Vet. Med. J., Giza. Vol. 59, No.4. (2011): 149-163

Evaluation of some chemical and bacterial quality parameters of mechanically deboned chicken meat

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Received: 07/09/2011
Accepted: 20/09/2011

SUMMARY

Mechanically Deboned Chicken Meat (MDCM) is the raw material removed from the skeleton bone tissues by grinding the starting materials such as frame, backs and necks by passing it through a sieve under high pressure. A total number of 60 samples of MDCM were collected from some chicken factories and supermarkets in Cairo governorate and subjected to laboratory examinations to assess their chemical and bacterial quality parameters. Results revealed that the mean percent values of the proximate chemical composition were 63.96± 3.21, 12.84 ±1.62 and 19.43±4.37 % for moisture, protein and fat contents, respectively. The mean values of Total Volatile Bases-Nitrogen [(TVB-N) (mg/100g)] and Thiobarbituric acid number [(TBA) (mg Mal/Kg)] were 6.92±1.49 and 0.437±0.138 respectively. The enumeration of the total bacterial count (cfu/g), Staphylococcus aureus (cfu/g) and coliforms counts (mpn/g) were $2.15X10^6 \pm 2.73X10^5$, $1.52X10^2 \pm 6.21X10$ and $7.40X10^2 \pm 1.84X10^2$ respectively while, the number of the positive samples for Escherichia coli and Salmonella Food-poisoning micro-organisms were 5 (8.33%) and 1 (1.67%) from 60 samples respectively.

INTRODUCTION

The high poultry consumption leads to concern that the products should be safe and have a low spoilage rate, the right composition, packaging, color, taste and appearances (Rio et al., 2007).

Mechanically Deboned Chicken Meat (MDCM) known as a value added by-products was normally used in sausage and meat ball productions. It absolutely retained from the meat with bone and cut parts with lower commercial value. The

consumer preference for chicken cuts instead of whole chicken and, later on, the demand for chicken fillets and convenience products, such as nuggets, hamburgers and marinated cuts, required the finding of ways to use backs, necks, and bones left overs from manual deboning processes. These parts make up about 24% of the edible part. From there on, the mechanically separated meat of poultry became available and started to be used in the manufacture of several products, such as sausages, bolognas, salamis and dry soups (Field, 1998 and Froning, 1981). In every deboning process, after the removal of the usual meat cuts, there is always an amount of meat which is firmly attached to the bones. Mechanically separated meat is a product resulting from of the mechanical separation of the meats attached to these bones. Normally the mechanical separation is made for bones of irregular shape, more difficult to be manually deboned, such as vertebral column and neck. However, other bones with attached meat, or whole carcasses, can be submitted to mechanical separation. MDCM is the raw material removed from the skeleton bone tissues by grinding the starting materials such as frame, backs, necks by passing it through a sieve under high pressure (Trindade et al., 2004). During the grinding and separating operations, a certain amount of bone marrow and flour simultaneously contaminate and gel into the meat, MDCM normally exhibits red in color and appears as a finely ground paste like product (Essary, 1979). Yield and composition of MDCM varies from 55 to 80% depending on the origin of raw material, i.e. skin tissues increase the lipid fraction and conversely the protein fraction decreases, bone to meat ratio, age, and species of bird, cutting method, and deboner setting (Mielnik et al., 2002). In general, regarding to this point, this raw material usually contained a great variety of chemical components released from bone fragments, bone marrow, and blood. This made the MDCM exhibiting high amounts of lipid, meat mineral, such as copper, calcium and iron, when compared to the regular ground meat (Froning and McKee, 2001)

It is recognized that at least 20% of chicken fresh-cut carcasses are transformed into MDCM, which could be used in processed meats, such as meat emulsion, paste meat and chicken nuggets (Negrão et al. 2005). MDCM is a by-product of the poultry industry increasingly used in processed meat products. It is also a source of high biological quality proteins that could be used to produce protein preparations with specific characteristics. MDCM is mostly obtained from necks and back parts of chicken and turkey carcasses (Froning, 1981).

Raw poultry surface and the other parts were known as high microbial load. The storage stability of the final product is affected by the raw materials and conditions used for mechanical deboning. 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). The large surface area, the release of cellular fluids and the heat generated during mechanical deboning all enhance bacterial count and growth (Kumar et al., 1986). On the other hand, mechanically deboned chicken meat is made from the deboning and cutting of parts with lower commercial value, such as the back and the neck although, The undesired way of deboning process decreases the quality of mechanically deboned poultry meat with the other reasons and also makes it short shelf-lived product with high microbial load (Field, 1998).

Lipid oxidation occurs easily in poultry because its fat contain highly unsaturated. It is known that heat treatment enhances lipid oxidation (Beltran et al., 2003). The polyunsaturated fatty acid located primarily in the phospholipids derived from the bone marrow is the major factor promoting the autoxidation. Thus, MDCM is highly susceptible to oxidative deterioration due to the extensive stress and aeration during the machine deboning process and the compositional nature such as bone marrow and lipids (Mielnik et al., 2002).

Lipids oxidation is responsible for reduction in nutritional quality as well as changes in flavor, while microbial contamination can precipitate major public health hazards and economic loss in terms of food poisoning and meat spoilage (Aguirrezábal et al., 2000).

The objective of the present work was carried out to assess the chemical and bacterial quality parameters of Mechanically Deboned Chicken Meat (MDCM) collected from some chicken factories and supermarkets at Cairo city.

MATERIALS AND METHODS

MATERIALS:

Sixty samples of fresh Mechanically Deboned Chicken Meat (MDCM) were collected from some chicken factories and supermarkets at Cairo city, each sample of about 500g, and each sample was placed and sealed in an individual sterile plastic bag surrounded by ice bags in an ice box and transferred immediately to the laboratory where they subjected directly to bacteriological and chemical laboratory tests.

METHODS:

I- Proximate analysis:

Moisture content was evaluated on the basis of moisture in meat and poultry products method (AOAC 2000).

Protein content was evaluated on the basis of crude protein in meat, block digestion method (AOAC 2000).

Crude Fat content was assayed by the Soxhlet method (AOAC, 2000).

II- Chemical deteriorative criteria:

1- Determination of Total Volatile Bases Nitrogen (TVB-N): according to (EC: 1995)

The Total Volatile Bases Nitrogen (TVB-N) were extracted from a sample by a solution of 0.6M perchloric acid. After alkalinization, the extract was submitted to steam distillation and volatile base components were absorbed by an acid receiver. The TVB-N concentration was determined by titration of the absorbed bases.

2- Determination of Thiobarbituric acid number (TBA): according to Jayasingh and Cornforth (2003).

Thiobarbituric acid reactive substances (TBARS) assay was performed in duplicate samples. Two g were mixed with 10 ml of stock solution containing 0.375 % TBA, 15% TCA, and 0.25 N HCl. The mixture was heated for 10 min in a boiling water bath (100°C) to develop a pink color, cooled in tap water and then centrifuged at 8000 rpm for 20 min. The absorbance of the supernatant was measured spectrophotometrically at 532 nm against a blank that contained all the reagents minus the meat and stock solution to blanks. The malonaldehyde (MDA) concentration was calculated and converted to TBA number (mg MDA/kg meat sample) as follow;

TBA NO. (ppm) = Sample A532 × 2.77

III- Bacteriological analysis: according to Food and Drug Administration (FDA, 2006).

Twenty five gm from each sample were blended in a sterile stomacher bag containing 225 ml of 0.1% (wt/vol) peptone water for 2 minutes. Decimal dilutions were carried out using the same diluents.

- Aerobic plate count (APC) were determined using Plate Count Agar, plates incubated at 35°C for 24-48 h.
- Coliforms and Escherichia coli (E. coli) were determined by separately inoculation 0.1 ml of the food homogenate and its decimal dilution into each of 3 Lauryl Sulphate Tryptose (LST) broth tubes supplemented with inverted Durham's tubes incubated at 35°C for 48 hours. Tubes showing acid

(turbidity) and gas (in the inverted Durham's tubes) were considered positive and loop fullfrom +ve tubes was streaked on BGLB and incubated at 35°C for 48 h.

IMViC test was performed on colonies that showed shiny-metallic green to identify E. coli. (Pattern of ++ - - considered to be E. coli).

- Staphylococcus aureus count were determined on Baird Parker Agar aerobically incubated at 37°C for 24-48h. Typical black colonies with zones around were considered as Staphylococci spp. Coagulase test was performed to isolate coagulase (+ ve) Staphylococci spp.
- Isolation of Salmonella: twenty-five g of samples were blended with 225 ml buffered peptone water and incubated at 37°C for 24 h. Subsequently 0.1 ml inoculated into Rappaport-Vassiliadis (RV) broth and incubated at 43°C for 24-48h. Streak plates were done with loopful on Xylose Lysine Desoxycholate (XLD) agar at 24 and 48 h and incubated at 37°C for 24-48 h. Pink- red colonies with or without black centre were subjected to biochemical tests for the identification of Salmonella.

RESULTS AND DISCUSSIONS

I- Proximate composition:

Mechanically Deboned Chicken Meat (MDCM) is the raw material removed from the skeleton bone tissues by grinding the starting materials such as frame, backs, necks by passing it through a sieve under high pressure. Yield and composition of MDCM varies from 55 to 80% depending on the origin of raw material, i.e. skin tissues increase the lipid fraction and conversely the protein fraction decreases, bone to meat ratio, age, and species of bird, cutting method, and deboner setting (Mielnik et al., 2002).

Froning and McKee (2001) reported that factors influencing the composition of the MDCM included bone to meat ratio, age of the chicken, skin content, cutting methods, deboner setting, and species. In general, younger chickens generally would have more heme and lipid component from the bone marrow influencing the proximate composition. Skin content might greatly increase the fat content. Deboner setting could affect the yields and the proximate composition. If the setting was set for high yields, the fat and ash content in MDCM might be largely increased. In addition, composition of MDCM varied depending on the origin of raw material, i.e. skin tissues increase the lipid fraction and conversely the

protein fraction decrease (Negrao et al., 2005).

Table (1): The proximate chemical composition values (%) of the mechanically deboned chicken meat (MDCM) samples (n=60)

Value %	Moisture	Protein	Crude fat
MIN.	61.28	10.35	13.75
MAX.	67.71	16.22	25.82
Mean	**63.96**	**12.84**	**19.43**
St. error (±)	3.21	1.62	4.37

The mean and range of the chemical composition (moisture, protein and fat) of the MDCM samples, results showed in table (1) pointed out that the minimum percentage of the moisture, protein and fat were (61.28, 10.35 and 13.75) respectively, while the maximum values were 67.71, 16.22 and 25.82, respectively with the mean values ± S.E of 63.96 ± 3.21, 12.84 ±1.62 and 19.43 ±4.37, respectively.

The proximate compositions of the obtained results nearly in agreement with results reported by many investigators like Froning and McKee (2001) who found that MDCM samples comprised 9.3-14.5% of protein, 63.4-66.6% of moisture, 14.4-27.2% of lipid (by wet basis); MacNeil et al. (1978) also found that the percentages of MDCM fat and protein was 27.17% and 14.66%, respectively.

Higher results recorded by Najdawi and Abdullah (2002), MDCM with skin and without skin contained high lipid content when compared to the regular meat since the major fat was directly extracted from bone marrow. Normally, the lipid content of chicken bone marrow was approximately 46.5%. Release of fat from skin and bone marrow elevated overall fat content in and this raw material simultaneously decreased the amount of protein.

II- Chemical deteriorative criteria:

MDCM so sensitive to be off odor and off color. The process of releasing heme pigments from the bone marrow into the MDCM resulting in increasing the heme protein. This increase was primarily due to hemoglobin from the bone marrow. Hemoglobin was more subjected to abnormal color problems since it was more

easily oxidized and more susceptible to heat denaturation during processing and storage. Abnormal brown, green, and gray color defects had been reported in further processed chicken meat products containing MDCM. During the deboning process, the meat was exposed to considerable air, which might accelerate the oxidation of heme pigments (Froning and McKee, 2001). Najdawi and Abdullah (2002) reported that MDCM was highly susceptible to oxidative deterioration. This was related to the release of heme, oxidative enzymes and incorporation of oxygen into the product during mechanical deboning, promoting auto-oxidation of polyunsaturated fatty acids (PUSFA) in the phospholipids content of poultry tissue. Factor effecting MDCM lipid oxidation included: fat content, PUFSA, metals e.g. iron (Fe) and copper (Cu), heme catalysts and enzymes such as lipoxygenase or cycloxygenase. Lipid oxidation of MDCM was more importance than spoilage of MDCM from microbial growth because several of these products were mixture of meat from various spices and preservatives. This showed that MDCM normally contained high meat mineral and was greatly susceptible to lipid oxidation during its storage.

Table (2): Means of the Total Volatile Bases-Nitrogen [(TVB-N) (mg/100g)] and Thiobarbituric acid number [(TBA) (mg Mal/Kg)] of the Mechanically Deboned Chicken Meat (MDCM) samples (n=60).

Value	TVB-N (mg/100g)	TBA (mg Mal./ Kg)
MIN.	3.15	0.243
MAX.	9.68	0.750
Mean	6.92	0.437
S.E (±)	1.49	0.138

Concerning the mean and range of the Total Volatile Bases-Nitrogen [(TVB-N) (mg/100g)] and Thiobarbituric acid number [(TBA) (mg Mal/Kg)] of the MDCM samples, results given in table 2 pointed out that the minimum values were (3.15 and 0.243) respectively, while the maximum values were 9.68 and 0.750, respectively with the mean values ± S.E of 6.92 ±1. 49 and 0.437 ±0.138, respectively.

The obtained results were lower that of than Egyptian Standards (2005) for Minced poultry meat-mechanically separated which recorded that the Total Volatile Bases-Nitrogen must not exceed 20 mg/100g.

III- Bacterial criteria:

Raw meat, particularly poultry meat, remains an important source of human infection with pathogenic microorganisms. It can easily be contaminated with microorganisms because fresh meat is very suitable for microbial multiplication. Meat has high water activity, is high in nutrients and readily utilizable low molecular weight substances and is a source of carbon and energy by means of glucose, lactic acid, amino acids, creatines, metal and soluble phosphorus. As a result, fresh meat is a suitable substrate for bacterial multiplication **(Hinton, 2000).**

Aerobic Colony count (ACC) also known as Aerobic Plate count (APC) and Total Viable Count (TVC); A measure of bacteria in the sample that can survive in the conditions on the surface of carcases or in processed meat, be harvested by the sampling procedure used and grow in the presence of air on an agar plate. These bacteria include those arising both from animals and from the slaughterhouse or meat processing environment. Because the APC includes the organisms responsible for spoilage of meat, it will also give an indication of the keeping quality of the meat.

Coliform bacteria are described and grouped, based on their common origin or characteristics, as either Total or Fecal Coliform. The Total group includes Fecal Coliform

bacteria such as Escherichia coli (E .coli), as well as other types of Coliform bacteria that are naturally found in the soil. Fecal Coliform bacteria exist in the intestines of warm blooded animals and humans, and are found in bodily waste, animal droppings, and naturally in soil. Most of the Fecal Coliform in fecal material (feces) is comprised of E. coli.

The average microbial count of MDCM increased after each step of processing. Its required to use good quality assurance guidelines to avoid speeding up the spoilage of MDCM from microbial growth (Ostovar et al., 1971).

Table-3: Enumeration of the total bacterial count (cfu/g), Staphylococcus aureus count (cfu/g) and coliforms count (mpn/g) of the Mechanically Deboned Chicken Meat (MDCM) samples (n=60)

	APC (cfu/g)	Staphylococcus aureus (cfu/g)	Coliforms (mpn/g)
MIN.	$1.70X10^4$	<10	0.74X10
MAX.	$8.83X10^6$	$4.19\ X10^2$	$7.55X10^3$
Mean.	$2.15X10^6$	$1.52X10^2$	$7.40X10^2$
S.E (±)	$\pm 2.73\ X10^5$	±6.21 X10	$\pm 1.84\ X10^2$

Regarding the mean and range of the bacterial counts of the frozen poultry samples, results given in table (3) pointed out that the minimum counts of the aerobic plate count (cfu/g), Staphylococcus aureus (cfu/g) and coliforms counts (MPN/g) were $1.70X10^4$, <10 and 0.74X10, respectively, while the maximum counts were $8.83X10^6$, $4.19\ X10^2$ and $7.55X10^3$, respectively with the mean counts ± S.E of $2.15X10^6 \pm 2.73X10^5$, $1.52X10^2$ ±6.21 X10 and $7.40X10^2$ $\pm 1.84\ X10^2$, respectively.

Coliforms have been, and still are used as indicators of possible faecal contamination, hence, the possibility that pathogenic organisms may also be present (Notermans et al., 1980).

Staph. aureus is important in relation to poultry meat hygiene because of its ability to produce enterotoxins which may cause food poisoning in human beings. S. aureus is a normal flora of live poultry; however it doesn't grow very well under refrigeration due to extermely high storage temperatures (Waldroup et al., 1996).

The obtained results were higher than Egyptian Standards (2005) for Minced poultry meat-mechanically separated which recorded that the aerobic plate counts, Coliforms and Staphylococcus aureus counts must not exceed 10^5, 10^2 and 10^2 (cell/g) respectively.

Table-4: Incidence of the Escherichia coli and Salmonella isolated from Mechanically Deboned Chicken Meat (MDCM) (n=60)

	E. Coli	Salmonella
No. of + ve of samples	5.00	1.00
Percentage	8.33%	1.67%

The occurrence of pathogenic microorganisms has always been attributed to several factors, which include contamination through water, soil, food processing equipments, food contact surfaces and most importantly food handlers (Nester et al., 2004). Improper handling of food is responsible for most cases of food- borne diseases and intoxication, including improper use of preparation and storage temperatures, cross contamination and poor personal hygiene. When food handlers do not practice proper personal hygiene or correct food preparation, they may become vehicles for microorganisms, through their hands, mouth, skin among others (Prescott et al., 2008).

Salmonella species are responsible for an estimated 93.8 million cases of foodborne disease in humans and an average of 155,000 deaths annually worldwide. Poultry and poultry meat product are considered one of the main carriers of the organism and represent a significant share of the attributed sources of salmonellosis in humans. At present, there are more than 2500 known serotypes or serovars of Salmonella and Salmonellosis is one of the most important food-borne diseases (WHO, 2005b).

Common vehicles of Salmonella transmission on poultry are carcasses arriving at the processing plants or carcasses that become cross-contaminated with intestinal contents during processing (Connor et al., 2001).

E. coli (EC); A group of bacteria that live in the intestines and are shed in the faeces of man and food producing animals. Presence of E.coli is an indicator of faecal contamination (Teck et. al, 2011).

Concerning the isolation of some Food-borne diseases caused by micro-organisms Escherichia coli and Salmonella, the data showed in table 4

revealed that the number the +ve samples for Escherichia coli and Salmonella were 5 (8.33%) and 1 (1.67%) from 29 samples respectively.

Higher results reported by Public Health Laboratory Service (1989) reported that 76.3% of salmonella food poisoning were attributed to meat (6% cattle, 13.4% pork and 78% poultry) which indicated that poultry played a major role in salmonellae food poisoning. Jerngklinchan et al. (1994) isolated Salmonellae from 467 (66%) of 705 chicken meat samples collected from open markets, supermarkets and poultry processing plants in Bangkok, Thailand. Telo et al. (1998) investigated eighty samples of imported poultry meat for the presence of salmonella strains. They detected Salmonella spp. in 10 (12.5%) samples (7 chicken meat and 2 turkey meat). Tibaijuka et al. (2003) isolated salmonella from 54 (17.5%) of retail raw chicken meat. Molla and Mesfin (2003) isolated salmonella from 21.1% of the samples analyzed from in raw chicken meat from poultry processing plants and retail markets at Debre Zeit and Addis Ababa, Ethiopia.

Egyptian Standards (2005) for Minced poultry meat-mechanically separated recorded that it must be free from Salmonella and Escherichia coli.

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تقييم الحالة الصحية لمفروم لحم الدواجن المنزوع ميكانيكيا

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الملخص العربي

مفروم لحم الدواجن المنزوع ميكانيكيا هو المادة الخام الناتجة من مرور هياكل الدجاج خلال ماكينات شفط قوية تقوم بنزع كل مايحيط بالعظم من أنسجة ثم تقوم بفرمها ويستخدم في العديد من الصناعات الغذائية و لذلك تم القيام بعمل هذه الدراسة لتقييم جودة هذا المنتج.

تم جمع ٦٠ عينه من هذا المنتج من بعض المصانع الموجودة داخل نطاق محافظة القاهرة وتم نقلها إلى المعمل في صندوق عازل للحرارة و محاطة بأكياس الثلج في أسرع وقت ممكن حيث أجريت عليها إختبارات الجودة وأظهرت النتائج أن المتوسط ±الخطأ المعياري للنسبة المؤية للرطوبة و البروتين و الدهون هي 3.21 ±63.96 و 1.62± 12.84 و 19.43±4.37 على الترتيب.

كما أظهرت النتائج أن المتوسط لنسبة النتروجين الكلى المتطاير (مجم لكل / 100جرام) و رقم حمض الثيوباربيتيورك (مجم مالونالدهيد لكل 1000 /جرام) هي 6.92±1.49 و 0.437±0.138 على الترتيب.

كما أظهرت النتائج أن متوسطات العد الكلي للبكتيريا الهوائية و العد الكلي لميكروب المكور العنقودي الذهبي و العد الأحتمالي الكلي لبكتريا المجموعة القولونية هو $2.15X10^6 \pm 2.73X10^5$ و $1.52X10^2 \pm 6.21X10$ و $7.40X10^2 \pm 1.84X10^2$ على الترتيب بينما بلغت نسبة عزل ميكروبات التسمم الغذائي الإشرشيا كولاي و السالمونيلا 8.33% و 1.67% من العينات على الترتيب .