

**PRELIMINARY EVALUATION OF MICROBIAL  
AND CHEMICAL PROPERTIES  
OF MECHANICALLY DEBONED POULTRY MEAT  
IN THE PHILIPPINES**

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**ABSTRACT**

The influx of mechanically deboned poultry meat (MDPM) in the Philippines has raised issues regarding food safety and health; however, no data is currently available on the quality of MDPM in the country. The study aimed to gather baseline data on the microbial quality and proximate composition of MDPM. MDPM and chilled fresh chicken were purchased from three different supermarkets and evaluated for total plate count (TPC), coliform count and presence of *Salmonella*. The proximate composition of the MDPM was also assessed. Chicken nuggets that were formulated from a mixture of MDPM and fresh chicken were evaluated for the presence of *Salmonella*. The data gathered from the experiment were subjected to T-test using SPSS. The TPC and coliform count of MDPM falls within the maximum acceptable limit set by the CODEX Alimentarius Commission. Fried chicken nuggets tested were negative for *Salmonella*, however, chicken nuggets that were steamed for 40 minutes were found positive. The effect of cooking in the study is inconclusive since limited samples were used. Moisture and

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**crude protein content in MDPM were less ( $P<0.01$ ) than in fresh whole chicken, but had greater ( $P<0.01$ ) crude fat and ash content. In conclusion, results indicate that MDPM can be used in processed meat products but should be properly and adequately cooked to completely destroy *Salmonella*.**

Keywords: Chilled fresh chicken, coliform, mechanically deboned poultry meat, *Salmonella*, total plate count

## INTRODUCTION

Poultry meat consumption continues to increase all over the world with a change in buying behavior and consumption attitudes from whole carcass to cut-up parts and further processed poultry products. The growing demand has provided poultry processors significant amounts of leftover parts of the carcass to be used for mechanical deboning (Milniek *et al.*, 2002). Mechanically deboned meat (MDM) or Mechanically separated meat (MSM) are generic terms used to describe residual meat which has been recovered or separated using mechanical equipment from animal bones or poultry carcasses from which the bulk of the meat has been previously manually removed (Candoûan *et al.*, 2001 as cited Serdaroulu and Yildiz-Turp, 2005). This process is an efficient method of harvesting meat from leftovers of hand deboning as well as from poor quality poultry which is generally accomplished by grinding meat and bone together and by forcing the mix through a fine screen or slotted surface in order to eliminate bone particles (Barker and Bruce, 1995; Milniek *et al.*, 2002).

Poultry meat and its derivatives are among the food products that cause the most concern to public health authorities, owing to the associated risks of bacterial food-poisoning (Baeumler *et al.*, 2000; Beli *et al.*, 2001; Hecer and Ulujsoy Sözen, 2011). MSM is usually heavily contaminated with microorganisms, which originate from the carcass raw material and its storage history and the processing environment, mainly as a result of poor hygienic measures. Improper holding temperatures during the production and storage phases allow growth and multiplication of contaminants (Yuste *et al.*, 2002). The highly perishable nature of the product and

the associated risk of food poisoning brought about by physical structure modification, microbial contamination, and chemical decomposition of MDM are coupled with the adverse effects of mechanical deboning. These includes cellular disruption resulting to release of cellular fluids, protein denaturation caused by the heat generated during mechanical deboning and increased lipid and haem oxidation due to increased surface area, the degree of muscle fiber degradation, and the associated release of nutrients and more uniform spreading of contamination which enhance bacterial count and growth (Viuda-Martos *et al.*, 2012; Candoûan *et al.*, 2001 as cited by Serdaroulu and Yildiz-Turp, 2005; and Kumar *et al.*, 1986).

As of 2009, Philippine imports of MDPM increased by 45 percent from 41 percent in 2008 (Ang, 2009) and it indicates that MDPM is part of the processed meat products available in the market. The quality of mechanically deboned meat offers good technological characteristics and comparatively, the low cost makes the product a profitable and useful raw material (Scientific Veterinary Committee, 1997). However, no data is currently available in the Philippines on the quality and safety of utilizing MDPM. With the influx of MDPM in the country today, food safety and human health is at stake. Hence, there is a need for scientists to gather baseline data by monitoring and evaluating the quality of MDPM. The study aimed to provide the meat industry relevant information on the microbiological and chemical properties of MDPM. The study specifically aimed to compare the microbial and chemical properties of MDPM and fresh chicken, and determine the effect of cooking method on the microbial quality of the chicken nuggets processed from a mixture of MDPM and fresh chicken meat.

## **MATERIALS AND METHODS**

### **Sample Collection and Preparation**

Three packs (per source) of MDPM were obtained from three different sources. All packs of the MDPM samples were mixed to constitute the bulk then three sub-samples were taken as representatives of the whole sample. Six chilled fresh whole chickens were purchased from three supermarkets in Los Baños, Laguna. The whole chickens were skinned, manually deboned, and ground in an electric meat grinder. The ground samples were mixed

and subsamples were subsequently taken. All samples were stored in a freezer set at -20°C until use.

Chicken nuggets were prepared by mixing 50% MDPM and 50% fresh chicken lean. The mixture of chicken nuggets per one formulation consisted of 188 g of MDPM and 188 g fresh chicken, 187 g cornstarch, 34 g, salt, 1 gr black pepper and 1 piece whole egg. After mixing and moulding, the nuggets were stored in the freezer overnight.

### **Experimental Treatment and Design**

The experiment on the microbial and proximate composition was carried out with two treatments in three replications. MDPM served as Treatment 1 while manually deboned fresh chicken as Treatment 2. For the effect of cooking on the survival of *Salmonella* in chicken nuggets, the treatments were uncooked, steaming, and frying.

### **Microbial Profile Determination**

The samples were subjected to microbial determination which included Total Plate Count, coliform count, and presence of *Salmonella*.

#### Total Plate Count and Coliform Detection

The Total Plate Count/Total Viable Count and coliform determination were conducted following the standard protocol of serial dilution and pour plating method. A serial dilution of each sample was made. Dilutions  $10^{-1}$  through  $10^{-4}$  and  $10^{-4}$  through  $10^{-7}$  were used in plating MDPM and fresh chicken, respectively. One ml of the sample from the desired dilution tubes was pipetted into a sterile petri plate followed by pouring approximately 10-20 ml of sterile liquefied agar (Plate Count Agar or Violet Red Bile Agar). The plates were then gently swirled against the bench to assure even mixing. The plates were incubated in an inverted position for 24 h at 37°C. After the prescribed incubation period, growth were counted including those of pinpoint size from plates with 30-300 colonies and colony forming units (CFU) was determined by using the following formula:

$$\text{CFU / ml} = \frac{\text{No. of Colonies} \times \text{Dilution factor}}{\text{Volume Plated (ml)}}$$

### Salmonella Detection

Detection of *Salmonella* was carried out following the method cited by Mclandsborough (2005).

*Sample Preparation and Pre-enrichment.* Twenty five grams of MDPM and ground fresh whole chicken were separately added to an Erlenmeyer flask with 225 ml sterile lactose broth and mixed thoroughly. It was then incubated at 37°C for 24 h.

*Selective Enrichment.* The enrichment was gently mixed and 1 ml volumes were aseptically transferred to two 10 ml SC and TT broth tubes to have a total of four selective enrichment tubes (two of each medium) from each pre-enrichment. The tubes were incubated at 37°C for 24 h.

*Selective Plating.* The turbid selective enrichments (SC and TT broths) were carefully mixed using a vortex mixer. One ml was poured from each enrichment tube into a sterile petri plate and added with Salmonella-Shigella Agar (SSA). The plates were incubated at 35°C for 24 h. Plates that showed blackening of the media indicate presence of *Salmonella*.

### **Evaluation on the effect of cooking method on the microbial quality of chicken nuggets**

Cooking of the chicken nuggets was carried out using steaming and frying at 100 and 180 C, respectively. Steaming was completed after 40 min while 2 min for frying. After cooling the cooked nuggets, they were subjected to microbial analysis to evaluate for the presence of *Salmonella* using the same procedure as above.

### **Proximate Composition**

The MDPM and ground fresh whole chicken were analyzed for moisture, ash, crude protein and crude fat contents using the standard protocol by AOAC as adopted by Nielsen (2010).

### **Statistical Analysis**

The data obtained from microbial analyses and proximate composition were analyzed using T-test of the SPSS software.

## RESULTS AND DISCUSSION

### Microbial Profile of MDPM

#### Total Plate Count

The average Total Plate Count of MDPM was less ( $P=0.028$ ) than the ground fresh chicken. Nevertheless, the microbial quality of the two treatments falls within the maximum range of allowable Standard Plate Count set by the CODEX Alimentarius Commission (CAC). According to CAC (1983), the acceptable level of microorganisms of comminuted meat and poultry determined by a specified method whose values are generally based on levels that are achievable under GMP is  $5 \times 10^5$  to  $5 \times 10^6$  CFU/g (Standard Plate Count/Aerobic Plate Count, CFU/g) for 5 sample units selected from a lot of food to be examined. While  $5 \times 10^7$  CFU/g is the level which when exceeded in one or more samples would cause the lot to be rejected as this indicates potential health hazard or imminent spoilage.

Table 1. Microbial property of Mechanically Deboned Poultry Meat (MDPM) and fresh whole chicken (FRESH).

Item	Treatment		P-value
	MDPM	FRESH	
Total Plate Count	$4.93 \times 10^4 \pm 2.88$	$4.42 \times 10^6 \pm 2.2$	0.028
Coliform	$6.35 \times 10^3 \pm 4.92$	<500	0.112
Presence of <i>Salmonella</i>	+	+	--

Proper hygiene and sanitation is an essential aspect to be considered during handling, manual deboning and sample preparation to avoid further contamination to the sample from the equipment, utensils, handlers and surroundings which may contribute to increased microbial load. Results may not actually reflect the true count of the microbial population. The higher total plate count of lean than MDPM may originate from the carcass raw material and its storage history and the processing environment, mainly as a result of poor hygienic measures (environment, handlers, and equipment). Improper holding temperatures during the production and storage phases allow growth and multiplication of contamination (Yuste *et al.*, 2002).

### Coliform Count

Mechanically deboned poultry meat exhibited higher ( $P=0.112$ ) coliform count than the fresh chicken. Although MSM products may be stored frozen and/or heat treated, several aspects of the mechanical recovery process, especially the small particle size and large surface area, the release of nutrient-rich cellular fluids due to tissue maceration, heat potentially generated during mechanical deboning, extensive handling, and cross-contamination and redistribution of contamination, may enhance bacterial growth. MSM is considered more perishable than fresh and minced meat (Viuda-Martos *et al.*, 2012).

### Salmonella

Results showed that *Salmonella* was positive in both samples. According to European Union as cited by ICSMF, *Salmonella* in poultry should be absent in 25 g sample (Scientific Veterinary Committee, 1997).

Both red meat and poultry meat can be a source of pathogens like *Salmonella* spp., *Campylobacter* spp., enterohaemorrhagic *E. coli* like *E. coli* 0157:H7, *Listeria monocytogenes*, *Yersinia enterocolitica*, *Staphylococcus aureus* etc. as well as spoilage bacteria such as *Pseudomonas* responsible for the development of rancidity (Scientific Veterinary Committee, 1997). They can be found on the surfaces of feet, feathers, skin, and also in the intestines. During processing, a high proportion of these organisms will be removed, but further contamination can occur at any stage of the processing operation (Kabour, 2011).

Generally, it can be said that if the number of bacteria on the surface of meat exceeds  $1 \times 10^8$  CFU/g the meat is unfit for human consumption. If the microbe count is  $1 \times 10^7$  CFU/g the meat is of poor quality (Scientific Veterinary Committee, 1997).

### **Effect of Cooking Method on *Salmonella***

The effect of cooking on the survival of *Salmonella* in chicken nuggets was evaluated. Results showed that frying the product for 2 min at 180°C completely destroyed the microorganism while steaming at 45 min did not eliminate *Salmonella* in the product (Table 2). *Salmonella* sp. can be reduced to a safe level by simply cooking the product to the appropriate destructive temperatures since the reported D-values for *Salmonella* on chicken at 70°C and 67.5°C were 0.176 and 0.286 min, respectively (Dookeran *et al.*,

2012). However, it is difficult to conclude when food products such as chicken nuggets have reached safe internal temperatures during conventional cooking methods. The Food Safety and Inspection Service (FSIS) guidelines to cook poultry products recommend reaching an internal temperature of 71.1°C to achieve a 7 log reduction of *Salmonella* (Mazzotta, 2000). According to Murphy *et al.* (2004), inadequate cooking time and temperature are important factors that contribute to foodborne illnesses. Cooking time and temperature fluctuates depending on size and shape of the meat, heat transfer medium (water, oil, air), and open or closed environments. Hence, various cooking methods, broadly categorized as boiled (water), fried (oil), grilled (air and open environment), and baked (air and closed environment), may impact differently on thermal inactivation of *Salmonella* (Smith *et al.*, 2001).

Table 2. Effect of steaming and frying on *Salmonella* presence in chicken nuggets.

Item	Salmonella
Cooking Method	
Uncooked	+
Steamed	+
Fried	-

(+) Positive for *Salmonella*

(-) Negative for *Salmonella*

### Proximate Composition

The chemical composition of a product is one way of determining its quality based on its content and attributes. Moreover, the chemical composition can vary according to the settings and type of machine used for the mechanical separation (Froning, 1981; Day and Brown, 2001). Manually deboned chicken had higher ( $P<0.001$ ) moisture and crude protein than MDPM. Since the fat content of MDPM is higher ( $P<0.001$ ) than the fresh chicken, higher moisture and protein contents of the latter can be observed as explained by the inverse relationship between fat and moisture, and fat and protein (Bull, 1951). Fresh chicken has higher moisture because the amount of dripping is expected to be at its minimum. As in regular meat, moisture content of MSM fluctuates with lipid content, which varies considerably depending on the material being deboned (Froning and McKee, 2001; Field, 2004; Viuda-Martos *et al.*, 2012). As a consequence, MSM contains lower available moisture than hand-deboned meat because of the higher



lipid content. However, water activity is in a range allowing growth of all microorganisms in all types of such products, if unfrozen (EFSA, 2013).

Table 3. Proximate composition of Mechanically Deboned Poultry Meat (MDPM) and fresh whole chicken (FRESH).

Item	Treatment		P-value
	MDPM	FRESH	
Moisture	68.66±0.32	75.59±0.92	<0.001
Crude protein	14.85±0.42	19.64±0.34	<0.001
Crude fat	13.49±0.24	3.05±0.35	<0.001
Ash	1.06±0.02	0.89±0.05	0.008

The high crude protein content of fresh chicken is attributed to the fact that the analyzed chicken sample was purely lean. Al-Najdawi and Abdullah (2002) reported that the skinned carcass of chicken has 20.35% protein. The variation in the protein content of the samples is dependent on the material being deboned and the animal (Navarro *et al.*, 2010). Usually, protein content is higher in manually separated meat than in MSM because raw materials used for mechanical deboning are richer in lipids (e.g. skin, subcutaneous fat, etc.) (Froning and McKee, 2002).

MDPM had higher ( $P<0.01$ ) crude fat and ash contents. The significant difference in the proximate composition of MDPM and fresh chicken is due to differences in the nature of the sample. The lipid content obtained from the study is in agreement with that of Trindade *et al.* (2004). He reported that mechanical deboning of meat affects the lipid composition of the resulting meat, which normally has higher lipid content than manually deboned meats. The higher content of lipid in MDPM is attributed to the extra lipids that may originate from subcutaneous fat, the skin or abdominal fat (depending on the animal species and method used) but mainly come from bone marrow and bone tissue. The marrow contains varying amounts of fatty acids, ranging between 7% and 48%, depending on the animal species and even type of bone since the marrow from leg bones of adult animals can contain up to 90-95% fat (Field *et al.*, 1980).

The significant difference in ash content between MDPM and fresh chicken is attributed to the amount of bone particles that may be incorporated during the deboning process and these particles

contain high levels of calcium. Thus, calcium content or ash is elevated compared to fresh meat (Mayer *et al.*, 2007).

## CONCLUSION

Under the conditions at which the study was conducted, it can be concluded that the microbial hazards in MDPM are expected to be similar to those in fresh meat, minced meat and meat preparations. Moreover, the microbial property of MDPM in terms of Total Plate Count falls within the allowable limit set by the CODEX Alimentarius Commission. The coliform counts also fall within the allowable limit in mechanically deboned meat. *Salmonella* present in meat can be eliminated by proper cooking methods. The proximate components of meat are influenced by the composition of the deboned meat.

To thoroughly assess the properties and quality of MDPM, it is recommended that further studies should include the measurement of the free fatty acid, cholesterol contents and oxidative rancidity of MDPM, detection of the presence of trace elements and heavy metals possibly present in MDPM, determination of the shelf-life of MDPM available in the Philippine supermarkets and, assessment of the presence of antibiotic and hormone residues in MDPM. Greater number of samples should be obtained from various sources.

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