Research Article

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Determination of Critical Control Points in Processing of Chicken Nuggets

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ABSTRACT

A study was conducted to identify the critical control points (CCP) in processing of chicken nuggets prepared from the dressed chicken carcasses purchased from local market, Puducherry. The pH and WHC was estimated for the fresh meat sample after mincing. Samples were collected for microbiological analysis (SPC, Coliform) from six different stages of nuggets processing viz stage 1 to stage 6. Standard plate counts (SPC) from stage 1 to stage 6 were 5.690 to 3.255 (log cfu/g) and was highest in stage 1and lowest in stage 6. Significant difference observed between stage 1 and all the other stages. There was no significant difference between stage 3, 4 and 5 in the SPC. Coliform counts from stage 1 to stage 6 ranged from 5.388 to 1.205 (log cfu/g) and was highest in stage 1 and lowest in stage 6. Significant difference observed between stage 1 and all the other stages and there was significant difference between all the stages except between stage 3 and 4 in coliform counts. The pH and WHC of minced meat were 5.692, 55.81, respectively. The pH, cooking yield %, moisture %, protein % and fat % of nuggets were 5.342, 100, 64.33, 15.55 and 12.97, respectively. Based on the microbiological analysis stage 2, 3 and stage 6 were identified as important CCP's in processing of chicken nuggets.

Keywords: Chicken meat; Critical control point; Nuggets; Physico-chemical; Microbiological analysis

INTRODUCTION

Meat is a highly perishable food, inherently susceptible to contamination by biological, chemical, and physical hazards at various stages of the production chain from slaughtering and processing to packaging and distribution. Meat and poultry products frequently have been implicated in outbreaks of foodborne illness which intensifies the need for food safety systems to prevent public health crisis and maintain consumer confidence (Sariq et al. 2025). The risk of food-borne illness can be reduced through implementation of the Hazard Analysis Critical Control Point (HACCP) concept (Tompkin 1990). Hazard has been defined as "the unacceptable contamination, unacceptable growth and/or unacceptable survival by microorganisms of concern to safety or spoilage and/or the unacceptable production or persistence in foods or products of microbial metabolism (e. g., toxins, enzymes, biogenic amines)" ICMSF, 1988.

HACCP concepts are not new in food industries. It was first developed in the late 1950s by a team of food scientists and engineers from The Pillsbury Company, the Natick Research Laboratories, and the National Aeronautics and Space Administration. HACCP was originally established for microbiological safety system as well as food preservation to guarantee food safety for astronauts (Sulieman et al. 2013). The Hazard Analysis and Critical Control Points (HACCP) system has emerged as a robust framework for identifying, evaluating, and controlling food safety hazards throughout the production process (Chavan et al. 2024). The logic sequence for application of HACCP includes, i. Assemble HACCP team ii. Describe product iii. Identify intended use iv. Construct flow diagram v. On-site confirmation of flow diagram vi. List all potential hazards conduct a hazard analysis to identify the significant hazard(s) consider control measures vii. Determine CCPs viii. Establish validated critical limits for each CCP ix.

Establish a monitoring system for each CCP x. Establish corrective actions xi. Validate the HACCP plan and establish verification procedures xii. Establish documentation and record keeping (FAO and WHO 2023).

Critical Control Point (CCP) 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 can reduce the risk to a satisfactory level. The cooking temperature should be taken as a CCP as internal temperature of product to verify the adequacy of the cooking (Codex 2005). The skinning and eviscerating steps are major sites of contamination during the slaughter and dressing of food animals and if these procedures are conducted in a correct manner, the degree of contamination can be reduced. The analysis of hazards must be quantitative if it is to be meaningful. CCP identification is particularly suitable for fresh meat and poultry as well as ready-to-eat products.

A key element of the HACCP system is the use of rapid measurements to monitor whether established criteria are being met at each CCP. Examples of rapid measurements used in the meat and poultry industry include visual observations and measurements for fat, moisture, pH, time, temperature, humidity, and air pressure or vacuum. Verification has been defined as the use of supplementary information to check whether the HACCP system is working. Measurements used for verification include microbiological assays, official methods for fat, moisture, protein and tests to check the final internal temperature of cooked products (Tompkin 1990). The effective implementation of HACCP was closely tied to the level of staff training and found a strong correlation between regular training programs and a reduction in contamination (Sariq et al. 2025).

For implementing HACCP system in meat products processing identification of critical control points (CCP's) is very important. Therefore, the present study was formulated with the aim of determination of critical control points in the processing of chicken nuggets.

MATERIALS AND METHODS

Procurement of raw materials

Dressed chicken carcass were purchased from local market, Puducherry and used for nuggets preparation in the Department of Livestock Products Technology, Rajiv Gandhi Institute of Veterinary Education and Research (RIVER), Puducherry. All the carcasses were manually deboned, cut into small chunks, packed in LDPE bags and stored in freezer (Blue star) (-18±1^{0}C) till further use. Other ingredients required for the nugget's preparation was purchased from local market, Puducherry.

Stages of sample collection

Samples for microbiological analysis were collected in six different stages of processing of chicken nuggets. Stage 1 – after receiving the dressed chicken carcass from the local market, Stage 2 – after washing the dressed chicken carcass in the processing site (dept. of LPT, RIVER), Stage 3 – after deboning the chicken carcass, Stage 4 – after mincing the deboned chicken meat, Stage 5 – after the preparation of chicken nuggets batter and Stage 6 – after final cooking of chicken nuggets.

Preparation of chicken nuggets

The frozen deboned chicken meat was thawed, minced by passing through 8mm plate in a meat mincer (Mado shop Mincer Junior, Germany). The batter was prepared in bowl chopper by mixing minced meat, salt (1.75%), sugar (1%), alkaline phosphate (0.4%), chilled water (12%) for 1minute, then vegetable oil (15%) was mixed for 30 seconds to get an emulsion. Then green condiments (3%), maida (3%) and dry spices (2%) mix were mixed for 1 min to get the batter. Cooking to get chicken block: The batter was filled into stainless steel mould lined with aluminium foil and were subjected for cooking by placing in hot water at 90^{o}C for 45 minutes (Mandal *et al*, 2002), followed by cooling under tap water. After cooling for an hour in refrigerator the moulds were opened to get the chicken nuggets block. Then the blocks were cut into small cubes of nuggets.

Physico-chemical analysis

Cooking yield percentage (Kim et al. 2015), pH (AOAC 2023), water holding capacity (Wardlaw et al. 1973) were analyzed for the minced meat and chicken nuggets. The minced meat and nuggets samples were subjected to moisture, fat, protein estimation by following the procedures of AOAC (2023).

Microbiological analysis

The samples collected at different stages of (Figure 1) processing chicken nuggets were subjected for Standard plate count and Coliform Count by following the procedure of APHA (2007)

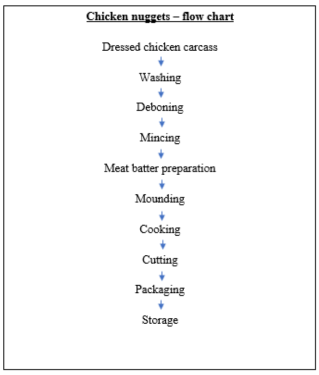

Figure 1. Flow chart for processing of chicken nuggets.

Statistical analysis

The experiment was replicated thrice and eachparameter was analyzed in duplicate. The data were analyzed using SPSS version 16.0 MSI (SPSS, Chicago, U.S.A). One way analysis of variance (ANOVA) was used for microbiological analysis. The level of significant effects was tested usingthe least significant difference (LSD) test (Snedecor and Cochran 1995).

RESULT AND DISCUSSION

Physico-chemical analysis of minced chicken meat

Physicochemical (Table1) analysis of minced chicken meat revealed pH, WHC, moisture %, protein % and fat % were 5.69, 55.81, 73.72,

21.17 and 5.10, respectively. Mukhtar et al. (2018) reported that moisture, protein and fat % of boneless chicken meat were 73.70, 22.9, 1.74 %, respectively.

Table 1. Physico-chemical analysis of minced chicken meat (Mean ± SE)

Parameter	Meat
pH	5.69±0.080
WHC	55.81±1.322
Moisture %	73.72±0.434
Protein %	21.17±0.089
Fat %	5.10±0.137

Physico-chemical analysis of chicken nuggets

Physico-chemical analysis of minced chicken meat (Table 2) revealed pH, cooking yield %, moisture %, protein % and fat % of nuggets were 5.342, 100, 64.33, 15.55 and 12.97 respectively. The protein % in the minced meat was 21.17 and in nuggets 15.55%, this reduction in protein content is due to dilution effect of added water, oil and maida in the processing of chicken nuggets. Similarly, Abiala *et al.* (2022) reported the moisture 60.18%, protein 25.17% and fat 6.18% in the legume extended chicken nuggets.

Table 2: Physico-chemical analysis of chicken nuggets (Mean ± SE)

Parameter	Nuggets
pH	5.34±0.004
Cooking yield (%)	100
Moisture (%)	64.33±0.199
Protein (%)	15.55±0.082
Fat (%)	12.97±0.113

Standard plate count (SPC) at different stages of processing of chicken nuggets

The standard plate count results (Table 3;) of the sample collected at different stages of processing of chicken nuggets revealed that there is significant difference in the stage 1 and all the other stages of chicken nuggets processing. SPC counts was highest in stage 1 (after receiving the dressed chicken carcass) 5.690 (log cfu/g) and lowest in stage 6 (after final cooking of chicken nuggets) 3.255 **(log cfu/g).** There was no significant difference observed between stage 3 (after deboning the chicken carcass), stage 4 (after mincing the deboned chicken meat) and stage 5 (after the preparation of chicken nuggets batter). There is significant reduction in the SPC counts between stage 1 and stage 2. The results reveal that proper washing of the dressed carcass, maintaining hygiene during deboning and proper maintenance of cooking time and temperature plays an important role in minimizing the source of contamination. Similarly, the total bacterial count decreased significantly the total bacterial count during the mixing stage of low-fat meat patties with ingredients before and after the implementation of the HACCP system were 5.97 **Log CFU/g** and 3.82 **Log CFU/g** [a2] respectively Fig 3 and by adhering to the comprehensive hygiene and sanitation protocols cross-contamination risks were minimized, ensuring that food safety was maintained at all times (Spanova et al. 2025). Five critical control points (CCPs) identified during the production of meat patties were raw material acceptance, blanching, cooking, cooling, and packaging/storage, each playing a key role in minimizing risks from environmental contaminants (Baikadamova et al. 2024). The total plate count (TPC) 4.2×10^5 of raw meat (Sariq et al. 2025).

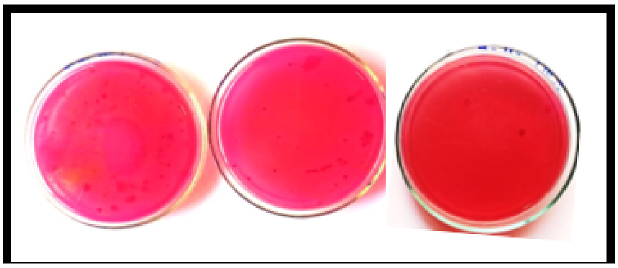

Figure 3. Coliform count plates of Stage 1 to Stage 3 (Left to Right)

Table 3. Standard plate count (SPC) at different stages of processing of chicken nuggets (log cfu/g) (Mean ± SE)

Stages	SPC counts (log cfu/g)
S1	5.690 ± 0.028^{d}
S2	4.990 ± 0.042^{c}
S3	4.394 ± 0.144^{b}
S4	4.372 ± 0.071^{b}
S5	4.341 ± 0.076^{b}
S6	3.255 ± 0.053^{a}

Means with different superscript column wise differ significantly (P<0.05) (Figure 2)

Coliform counts at different stages of processing of chicken nuggets

The coliform count results (Table 4; Figure 4) of the sample collected at different stages of processing of chicken nuggets revealed that there is significant difference in the stage 1 and all the other stages of chicken nuggets processing. Coliform counts was highest in stage 1 (after receiving the dressed chicken carcass) and lowest in stage 6 (after final cooking of chicken nuggets). There is no significant difference observed at stage 3 (after deboning the chicken carcass) and stage 4 (after mincing the deboned chicken meat). There is significant reduction in the coliform counts between stage 1 and stage 2. The coliform count in stage 6 was below detection limit, indicating proper cooking play a key role in destroying the coliforms. The results reveal that proper washing of the dressed carcass, maintaining hygiene during deboning and proper maintenance of cooking time and temperature plays an important role in minimizing the source of contamination. Similarly, Spanova et al. (2025) observed that there is significant reduction in the coliform count before (1.34 log cfu/g) and after (NIL) the implementation of HACCP during the production of low-fat meat patties. Sariq et al. (2025) reported that both HACCP and Food Safety Management Systems (FSMS) were highly effective in reducing the microbial load, particularly in controlling pathogens like *Salmonella spp., Listeria monocytogenes*, and *E. coli* O157:H7 in raw meat. coliforms, *E. coli*, *Staphylococcus aureus*, and yeasts and molds recorded at 1.34, 1.67, 4.01, and 1.73 **Log CFU/g,** [a1] respectively The CCPs identified in the manufacture of chicken nugget in the processing plants 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 (Asaduzzaman 2021).

Table 4. Coliform counts at different stages of processing of chicken nuggets (log cfu/g) (Mean ± SE)

Stages	Coliform counts (log cfu/g)
S1	5.388 ± 0.023^{d}
S2	4.401 ± 0.048^{c}
S3	3.095 ± 0.059^{b}
S4	2.839 ± 0.057^{b}
S5	1.205 ± 0.369^{a}
S6	NIL

Means with different superscript column wise differ significantly (P<0.05)

CONCLUSION

Based on findings of the present study it is concluded that, Stage 2 (thorough washing of carcass with water), Stage 3 (maintaining hygienic steps during deboning) and Stage 6 (subjecting the product for optimum cooking temperature and time) identified as CCP's in processing of chicken nuggets and strict monitoring need to be observed under these stages.

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COMPETING INTERESTS

The authors do not have any competing interests among themselves or others related to this research work.

ETHICS STATEMENT

Not applicable

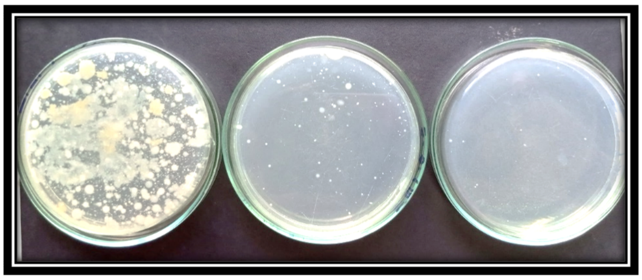

Figure 2. SPC plates of Stage 1 to Stage 3 (Left to Right)

REFERENCES

Abiala, O., Abiala, M., & Omojola, B. (2022). Quality attributes of chicken nuggets extended with different legume flours. *Food Production, Processing and Nutrition, 4*(20), 14–22.

Association of Official Analytical Chemists. (2023). *Official methods of analysis* (22nd ed.). Association of Official Analytical Chemists.

American Public Health Association. (2007). *Compendium of methods for the microbial examination of foods* (2nd ed.). American Public Health Association.

Asaduzzaman, M. (2021). The implementation of hazard analysis critical control point (HACCP) plan for chicken nugget plant. *Asian Food Science Journal, 20*(5), 11–24.

Baikadamova, A., Yevlampiyeva, Y., Orynbekov, D., Idyryshev, B., Igenbayev, A., Amirkhanov, S., & Shayakhmetova, M. (2024). The effectiveness of implementing the HACCP system to ensure the quality of food products in regions with ecological problems. *Frontiers in Sustainable Food Systems, 8*, 1441–1479.

Chavan, Y., Paul, K., & Nikhil, K. (2024). Food safety and hygiene: Current policies, quality standards, and scope of artificial intelligence in food production, diversity, and safety under climate change. In *Advances in Science, Technology & Innovation* (pp. 319–331). Springer.

Codex Alimentarius Commission. (2005). *HACCP: Code of hygiene practice for meat (CAC/RCP 58-2005).* Codex Alimentarius Commission.

International Commission on Microbiological Specifications for Foods. (1988). *Microorganisms in foods: Application of the hazard analysis critical control point (HACCP) system to ensure microbiological safety and quality.* Blackwell Scientific Publications.

Food and Agriculture Organization of the United Nations, & World Health Organization. (2023). *General principles of food hygiene: Codex Alimentarius code of practice (CXC 1-1969).* Codex Alimentarius Commission.

Kim, J. H., Hong, G. E., Lim, K. W., Park, W., & Lee, C. H. (2015). Influence of citric acid on the pink color and characteristics of sous vide processed chicken breasts during chill storage. *Korean Journal for Food Science of Animal Resources, 35*(5), 585.

Mandal, P. K., Pal, U. K., Das, C. D., & Rao, V. K. (2002). Changes in the quality of restructured cured chicken during refrigerated storage. *Indian Journal of Poultry Science, 37*(2), 151–154.

Mukhtar, S., Zahoor, T., Randhawa, M. A., Iqbal, R., & Shabbir, A. (2018). Synergistic effect of chitosan and clove oil on raw poultry meat. *Journal of Food Processing and Technology, 9*, 737.

Sariq, M., Pant, P., Kumar, A., Mishra, R. C., & Nomani, A. N. (2025). The effectiveness of HACCP and FSMS in enhancing food safety in meat industry. *International Journal for Research in Applied Science & Engineering Technology, 13*, 2945–2952.

Snedecor, G. W., & Cochran, W. G. (1995). *Statistical methods* (8th ed.). East West Press Pvt. Ltd.

Spanova, A., Nurgazezova, A., Rebezov, M., Nurymkhan, G., Assirzhanova, Z., Kazhibayeva, G., & Atambayeva, Z. (2025). Hazard analysis and critical control point (HACCP) application to the production of a new low-fat meat patty. *Cogent Food & Agriculture, 11*(1), 1–20.

Sulieman, A., Moneim, E., Helba, M. S., & Zakaria, A. S. (2013). The design of hazard analysis critical control point (HACCP) plan for biscuit plant. *Food and Public Health*, 240–246.

Tompkin, R. B. (1990). The use of HACCP in the production of meat and poultry products. *Journal of Food Protection, 53*(9), 795–803.

Wardlaw, F. B., McCaskill, L. H., & Acton, J. C. (1973). Effect of postmortem muscle changes on poultry meat loaf properties. *Journal of Food Science, 38*(3), 421–423.

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