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Sensory, Deterioration and Bacteriological Assessment of Some Ready to Eat Poultry Products

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ABSTRACT

This study was carried out to assess the quality of some RTE (ready to eat) chicken meat products collected from different poultry meat processing plants in Menofia and Gharbia Governorate. A total of 60 commercially produced RTE poultry products such as chicken ham, chicken shawarma, chicken with herps, smoked turkey and turkey smoked lobes (12 each) were collected from supermarkets and examined for sensory, deterioration criteria and bacteriological quality. The results revealed that the sensory panel scores of all examined RTE poultry meat products samples were generally low especially in chicken with herps, chicken ham and smoked turkey RTE poultry meat products. Moreover, pH values of most of the examined samples were relatively alkaline whereas the lowest value was recorded in smoked turkey samples and highest value was observed in chicken with herps samples. In addition, higher thiobarbituric acid (smoked turkey) and slightly increases of total volatile basic nitrogen values (chicken with herps) were recorded in most of the examined samples. All investigated bacterial counts were significantly high in all examined RTE poultry meat products samples. *Staph. aureus* was isolated from chicken ham and *E. coli* strains were isolated from chicken shawarma, smoked turkey and turkey smoked lobes. However, *E. coli* O_{157}:H_7 and Salmonella strains failed to be isolated from all the examined samples. It could be concluded that all the examined RTE poultry meat products were deteriorated in terms of sensory, chemically and bacteriologically and exceeded the limit described by E.S. (3493/2005) for cooked poultry meat products. In addition, these samples were probably produced and prepared under bad hygienic measures which could be responsible for lowering their quality and reduce shelf life.

Key words: RTE; Sensory, Deterioration criteria, Bacteriological examination

INTRODUCTION

Consumption of poultry meat such as chicken meat continues to increase all over the world especially in developing countries. This may be due to the fact that chicken meat is not target to any culture or religious restrictions (Kralik *et al.*, 2018). In addition, chicken meat is considered as an easily accessible high-quality protein source, of low saturated fat and rich with other nutrients that are essential for consumers and recommended for consumption by all age groups (Cavani *et al.*, 2009). Chicken meat is suitable for fast and simple preparation and more available with affordable prices which making it as the best choice for consumers to be match with the modern lifestyle (Kralik *et al.*, 2018). In addition to chicken meat, turkey meat is also preferred than red meat in terms of health purpose because of having protein/calorie ratio and low cholesterol. Moreover, turkey meat is rich in vitamins such as thiamin (B1), riboflavin (B2), niacin (B3), pyridoxine (B6), and minerals like calcium, phosphorus and potassium (Çolak *et al.*, 2011; El Jalil *et al.*, 2020; Mehmood *et al.*, 2020).

The great diverse in our life attitudes, in addition to increase working hours force the consumers to depend on ready to eat (RTE) meat products in their daily meals. RTE poultry products can be eaten without preparation, heating or cooking or requiring some preparation such as reheating before consumption (Howard *et al.*, 2012). There is a wide variety of RTE meat products such as luncheon, frankfurter, shawarma, kebabs, ham, smoked turkey and other deli meats. The shelf life of these products depends on the degree of cooking, composition of the cure, smoke protocol, storage temperature, and type of packaging. Cooking method, spices, herps and their extracts, in addition to contributing to taste and flavor represent an increasing source of natural antimicrobials for food preservation. However, the microbiological quality problems of RTE products rely on low quality raw meat & ingredients used in processing, imperfect sanitary practices for personnel and processing utensils and

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inefficient cooking process (Kayaardi *et al.,* 2006). In addition, Kralik *et al.* (2018) found that contamination during post processing such as slicing and repackaging with pathogenic organisms can also occur, causing food borne diseases. Moreover, the presence of spoilage organisms on the products as a result of contamination may deteriorate its quality attributes and decrease storage shelf life.

Consumers become more aware about obtaining safe food and of high quality. Consumer's decision to select the RTE products is depending mainly on some criteria such as appearance, taste, aroma, and texture. Safe food is the main human right despite the fact several foods are often contaminated with microorganisms which cannot be noticed organoleptically. The major components which affect the keeping quality and shelf life of the chicken meat products are lipid oxidation and protein degradation. Lipid oxidation reaction in chicken meat occurs very rapidly because it is rich in unsaturated fatty acid (Sabhadinde, 2014). Several studies focus on the microbiological assessment of RTE meat products, however, the studies on the assessment of deterioration and sensorial quality of RTE are rare. Therefore, the present study was designed to determine the quality of some RTE poultry meat products such as chicken ham, chicken shawarma, chicken with herps, smoked turkey and turkey smoked lobes in term of sensory, deterioration and bacteriological assessment.

MATERIALS AND METHODS

Collection of samples

A total of 60 commercially produced RTE poultry products (12 each from chicken ham, chicken shawarma, chicken with herps, smoked turkey, turkey smoked lobes) produced by different meat processing plants were collected. These samples were collected within one month after processing from supermarkets and restaurants at Menofia and Gharbia governorate, Egypt. Each sample was represented ~500g from the same processing lot. All samples were transferred immediately after purchasing in cooling ice box to the laboratories of Animal Health and Research Institute at Gharbia governorate and kept chilled at 4°C until the time of investigation.

Parameters studied

Sensory quality

Sensory panel analysis was performed by 5 panelists from the members of Animal Health and Research Institute. All samples were evaluated for color, taste, flavor, consistency and overall acceptability using a 10-point scale (where 10 denotes extremely acceptable and 1 denotes extremely unacceptable) according to the method recommended by AMSA (1995). Prior to the analysis panelists were trained in the definition and intensities of all investigated sensory parameters.

Deterioration criteria

To measure pH value of RTE poultry meat product samples, the pH meter was firstly calibrated by two buffers (7.0 and 4.0). Using pH meter (Lovibond Senso Direct Ltd), three reading for each sample were taken and the average was calculated (Kandeepan *et al.,* 2009). Measurement of total volatile basic nitrogen (TVBN) of RTE poultry meat product samples was followed by the procedure of Kearsley *et al.* (1983) using macro-Kjeldahl distillation apparatus. In addition, thiobarbituric acid (TBA) was determined by the procedure recommended by Du and Ahn (2002).

Bacteriological examination

For enumeration of total mesophilic and psychrotrophic bacterial count, standard plate count agar plates (Oxoid CM 463) were incubated after the inoculation at 32ºC for 48 hours (Swanson *et al.,* 1992) at 7ºC for 7 days (Cousin *et al.,* 1992), respectively. For enumeration of *Staph. aureus*, the inoculated Baird-Parker agar plates (Oxoid CM 145) were incubated at 37ºC for 48 hours according to the method recommended by Bailey and Scott (1982). Moreover, enumeration of Coliforms was done by Most Probable Number technique "MPN" adopted by Hitchins *et al.* (1992). For isolation of *E. coli*, loopful from each of the positive *E. coli* broth tube was inoculated over the surface of Eosine Methylene Blue (EMB) agar plates (Krieg and Holt, 1984). In addition, all samples were analyzed to determine the presence of any *E. coli* O_{157}:H_7 serotype according to the procedure proposed by FDA (2001). The suspected colonies of *E. coli* were biochemically and serologically identified. Salmonella isolation was carried out by streaking onto each of Xylose-Lysine Desoxycholate (XLD) and MacConkey agar according to procedure recommended by FAO (2002).

Statistical analysis

All data were statistically analyzed by ANOVA using SPSS 17.0 for windows (SPSS Inc, Chicago, IL, USA) and represented as means±SE. The differences between the mean values were determined by least square difference test (LSD) procedure and the main effects were considered significance at $P<0.05$.

RESULTS AND DISCUSSION

Sensory quality

Sensory attributes of meat and meat products are widely considered to be the most important determinant factor of consumer acceptability, with special consideration to appearance, flavor and texture. Moreover, sensory analysis permits evaluating sensory properties that are directly related to consumer understanding of quality. Data in Table 1 summarized results of sensory panel scores of RTE poultry meat products samples collected from local markets at Menofia and Gharbia governorate. Sensory panel scores for all examined RTE poultry meat products samples including chicken ham, chicken shawarma, chicken with herps, smoked turkey and turkey smoked lobes indicated that the overall acceptability was generally low as they scored 4.97, 5, 4.88, 4.98 and 5.57, respectively. As a rule, chicken with herps, chicken ham and smoked turkey RTE products showed the lower sensory panel scores.

Overall acceptability of all examined RTE poultry meat products was low probably due to the marked decrease in all the investigated sensory attributes specially flavor, taste and consistency. The obtained results were in

Table 1: Sensory panel scores of RTE poultry meat products samples (n=60)

	Chicken ham	Chicken shawerma	Chicken with herps	Smoked turkey	Turkey smoked lobes
Color	6.12±0.30a	6.57±0.23a	6.62±0.22a	6.32±0.21a	6.63±0.21a
Taste	5.63±0.14a	5.87±0.29a	5.47±0.29a	6.08±0.15a	5.98±0.20a
Flavor	4.97±0.26a	5.00±0.28a	4.88±0.40a	4.98±0.22a	5.57±0.42a
Consistency	5.28±0.23a	5.45±0.23a	5.30±0.29a	5.28±0.24a	5.78±0.26a
Overall acceptability	4.97±0.26a	5.00±0.28a	4.88±0.40a	4.98±0.22a	5.57±0.42a

Values (mean±SE) bearing different alphabets in a row differ significantly (P<0.05).

Table 2: Deterioration criteria of RTE poultry meat products samples (n=60)

Parameters	Chicken ham	Chicken shawerma	Chicken with herps	Smoked turkey	Turkey smoked lobes
pH	6.61±0.09a	6.53±0.08a	6.63±0.10a	6.30±0.05b	6.41±0.05ab
TBA	0.61±0.03ac	0.62±0.06a	0.47±0.03c	0.99±0.08b	0.48±0.03ac
TVBN	9.38±0.53ad	10.38±0.56ac	13.41±0.44b	9.00±0.32d	10.81±0.44c
Overall acceptability	4.97±0.26a	5.00±0.28a	4.88±0.40a	4.98±0.22a	5.57±0.42a

Values (mean±SE) bearing different alphabets in a row differ significantly (P<0.05). TBA (Thiobarbituric acid) expressed as milligrams of malonaldehyde/kg**:** TVBN (Total volatile basic nitrogen) expressed as mg/100g sample.

Table 3: Bacterial load (log_{10} CFU/g) of RTE poultry meat products samples (n=60)

Parameters	Chicken ham	Chicken shawerma	Chicken with herps	Smoked turkey	Turkey smoked lobes
Total mesophilic bacterial counts	4.49±0.16ac	4.37±0.19ac	4.11±0.07ab	4.78±0.16c	3.94±0.14b
Total psychrotrophs	2.73±0.22ab	2.74±0.10ab	2.54±0.20a	3.09±0.10b	2.83±0.15ab
Total staphylococcus counts	2.16±0.26a	2.61±0.29ab	2.80±0.10b	2.84±0.21b	2.49±0.14ab
Coliforms counts	2.44±0.20a	2.82±0.43a	1.20±0.22b	2.63±0.42a	1.28±0.20b

Values (mean±SE) bearing different alphabets in a row differ significantly (P<0.05).

Table 4: Incidence (%) of pathogens in RTE poultry meat products samples (n=60)

Organisms	Chicken ham		Chicken shawerma		Chicken with herps		Smoked turkey		Turkey smoked lobes	
	No.	%	No.	%	No.	%	No.	%	No.	%
Staph. aureus	1	8.33	0	0	0	0	0	0	0	0
E. coli poly3: O151	0	0	1	8.33	0	0	0	0	0	0
E. coli poly1: O1	0	0	1	8.33	0	0	1	8.33	1	8.33
E. coli poly1: O26	0	0	0	0	0	0	0	0	1	8.33
Salmonella	0	0	0	0	0	0	0	0	0	0

agreement with Ramarathnam and Rubin (1994) who reported that the overall acceptability of meat products depends on their flavor. Flavor is a complex sensation includes taste and aroma or smell and considered one of the most important factors affecting consumers' meat-buying habits and preferences even before eating the meat. Development of off-flavors (rancidity) is due to lipid oxidation which can be determined by sensory evaluation and measurement of the degradation products such as TBA (Naveena *et al.*, 2005).

The obtained data of chicken ham was in agreement with Abdel-naeem *et al.* (2010) who observed that chicken ham samples had very low score for all sensory attributes. The mean sensory panel scores for appearance, color, flavor, tenderness, juiciness, binding and overall acceptability were 3.98, 3.81, 2.78, 3.1, 2.73, 4.22 and 3.23, respectively. The low sensory panel scores for the examined chicken ham may be due to incorporation of low-quality materials. Jackman *et al.* (2010) reported that ham differs in quality mostly due to the number of muscle pieces forming the ham. To produce highest quality ham, it should be processed from a single muscle with least or without brine injection to increase cooking yield. However, the obtained results for chicken shawarma were not in agreement with Ibrahim *et al.* (2014) who observed relatively high sensory scores which ranged from 6.3 and 7.45 with overall acceptability of 7.05.

Deterioration criteria

pH value is one of keeping quality parameter which is used to assess the shelf-life of the meat products. The variations of TBA values may be attributed to fat content of the examined chicken meat products and is usually considered as an index of lipid oxidation related to the sensory characteristics as rancidity (Raharjo and Sofos, 1993; Mehmood *et al*., 2020). Furthermore, TVBN measurement is considered as a reliable indicator of various chicken meat products especially during storage where protein break down (ammonia) may occur due to microbial growth and its proteolytic enzymes (Alina and Ovidiu, 2007).The results of the deterioration criteria of RTE poultry meat products samples are presented in Table 2. The pH values of most of the examined RTE poultry meat samples were relatively alkaline and the lowest value was recorded in smoked turkey samples (6.30) while, the highest value was observed in chicken with herps samples (6.63). The relatively alkaline pH values may be attributed to metabolites accumulation through bacterial action of spoilage microorganism on protein and amino acids (Kumar and Tanwar, 2011).

TBA values of chicken ham, chicken shawarma, chicken with herps, smoked turkey and turkey smoked lobes were 0.61, 0.62, 0.47, 0.99 and 0.48mg malonaldehyde/kg, respectively. The highest TBA value was recorded in smoked turkey products and exceeded the limit described by E.S. (3493/2005) for cooked poultry meat products. This relatively high TBA value may be due to fat oxidation throughout storage or due to the use of low quality meat ingredients in the processing of such product and/or to the high level of lipids and unsaturated fatty acids present (Tang *et al.*, 2001). In this

consideration, Gomes *et al.* (2003) pointed out that the development of TBA is used as indication for fat oxidation of chicken meat products. Moreover, Al-Dughaym and Altarabi (2010) claimed that relatively higher TBA value is responsible for the changes in nutritional, sensory quality, acceptability and reduced shelf life of poultry products. Furthermore, lipid oxidation has economic importance for meat industry as it leads to the development of rancidity and chemical spoilage in food (Tang *et al.*, 2001). The obtained result concerning the higher TBA of smoked turkey products than other RTE poultry meat products is in agreement with Wilson *et al.* (1976) who found that turkey meat was the most susceptible to development of fat rancidity by TBA analysis. Al-Dughaym and Altabari (2010) observed that higher degree of TBA value is associated with noticeable objectionable flavor and lower degrees of acceptability in further processed poultry products.

TVBN values of the examined RTE poultry products samples ranged from 9.00 to 13.41mg/100g. There were significant ($P<0.05$) differences in TVBN values between the examined RTE poultry meat samples and the highest value was recorded in chicken with herbs samples. Decreasing of TVBN of examined samples may refer to its low protein content. The obtained results were in disagreement with Ibrahim *et al.* (2014) who recorded higher TVBN values of shawarma samples.

Bacteriological examination

The bacteriological quality of RTE foods is assessed by estimation of its total viable bacterial and Coliforms counts which can give general idea about the hygienic measures taken during handling preparation and processing of foods (Aberle *et al.*, 2001). Safety of RTE cooked chicken meat products are depending on the correct cooking and post processing sanitary practices. The presence of food borne pathogens on the equipment surfaces or the environment, especially in post-cooking zone are the most important routes for contamination of RTE meat products which lead to outbreaks of food-borne disease (Ansari, 2015).

Table 3 reveals the results of bacterial load (log_{10} CFU/g) of RTE poultry meat products samples. All investigated bacterial counts (APC, psychrotrophs, total staph and Coliforms) in all examined RTE poultry meat products samples were significantly high and exceeded the limit established by E.S. (3493/2005) for cooked poultry meat products. *Staph. aureus* was isolated from chicken ham, *E. coli* $poly_3$: O_{151} was isolated from chicken shawarma, *E. coli* $poly_1$: O_1 was isolated from chicken shawarma, smoked turkey and turkey smoked lobes and *E. coli* $poly_1$: O_{26} was isolated from turkey smoked lobes. However, *E. coli* O_{157}:H_7 and Salmonella strains failed to be isolated from all the examined samples (Table 4). According to E.S. (3493/2005) for cooked poultry meat products, these products must be free from *Staph. aureus*, *E. coli* and Salmonella. The obtained results concerning higher bacterial counts of RTE poultry meat products were in agreement with El-Mossalami (2003). In addition, isolation of *E.coli* from RTE poultry meat products were in agreement with Kakar and Udipi (2002) and failing of isolation of Salmonella strain was in agreement with El-Mossalami (2003). The high microbial load of marketed chicken products may be due to mishandling, incorporation of contaminated raw material & ingredients, and contact with insanitary equipment (Andrés *et al.*, 2006). Moreover, poultry products offer ideal medium for microbial growth due to their suitable chemical composition and favorable pH (Johnston and Tompkin, 1992). This necessitates the improvement of the microbiological quality of such products.

Conclusion

From this study it could be noticed that overall acceptability of all examined RTE poultry meat products samples (chicken ham, chicken shawarma, chicken with herps, smoked turkey and turkey smoked lobes) collected from Menofia and Gharbia governorate were significantly low. In addition, higher pH, TBA values, APC, psychrotrophs, total Staph and Coliforms were observed in all examined samples. Moreover, *E. coli* $poly_3$:O_{151}, *E. coli* $poly_1$:O_1, *E. coli* $poly_1$:O_{26}, and *Staph. aureus* strains were isolated from some samples. A matter which suggested an improvement of the microbiological quality of poultry meat products is necessary. While, *E. coli* O_{157}:H_7 and Salmonella were absent in all examined RTE poultry meat products samples.

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REFERENCES

Abdel-Naeem HHS, Emara MMT, Ibrahim AMM, *et al.*, 2010. Quality improvement of some poultry meat products. Master thesis, Faculty of Veterinary Medicine, Cairo University, Egypt.

Aberle ED, Forrest JC, Gerrard DE, *et al.*, 2001. Principles of Meat Science. 4th Ed. Kendall/Hunt Publishing Co, Dubuque, IA.

AL-Dughaym A and Altabari GF, 2010. Safety and quality of some chicken meat products in Al-Ahsa markets-Saudi Arabia. Saudi J Biol Sci, 17: 37-42.

Alina H and Ovidiu T, 2007. Determination of total protein in some meat products. Analele Stiintifice ale Universitatii, Alexandru Ioan Cuza, Sectiunea genetica si Biologic Moleculara, TOM VI.

AMSA "American Meat Science Association" 1995. Research guidelines for cookery, sensory evaluation and instrumental tenderness measurements of fresh meat. Chicago, IL, USA: American Meat Science Association.

Andrés SC, Garcıa ME, Zaritzky NE, *et al.*, 2006. Storage stability of low-fat chicken sausages. J Food Eng, 72: 311–319.

Ansari CB, 2015. Bacteriological examination of ready-to-eat foods (RTE) products of Tehran province, Iran. Adv Food Sci Technol, 3: 328-331.

Bailey WR and Scott EG, 1982. Diagnostic Microbiology. A Textbook for Isolation and Identification of Pathogenic Microorganisms. 6th Ed, Mosby Company, Saint Louis, USA.

Cavani C, Petracci M, Trocino A, *et al.*, 2009. Advances in research on poultry and rabbit meat quality. Italian J Anim Sci, 8: 741-750.

Çolak H, Ugurluay G, Nazlı B, *et al.*, 2011. "Paketlemede kullanılan nem tutucu filtrelerin hindi etinin raf omru uzerine etkisi," İstanbul Universitesi Veteriner Fakultesi Dergisi, 37: 107-116.

Cousin MA, Jay JM and Vasavada P, 1992. Psychrotrophic microorganisms, in: Vanderzant C, Splittstoesser DF (Eds), Compendium of methods for the microbiological examination of foods, third ed. American Public Health Association, Washington, DC. Chapter 9, pp: 153-164.

Du M, and Ahn DU, 2002. Effect of antioxidants on the quality of irradiated sausages prepared with turkey thigh meat. Poult Sci, 81: 1251–1256.

ES (3493/2005). Cooked poultry meat products, Egyptian Organization for Standardization and Quality Control, Egypt.

El Jalil MH, Khamar M, Maaninou S, *et al*., 2020. Antibiotic resistance of *Escherichia coli* strains isolated from broiler meat in Morocco. Int J Vet Sci, 9: 305-308.

El-Mossalami E, 2003. Risk assessment of ready prepared meat products. Ph.D., Thesis (Meat Hygiene), Faculty of Veterinary Medicine, Cairo University, Egypt.

FAO 2002. Risk assessments of Salmonella in eggs and broiler chickens. World Health Organization Food and Agriculture Organization of the United Nations.

FDA 2001. *E. coli* and the Coliform Bacteria. Chapter 4. Food and Drug Administration. Bacteriological Analytical Manuel Online.

Gomes HA, Silva EN, Nascimento MRL, *et al.,* 2003. Evaluation of the 2- thiobarbituric acid method for the measurement of lipid oxidation in mechanically deboned gamma irradiated chicken meat. Food Chem, 80: 433-437.

Hitchins AD, Hartman PA and Todd EC, 1992. Bergey's Manual of Systematic Bacteriology. Vol. 1, Williams and Willkins Baltimore, USA.

Howard S, Adams J and White M, 2012. Nutritional content of supermarket ready meals and recipes by television chefs in the United Kingdom: cross sectional study. Brit Med J, 345: 1-10.

Ibrahim HM, Sallam AM and Mahmoud SS, 2014. Quality evaluation of some locally manufactured chicken meat products. Benha Vet Med J, 26: 143-149.

Jackman P, Sun D, Allen P, *et al.,* 2010. Identification of important image features for pork and turkey ham classification using color and wavelet texture features and genetic selection. Meat Sci, 84: 711-717.

Johnston RW and Tompkin RB, 1992. Meat and Poultry Products. In "Compendium of Methods for the Microbiological Examination of Foods". Pp. 821-835 publ. American public Health Association.

Kakar DA and Udipi SA, 2002. Microbiological quality of ready-to-eat meat and meat products sold in Mumbai city. J Food Sci Technol-Mysore, 39: 299-303.

Kandeepan G, Anjaneyulu ASR, Kondaiah N, *et al.,* 2009. Effect of age and gender on the processing characteristics of buffalo meat. Meat Sci, 83: 10-14.

Kayaardi S, Kayacier QA and Gok V, 2006. Sensory and chemical analysis of döner kebab made from turkey meat. J Muscle Food, 17: 165-173.

Kearsley MW, El-Khatib L and Gunu COKA, 1983. Rapid determination of total volatile nitrogen in fish and meat. Assoc Public Analy, 21: 123-128.

Kralik G, Kralik Z, Grčević M, *et al.,* 2018. Quality of Chicken Meat. In: Animal Husbandry and Nutrition. Chapter 4, pp: 64-93.

Krieg NR and Holt JG, 1984. Bergey's Manual of Systematic Bacteriology. Vol. 1, Williams and Willkins Baltimore, USA.

Kumar D and Tanwar VK, 2011. Effects of incorporation of ground mustard on quality attributes of chicken nuggets. J Food Sci Technol, 48: 759-762.

Mehmood K, Bilal RM and Zhang H, 2020. Study on the genotypic and phenotypic resistance of tetracycline antibiotic in *Escherichia coli* strains isolated from free ranging chickens of Anhui Province, China. Agrobiol Records 2: 63-68.

Naveena BM, Muthukumar M, Sen AR, *et al.,* 2005. Quality characteristics and storage stability of chicken patties formulated with finger millet flour (Eleusine coracona). J Muscle Foods, 17: 92-104.

Raharjo S and Sofos JN, 1993. Methodology for measuring malonaldehyde as a product of lipid peroxidation in muscle tissues: a review. Meat Sci, 35: 145–16.

Ramarathnam N and Rubin LJ, 1994. The flavor of cured meat. In "Flavor of meat and meat products". pp: 174-198. F Shahidi (Ed.). London: Blackie Academic and Professional.

Sabhadinde VN, 2014. Physico-Chemical characteristics of chicken sausage during refrigerated storage. Indian J Fundam Appl Life Sci, 4: 149-152.

Swanson KMJ, Busta FF, Peterson EH, *et al.,* 1992. Colony count methods. In: Vanderzant C and Splittstoesser DF (Eds), compendium of methods for the microbiological examination of foods, third ed. American Public Health Association, Washington, DC, Chapter 4, pp: 75–77.

Tang S, Kerry PJ, Sheehan D, *et al.,* 2001. Antioxidative effect of added tea catechins on susceptibility of cooked red meat, poultry and fish patties to lipid oxidation. Food Res Int, 34: 651-65.

Wilson BR, Pearson AM and Shorland FB, 1976. Effect of total lipids and phospholipids on warmed-over flavor in red and white muscle from several species as measured by thiobarbituric acid analysis. J Agric Food Chem, 24: 7-11.