carcasses

The cropper should be evacuated to ensure that it is properly cleaned and sanitized before they are ready to enter another carcass. This will help reduce cross contamination. The cropper should be rinsed with chlorinated high pressure sprays (Hargis *et al*, 1995).

Washers and Rinses

The inside/outside bird washers (BW) and all other washers or rinses should be checked frequently to determine levels of pH, ammonia, contaminants, hardness, pressure, and distribution. SSOP-guidelines stipulate that proper nozzle pressures be maintained, with proper water pH and chlorine level. At pH 8.0, chlorine is not found in its active form (hypochlorous acid) in high quantities and is ineffective for killing bacteria. If ammonia from city water is made to contact chlorine used in the plants, trichloramines with noxious odours are formed. Well and city water should be evaluated for chemical and biological contaminants present before use. Water hardness should be controlled because salts contained in hard water can make some disinfectants ineffective (Okrend *et al*, 1986).

Chiller

There should not be a re-use of water for ice formation without adequate treatment. Fresh ice should be carefully stored and transported to avoid contamination prior to being used on the product. This is done by using covered augers to prevent cross-contamination by staff (Izat and Waldroup, 1989). Ice chutes/conveyors should be evaluated frequently for microbial contamination using psychrotrophic plate counts. Additional bacterial reduction can be accomplished in a properly balanced chiller than anywhere else in the processing plant (Bashor *et al* 2004).

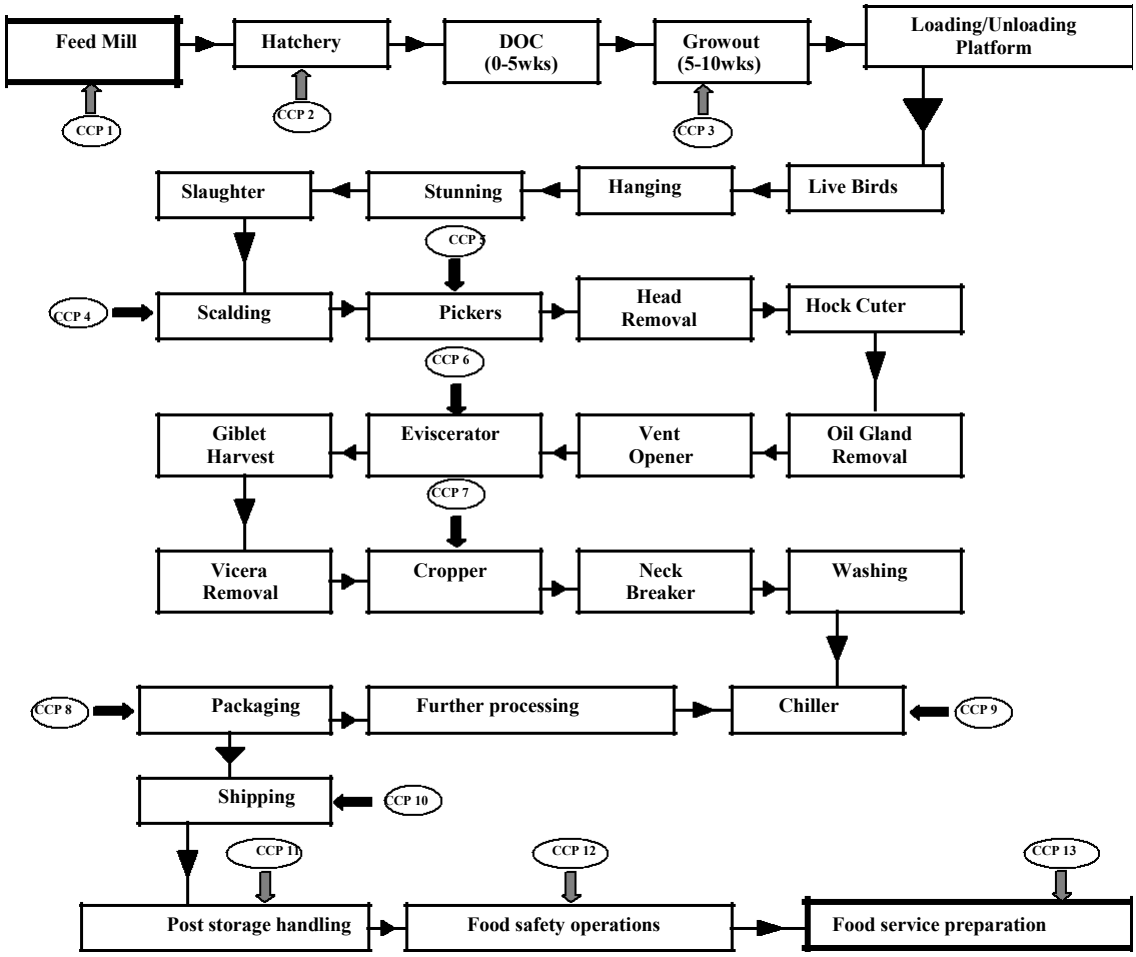
Employee hygiene

All plants should be equipped with mandatory hand washing/sanitizing stations that are refreshed frequently. There should be no access to rest rooms directly from the processing floor. Each employee should begin his/her shift with a clean uniform, hairnet and gloves (Corry *et al*, 2002).

Examine employees daily for illness, and send visible sick ones home. Briefly interview employees returning from leave of absence to determine, if they have any food-borne illnesses. Strategies for controlling the hygiene of personnel include the control of personnel flow so that they do not easily move from raw material to finished product areas (Soliman, 2004). The managers must ensure that the standard operation procedures spelt out for each area and personnel are implemented. The manager should also train employees regularly concerning proper hygiene (Soliman, 2004; Potter and Hotchkiss, 2006).

HACCP Rules On Food Service Handling Of Ready-To-Eat Chicken

Certain practices frequently contribute to the causation of disease outbreaks during food services operations especially by salmonella. Generally food poisoning may result from:



HACCP Design Reference Chart

	UNIT OPERATIONS	ACTIONS TO BE TAKEN
	PRODUCTION	
1	Feed	Ensure *salmonella* - free rations, avoid meat/fish/blood meals and avoid cross contamination.
2	Hatching	Ensure *salmonella* free DOC. Vaccination of birds.
3.	Grow-out	Avoid scavenging. Farm sanitation and personnel hygiene very important.
4	Farm Yard	Establish biosecurity measures and flock health program.
5.	Medication	Should be administered based on labels.
6.	Transportation	Should be done in coops and trucks, decontaminated between flocks.
	PROCESSING	
1.	Plant Operations	Follow plant operating (SSOP) guidelines.
2.	Facilities and Equipments	Must be kept clean, in good repair and washed after use.
3.	Water	Must be of portable quality.
4	Sanitizers & Disinfectants	Must meet legal requirements and be effective.
5.	Air supply	Must be pathogen free
6.	Employee Hygiene	Staff must be healthy
	POST-PROCESSING	
7.	Storage	Store in conditions unfavourable to microbial growth.
8.	Handling	Adopt strategies unfavourable to microbial growth.
9.	Food service operations	Adopt WHO Golden rule for food safety.

(a) Improper cooking
(b) Improper hot holding
(c) Foods from unsafe sources
(d) Improper cleaning of equipments and utensils
(e) Cross contamination from raw to cooked foods
(f) Inadequate cooking
(g) Colonized/infected persons handling foods
(h) Inadequate reheating of food and lapse of 12 or more hours, between food preparation and food consumption (Scott, 2000; Tamer, 2002).

Most if not all of the Salmonella food poisoning will be prevented, minimized or totally eliminated if the world health organization (WHO) golden rules for safe food handling and preparation are strictly followed (Ezeama, 2007). Preferably processed foods should be chosen for safety reasons, while for raw foods the following additional steps should be adopted:

1. Cook food thoroughly.
2. Eat cooked food immediately.
3. Store cooked food carefully either hot above 60oC or near below 10oC).
4. Reheat cooked food thoroughly not below 70oC.
5. Avoid contact between raw food and cooked food
6. Wash hands repeatedly.
7. Keep all kitchen surfaces meticulously clean.
8. Protects foods from insects, rodents and other animals.
9. Use pure water always.

Management

It is important to employ qualified and highly experienced manager/coordinator, to review and effectively upgrade the current guidelines in operation. The person must be familiar with the principles of HACCP, backed up with adequate food safety qualifications. The upper management must support all his initiatives and strategies for effective implementation to reduce or eradicate the prevalence of Salmonella (Hoffman and Mcwilliams, 2007).

CONCLUSION

Numerous studies are being conducted by the poultry industry, associations, research and safety enforcement bodies, in attempting to devise solutions to food poisoning by salmonellae. The application of HACCP guidelines, coupled with the use of innovative sanitizers and disinfection processes as well as commitment on the part of various operators in the production, processing and preparation of ready-to- eat broiler chicken, will dramatically reduce if not eliminate the prevalence of and level of salmonella on processed and ready-to-eat-broiler chicken and at the same time reduce the incidence of food poisoning in the society at large. The safety of foodstuffs needs to be ensured by a preventative approach covering product and process design and applying internationally recognized industry standards such as Good Hygiene and Manufacturing Practices (GHP and GMP) and Hazard Analysis Critical Control Point (HACCP) principles.

REFERENCES

Bashor M, Curtis P, Keener K, Sheldon B, Kathariou, S and Osborne J (2004). Effects of Carcass Washers on Campylobacter Contamination in Large Broiler Processing Plants. Poultry Science. 83:1232–1233.

Bolat T (2002). Implementation of the Hazard Analysis Critical Control Point (HACCP) System in a Fast Food Business. Food Reviews International. Vol. 18, No. 4, p. 337–371.

Cason JA, Barley JS, and Cox NA (1994). Location of Salmonella typhimurium during incubation and hatching of broiler chicks. Avian J. 38: 583 – 588.

Center for Disease Control. (1999). Salmonella Surveillance: Annual summary: (1998). U.S. Dept. of Health and Human Services. Atlanta.

Corry J, Allen V, Hudson W, Breslin M, and Davies R, (2002). Sources of salmonella on broiler carcasses during transportation and processing: modes of contamination and methods of control. J. Applied Microbiol. 92: 424-432.

Davies R, Breslin M, Corry J, Hudson W and Allen VM (2001). Observations on the distribution and control of Salmonella enterica in two integrated broiler companies. Veterinary Record. 149: 227-232.

Ezeama CF (2007). Food Microbiology. Fundamentals and Applications. Natural Prints Ltd. Lagos.

Hargis BM, Caldwell DJ and Deloach J (1995). Evaluation of Chicken Crop as a source of Salmonella contamination of broiler carcasses. Poultry Sci. 74: 1548 – 1552.

Hoffman M and McWilliams A (2007). Using expert elicitation to link food borne illnesses in the U.S. to foods. J. Food Prot. 70 (5): 1220-9.

Ikeme AJ (1990). Meat Science and Technology. Africana FEP Publ. Ltd. Zaria.

Izat L and Waldroup H (1989). Production and Processing studies to reduce the incidence of Salmonella on Commerical broilers. J. Food Protect 52: 67-673.

Jay MJ (1987) Modern Food Microbiology. 3rd ed. CBS Publishers and Distributors. Delhi, India.

Okrend AJ, Johnston RW and Moran AB (1986). Effect of acetic acid on the death rates at 52oC of Salmonella Newport, Salmonella typhimurium and Campylobacter jejuni in poultry scald water J. Food Protect. 49: 500-503.

Onuorah CE, Ayo JA, Uhiara NS (2003). Sanitation: Key to success in food processing plant. Publ. Amana Printing and Advert. Ltd, Kaduna, Nigeria.

Potter NN and Hotchksis JH (2006). Food Science. 5th Ed. CBS Publ. New Delhi.

Scott M Russel (2000). Guideliens for the microbiological quality of some ready-to-eat-foods. Pub. Health J. 3: 9.

Scott M Russel (2002). Intervention Strategies for reducing salmonella prevalence. Univ. of Georgia Agric. Ext. Bulletin 1222 p. 1-14.

Sheridan JJ (1998). Sources of contamination during slaughter and measures of control. J. Food Safety. 18 (4): 321-339.

Silvia Michanie, Frank L Bryan, Persia Alvarez and Auria Barros Olivo (1987). Critical control points for foods prepared in households in which babies had salmonellosis. International J. Food Microbiol. 5: 337-354.

Soliman F (2004). Application of Knowledge Management for Hazard Analysis in the Australian Dairy Industry. J. Knowledge Manage. (4): 287–294.

USDA-FSIS (2001). Salmonella Risk Assessment: Shell Eggs and Broiler Final Report prepared by FSIS team (1998). p. 268.

Whyte P, Mcgill K and Collins DJ (2003). A survey of the prevalence of salmonella and other enteric pathogens in a commercial poultry feed mill. Journal of Food Safety. 23:13-24.