QUALITY AND SAFETY OF LOCALLY PRODUCED CHICKEN LUNCHEON

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ABSTRACT

Ninety samples of Egyptian chicken luncheon sausage produced by six different meat processing plants (Fifteen samples each) were collected from different production lots within one month after processing from the supermarkets in Giza and Cairo. These samples were subjected to sensory investigation, determination of deterioration criteria, bacteriological examination as well as detection of non-meat tissues by histological examination to assure their quality and safety. The obtained results revealed that all samples had deteriorated sensory attributes, high TBA, pH value as well as very high bacteriological load. The results of histological examination showed that low skeletal muscular tissues and high fat content were evident in all samples. Moreover, bone particles, cartilage particles, skin tissue with feather and other non meat tissue such as digestive tract were observed.

Keywords: Chicken/Luncheon sausage/ pH/TBA/Bone/Cartilage/Skin.

1. Introduction

Poultry meat production and consumption has dramatically increased over the last few decades ***(American Meat Institute, 2004)***. This increase can be attributed to low production costs, rapid growth rates, high nutritional values, and the increased production of further processed products ***(Barbut, 2002)***. For several reasons, people prefer poultry meat products as compared to beef or pork. The manufacture of such products usually costs less than that of similar beef and pork products ***(Guerrero-Legarreta and Hui, 2010)***. An added benefit is that poultry meat is not restricted by most cultural and religious laws, and it is consumed by both Jews and Muslims ***(Deumier and Collignan, 2003)***. Further processing of poultry meat involves conversion of raw poultry carcasses into value added products ***(AL-Dughaym and Altabari, 2010)***. The production and consumption of chicken luncheon sausages has been increasing globally in particular chicken emulsion sausage ***(Bonoli et al., 2007*** and ***Hwang et al., 2011)***. These luncheon sausages are becoming more popular due to their sensory characteristics and ease of preparation, which reflects the development of more functionality enhanced chicken emulsion sausages with added dietary fiber ***(Park et al., 2012)***. Emulsion based product is one such technology which can convert meat of low organoleptic value into a highly acceptable product without tenderization ***(Ilayabharathi et al., 2012)***.

The first consumer right is to have a product of good quality and not constituting any health hazard. Quality products are those that meet some need or expectation of consumers and are safe and wholesome as well. The acceptance of further processed chicken meat products depends upon overall-acceptability, color, odor, taste and consistency. Therefore, consumers had given much greater choice over the foods which are more selective, of high quality and cheap. Finally, the product quality became more significant factor in meat products marketing ***(Potter, 2001*** and ***Agamy and Hegazy, 2011)***.

The increasing demand for meat products as well as the relative shortage in raw meat has led to its adulteration with various tissues and non-meat ingredients ***(Emara and Nouman, 2002)***. Mechanically deboned meat is commonly used as a major ingredient in producing of

emulsified and comminuted meat products such as chicken sausages, frankfurters and burger either as a binding agent or as an inexpensive source of meat to reduce the cost of the products. Moreover, it offers the food industry with a raw material with excellent nutritional (high protein content), good technological and functional properties ***(Daros et al., 2005*** and ***Püssa et al., 2009)***. However, it has some disadvantages, such as rapid onset of oxidative rancidity resulting in off-flavours and off-odours, colour and texture problems ***(Freitas et al., 2004)*** and the high microbial load, which makes it a highly perishable raw material ***(Gill, 1988)***. Based on ***E.S.S. (1696/2005)*** view point, the use of undesirable organs of slaughter animals, including the visceral organs, hyaline cartilage and bone instead of meat in heated meat products is considered as fraud. Due to the economic value of meat, the likelihood of using this unauthorized tissue is possible and formulation used in the preparation of meat products does not respect the standard and hygiene food regulation. Moreover, addition of inedible offales such as udders, lung, spleen, etc into most products which is sometimes used by producers only can be detected histologically ***(Rezaian and Rokni, 2003*** and ***Latorre et al., 2015)***. Therefore, the present study was designed to:

1. Examine the marketed chicken luncheon sausage for its quality and safety for human consumption through assessment of bacteriological quality with special reference to food poisoning microorganisms.
2. Analyze the sensory parameters and deterioration criteria to assure quality in the aspects of consumer acceptability and degree of freshness.
3. Detect the presence of bone and cartilage of MDM and the non meat tissues through histological examination.
4. Compare the obtain results with the Egyptian standard specification of chicken luncheon.

2. Materials and methods

Market survey

A total of ninety Egyptian chicken luncheon sausage produced by six different meat processing plants (Fifteen samples each) were collected from different production lots within one month after processing from the supermarkets in Giza and Cairo. Samples were transferred to the laboratories of Food Hygiene and Control Department, Faculty of Veterinary Medicine, Cairo University and kept chilled at 4°C till the time of investigation. All samples were subjected to sensory investigation, determination of deterioration criteria, bacteriological examination as well as detection of non-meat tissues by histological examination.

Investigations

1. Sensory panel analysis

Sensory panel analysis was performed by 5 panelists from the members of Food Hygiene and Control Department, Faculty of Veterinary medicine, Cairo University. All chicken luncheon sausage samples were evaluated for appearance, flavor, taste, consistency and overall acceptability using a 7-point scale (where 7 denote extremely acceptable and 1 denotes extremely unacceptable) according to the method described by ***AMSA (1995)***. Prior to the analysis panelists were trained in the definition and intensities of all investigated sensory parameters.

2. Deterioration criteria

2.1. pH value

Five grams from each of the prepared sample were homogenized with 20 ml distilled water for 10-15 seconds ***(Kandeepan et al., 2009)***. The pH was measured using pH meter (Lovibond Senso Direct) with a probe type electrode (Senso Direct Type 330) where three reading for each

sample were obtained and the average was calculated. The pH meter was calibrated every two samples using two buffers pH 7.0 and 4.0.

2.2. Thiobarbituric Acid value

Five grams from each sample were homogenized with 15 ml deionized distilled water. One milliliter of the homogenate was mixed with 50 µl butylated hydroxyanisole (7.2%) and one ml each of 15mM 2-thiobarbituric acid and 15% trichloroacetic acid. The mixture was vortexed, incubated in a boiling water bath for 15 minutes to develop color, then cooled and centrifuged for 15 min at 2500 rpm. The absorbance of the resulting supernatant was measured at 531 nm using Unico 1200 (USA) series spectrophotometer against a blank containing 1 ml of deionized water and 2 ml of 2-thiobarbituric acid-trichloroacetic acid solution. TBA (mg/ malonaldehyde/Kg) reading was multiplied by 7.8 ***(Du and Ahn, 2002)***.

2.3. Total Volatile Basic Nitrogen

Ten grams sample were macerated with 100 ml tap water and washed into a distilling flask with 200 ml tap water, then 2 grams magnesium oxide were added. A macro-Kjeldahl distillation apparatus was connected to the distillation flask containing 25 ml of 2% boric acid solution and few drops of methyl-red indicator (0.016 g methyl red, 0.083 g bromocresol green per 100 ethanol) with the receiving tube was dipped below the liquid, with distillation continued till collection of 200 ml. The condenser was then washed with distilled water and the distillate was titrated with 0.05 M (0.1N) sulphuric acid. The Total Volatile Base Nitrogen (mg/100 gram sample) was calculated as the titration multiply by 14 ***(Kearsley et al., 1983)***.

3. Bacterial examination

The spreading technique and the standard plate count agar were used for enumeration of aerobic mesophilic count ***(Swanson et al., 1992)***, and aerobic psychrotrophic count ***(Cousin et al., 1992)***. While, reinforced clostridial agar and the anaerobic system were performed for enumeration of the anaerobic sporeformers ***(Brewer and Allgeier, 1966).*** Coliforms were enumerated "MPN" using lauryl sulfate tryptose broth according to ***Hitchins et al. (1992)***, faecal coliforms "MPN" were calculated according to ***FAO (1992)*** and *E. coli* was isolated by inoculation on EMB according to ***Krieg and Holt (1984)***. For Salmonella isolation, the technique adopted by ***FAO (1992)*** was used by pre-enrichment in buffered peptone water 1% followed by selective enrichment in Rappaport medium and selective plating on both S.S. and XLD agar.

4. Histological examination

A duplicate 1x1 cm blocks from all the investigated samples were fixed in 10% formol saline for twenty four hours followed by overnight washing with running water. Fixed samples were dehydrated in a chain of upgrading concentration of ethyl alcohol, cleaned in xylene, and embedded in paraffin. Paraffin blocks were sectioned at 4-6 um thickness, and stained with Haematoxyline and Eosine ***(Banchroft et al., 1996)***.

Statistical analysis

All data were analyzed using SPSS statistics 17.0 for windows and results were recorded as mean±SE. Analysis of variance was performed by ANOVA procedure to compare between chicken luncheon sausages of different processing plants by the least significant difference (LSD) and significance was defined at $P<0.05$.

3. Results and discussion

Table (1): Sensory panel scores of Egyptian chicken luncheon sausage produced by different processing plants (n=90):

	Appearance	Flavor	Taste	Consistency	Overall acceptability
			Mean±SE		
1	$2.81^{a,c}$±0.29	$2.64^{a,c}$±.30	$2.38^{a,c}$±0.2	$2.92^{a,d}$±0.29	2.69^{a}±0.22
2	2.09^{a}±0.19	1.82^{a}±0.26	1.73^{a}±0.16	2.05^{b}±0.18	1.93^{b}±0.11
3	$3.57^{c,b}$±0.25	4.24^{b}±0.31	4.01^{b}±0.29	$3.56^{a,c}$±0.26	3.90^{c}±0.24
4	4.29^{b}±0.42	4.25^{b}±0.40	4.04^{b}±0.43	4.00^{c}±0.43	4.15^{c}±0.40
5	2.97^{c}±0.29	2.90^{c}±0.38	$2.41^{a,c}$±0.2	3.13^{a}±0.34	2.90^{a}±0.27
6	$2.81^{a,c}$±0.12	3.11^{c}±0.31	2.90^{c}±0.22	$2.27^{b,d}$±0.21	2.82^{a}±0.12
Mean	3.09±0.13	3.16±0.16	2.91±0.14	2.99±0.14	3.06±0.13

* a-d: Means with different superscripts differ significantly at P<0.05. 1-6: number of processing plants

Table (2): Deterioration criteria of Egyptian chicken luncheon sausage produced by different processing plants (n=90):

	PH	TVBN	TBA
		Mean ±SE	
1	6.71^{a}±0.05	5.97^{a}±0.52	1.11^{a}±0.08
2	$6.51^{a,b}$±0.04	5.90^{a}±0.49	1.14^{a}±0.10
3	6.43^{b}±0.09	8.14^{b}±0.43	$0.94^{a,b}$±0.11
4	6.49^{b}±0.09	$6.33^{a,c}$±0.57	0.86^{b}±0.03
5	$6.36^{b,c}$±0.07	$7.39^{b,c}$±0.55	$1.00^{a,b}$±0.07
6	6.19^{c}±0.11	5.41^{a}±0.33	$1.09^{a,b}$±0.10
Mean	6.45±0.03	6.52±0.22	1.02±0.04

* a-c: Means with different superscripts differ significantly at P<0.05. 1-6: number of processing plants
TVBN expressed as mg/100g sample. TBA expressed as milligrams of malonaldehyde/kg

Table (3): Bacterial load (log_{10} CFU/g) of Egyptian chicken luncheon sausage produced by different processing plants (n=90):

	Aerobic plate count	Psychrotrophes	Anaerobes
		Mean ±SE	
1	$5.31^{a,c}$±0.14	5.44^{a}±0.18	3.73^{a}±0.14
2	5.79^{a}±0.18	5.68^{a}±0.15	$3.43^{a,c}$±0.13
3	$5.15^{c,b}$±0.21	5.48^{a}±0.16	3.66^{a}±0.20
4	$4.73^{b,d}$±0.21	4.50^{b}±0.14	$3.00^{b,c}$±0.20
5	$5.19^{c,d}$±0.19	4.77^{b}±0.21	2.81^{b}±0.12
6	4.69^{b}±0.11	4.88^{b}±0.18	2.79^{b}±0.22
Mean	5.14±0.08	5.12±0.08	3.24±0.08

* a-c: Means with different superscripts differ significantly at P<0.05, coliforms, fecal coliforms, salmonella and *E.coli* were not detected in any sample. 1-6: number of processing plants

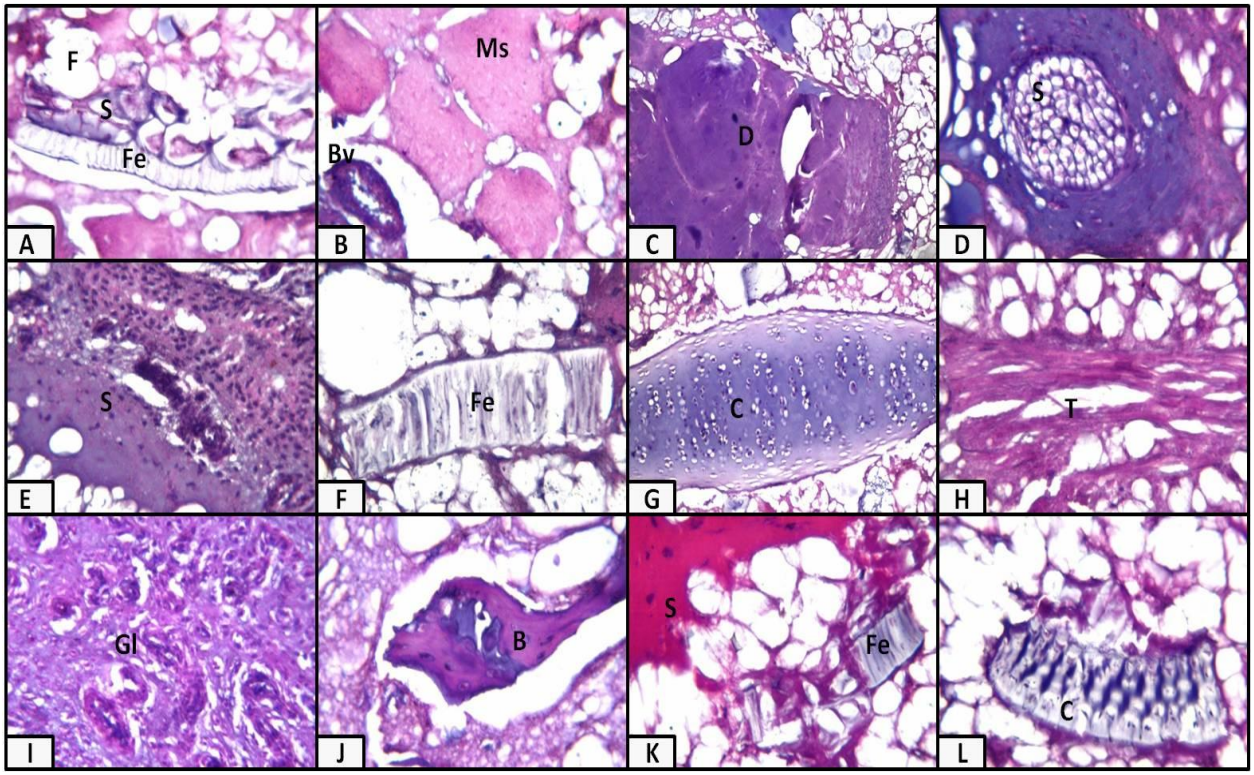

Photo (1): Histological sections stained with H&E (x40) of market Egyptian chicken luncheon sausage. First (A-B); Second (C-D); Third (E-F); Forth (G-H); Fifth (I-J) and Sixth meat processing plant (K-L). Feather (Fe); Skin (S); Fat (F); Blood vessel (Bv); Muscle (Ms); digestive tract (D); Cartilage (C); Tendon (T); Glandular structure (Gl) and Bone (B).

Product quality and safety is probably the most important aspect of making poultry meat products because it addresses the question of consumer acceptance and public health safety. While a processor may produce a wonderful sausage, the product must ultimately satisfy the consumer in terms of appearance, color, texture, and flavor ***(Toldrá et al., 2007*** and ***Jayasena et al., 2013)***. In this concern ***AMSA (1984)*** pointed out that sensory attributes of meat and meat products are widely considered to be the most important determinant factor of consumer acceptability. Moreover, sensory analysis permits assessing sensory properties which are directly related with quality perception by consumers ***(Skinner and Rao, 1986).*** Data in Table 1 summarized results of sensory evaluation of chicken luncheon sausage collected from six different meat processing plants. It was evident that the overall acceptability of all examined samples was obviously low probably due to the marked decrease in all the investigated sensory attributes. The product of the third and forth processing plant scored significantly ($P< 0.05$) higher overall acceptability score but still unacceptable (3.90 and 4.15 respectively).

The obtained results were in agreement with ***Sitz et al. (2005)*** who reported that the overall acceptance of meat products depends on their flavor which is mainly determined by taste and odor compounds. Unacceptable flavor was predominant in most examined samples, which may be explained on the basis of addition of high amount of non meat tissue such as mechanically deboned meat (Photo 1). This non meat tissue is liable for rapid onset of oxidative rancidity resulted in off-flavors and off-odors that ultimately reduced the consumer acceptability ***(Field, 1988)***. Moreover, ***Hargin (1996)*** and ***Lumley (1996)*** stated that undeclared additions of non meat tissues at the expense of skeletal muscle to meat products may not meet its expected sensory, microbiological and nutritional attributes. Furthermore, the unacceptable flavor and lower degrees of acceptability may be due to oxidation of the higher polyunsaturated fatty acids in chicken meat ***(Jayasena et al., 2013*** and ***Amensour et al., 2015)*** or due to the use of low

quality meat in the processing of such product ***(Sallam et al., 2004)***. At the same time, ***AL-Dughaym and Altabari, (2010)*** found that thirty percentages of chicken frankfurter not comply with Saudi Standards due to sensory unacceptability**.** While ***Gab-Allah (1990)*** reported that 100% of chicken luncheon were organoleptically acceptable.

Concerning the deterioration criteria of chicken luncheon sausage samples (Table 2), the relatively higher alkaline pH was observed in most processing plant with a mean value (6.45). This may be attributed to metabolites accumulation through bacterial action of spoilage microorganism on protein and amino acids ***(Kumar et al., 2011)***. Moreover, ***Pereira et al. (2011)*** attributed the higher pH value of emulsion type sausage to higher MDM content. ***El-Khateib et al. (1988)*** reported higher pH values (6.3) and ***El-deeb et al. (2011)*** found lower pH values (6.08) for chicken luncheon. The results of total volatile base nitrogen were ranged from 5.41 to 8.14 with an average of 6.52 (mg/100g). The higher TVBN value was recorded in the third (8.14) and fifth processing plant (7.39). Low TVBN of examined samples may refer to its low protein content ***(Farouk et al., 2002)***. As most of meat processors use MDM as an inexpensive material to substitute meat either partially or even totally in formulation of poultry and meat products ***(Emara, 2005)***. The obtained results were confirmed with histological examination where all photo filled with bone, cartilage and skin. Most of TBA values of the examined samples were exceeded the maximum limit for (0.9 mg malonaldehyde/kg sample) according to ***ESS (1696/2005)***, where the samples had values ranged from 0.086 to 1.14 with an average of 1.02 (mg malonaldehyde/kg). This may be due to fat oxidation or due to the use of low quality meat ingredients in the processing of such products and/or to the high level of lipids and unsaturated fatty acids present. Formulation of luncheon sausage with MDM may promote lipid oxidation of the product ***(Ertaş, 1998)***, because MDM contains more polyunsaturated fatty acids and haemoproteins which are more susceptible to both chemical and biochemical oxidation**.** Moreover, heat generation during production of MDM enhances fat rancidity ***(Püssa et al., 2008)***. Meanwhile, ***Andreo et al. (2003)*** found that thermal process of meat emulsion tend to promote lipid oxidation by disrupting cell membranes and releasing pro-oxidants, thereby inducing the development of 'warmed-over' flavor. The present result was in disagreement with ***Al-Abdullah and Al-Majali (2011)*** who concluded that the oxidative rancidity of all examined chicken meat luncheon samples were less than the threshold level.

Data in Table 3 summarized results of bacterial load ($\log_{10}$ CFU/g) of Egyptian chicken luncheon sausage samples. Total aerobic mesophilic bacterial counts were exceeded the limit established by ***ESS (1696/2005)*** (not more than 10^4 CFU/g). Where the samples had values ranged from 4.69 to 5.79 with an average of 5.14 (CFU/g). While, psychrotrophic bacterial counts of chicken luncheon sausage were high in all examined processing plants where the first, second and third processing plant showed significant higher values than other processing plants. Moreover, anaerobic bacterial counts ranged from 2.81 to 3.73 with an average of 3.24 CFU/g. ***ESS (1696/2005)*** for Egyptian chicken luncheon sausage doesn't include anaerobic bacterial count as quality indicator parameter. The marked increase of all investigated bacterial counts in chicken luncheon sausage samples might be attributed to incorporation of high amount of non meat tissue such as MDM, skin with feather and digestive tract (Photo 1).

Several authors explained the high bacterial loads to mishandling, incorporation of contaminated raw material, contact with insanitary equipment and insufficient heat treatment during processing as well as un-suitable condition during storage ***(Cox et al., 1998;; Zahran et al., 2008*** and ***Shawish, 2011)***. In addition to, poultry products offer ideal medium for microbial growth due to their suitable chemical composition and favorable pH a matter which suggested that an improvement of the microbiological quality of poultry meat is necessary. ***Luiz et al. (2004)*** recorded a considerable number of spoiled chicken sausages delivered to retailers before

the recommended sell-by date incurring large financial losses. Therefore, when contamination and illness occurred, investigators tend to look at the product (how it was produced, processed and handled) and press for elimination of pathogens before the product reaches the consumer. This creates a challenge to the poultry industry to improve the microbiological safety and quality of its products ***(Shackelford et al., 1988)***. The present results for APC nearly similar to those obtained by ***Essa et al. (2004); El-deeb et al. (2011)*** and ***Ibrahim et al. (2014).*** While, lower results were recorded by ***Sharaf and Sabra (2012)*** and higher results were recorded by ***Zahran et al. (2008); AL-Dughaym and Altabari (2010); Shawish (2011)*** and ***Nabil et al. (2014)***. Moreover, lower result than the present result of psychotropic and anaerobic count was recorded by ***Bkheet et al. (2007)*** and ***Nabil et al. (2014)*** in chicken luncheon, respectively.

Regarding our results of coliforms counts, it is failed to be detected in all examined chicken luncheon sausage samples. However, ***El-deeb et al. (2011)*** recorded low contamination rate with coliforms in chicken luncheon and frankfurter (3.4x10 and 3.9x10 respectively Cfu/g)**.** ***Zhang et al. (2001)*** explained that to good packaging, good retailing and no handling by workers, in addition to their exposure to heat treatment and smoking during processing. On other hand, ***Bkheet et al. (2007); Shawish (2011)*** and ***Nabil et al. (2014)*** observed high contamination rate of coliforms in chicken luncheon. Moreover, both *E. coli* and Salmonella failed to be isolated from all examined samples and it may be due to sufficient cooking temperature of such product. According to ***ESS (1696/2005)*** for Egyptian chicken luncheon sausage it must be free from both *E. coli* and Salmonella. ***Morrison and Fleet (1985)*** attributed the absence of Salmonellae in chicken meat products to the different processing which injured these sensitive bacteria, such as heat treatment or use of antimicrobial substances as chlorine components and sorbates**.** However, ***Luiz et al. (2004)*** confirmed that Salmonella was able to survive in chicken meat emulsion after the addition of preservatives a fact that could signify a serious risk in the final product and failed to isolate from chicken frankfurter sausages due to adequate industrial cooking process. Similar findings regarding isolation of *E. coli* were reported by ***Edris et al. (1992); Ebeid (1996); El-Sbagh (2010)*** and ***Shawish (2011)***. On the other hand, ***Sharaf and Sabra (2012)*** isolated *E. coli* from chicken luncheon with incidence 25%. The present result concerning isolation of Salmonellae was in agreement with ***AL-Dughaym and Altabari (2010); Shawish (2011);*** and ***Ibrahim et al. (2014)***. However, ***Essa et al. (2004)*** isolated 2 strains of Salmonella serotyped as *S.* Typhimurium and *S.* Typhi from chicken luncheon.

Histological examination seems to be very accurate and rapid technique (lasts one day only) that can be used effectively to detect adulteration of meat products such as Egyptian luncheon as an emulsion type product with avian skin even in products subjected to severe treatments ***(Emara and Nouman, 2002*** and ***Tremlova and Štarha, 2003)***. Therefore, it is suitable method for the meat quality control ***(Buche and Mauron, 1997)***. The results of histological examination (Photo 1) showed that low skeletal muscular tissues and high fat content were evident in all samples. Moreover, bone particles, cartilage particles, skin tissue and other non meat tissue such as digestive tract were observed. All these non meat tissues have negative impact on the quality and safety of the examined product which confirmed the results of sensory (Table 1), deterioration (Table 2) and bacteriological investigation (Table 3). Several authors observed presence of non meat tissue like salivary gland tissue, nuchal ligament ***(Rokni et al., 1997)***, chicken skin, hyaline cartilage, peritoneal fat and kidney ***(Sepehri, 2008)*** in heated sausage. Moreover, ***Latorre et al. (2015)*** concluded that the formulations used in the preparation of the examined products do not respect the standard and hygiene food regulation and the products are of bad quality.

4. Conclusions

This study has shown that most of the investigated chicken luncheon sausages were not copy with the Egyptian Standard Specifications for chicken luncheon in term of sensory attributes, deterioration criteria as well as very high bacteriological load. Chicken luncheon sausages samples were highly contaminated with aerobic and anaerobic bacterial counts while *E. coli* and Salmonella failed to be isolated. Moreover, the results of histological examination confirmed the use of unauthorized tissue in formulation of such product which does not respect the standard and hygiene food regulation. Therefore, based on this evidence, control of the formulation process along with detailed monitoring and continuous inspection of this product manufacture is essential to achieve its quality and safety.

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الملخص

تم جمع عدد تسعين عينه من لانشون لحم الدجاج المنتج محليا من سته شركات مصنعات اللحوم المختلفه بواقع خمسه عشر عينه من كل شركه. فقد تم جمعها بصورة عشوائية في خلال الشهر الأول بعد تصنيعها وفحصها لتحديد مدى جودتها. واجريت على هذه العينات اختبارات الفحص الحسى، وفحوصات دلالات الفساد، الفحص الميكروبيولوجى بالاضافه الى الكشف على وجود مدخلات اخرى خلاف لحم الدجاج بالفحص المجهرى باستخدام الميكروسكوب الضوئي. فقد دلت نتائج فحص تلك العينات على تدهور الخواص االحسية عن الصورة المتعارف عليها لمصنعات لانشون الدواجن بدرجة كبيرة

بالاضافه الى وجود رائحه التزنخ الطاغيه على المنتج. بينما دلت فحوصات دلالات الفساد على إرتفاع درجه الأس الهيدروجيني وحامض الثيوباربتيورك وهذا يؤكد نتائج الفحص الحسى. كما أشارت نتائج الفحص الميكروبيولوجى الى زياده العد الكلي للبكتريا الهوائيه واللاهوائيه بينما لم يتم عزل كلا من الايشيريشياكولاى و السالمونيلا. وقد أظهر الفحص المجهرى باستخدام الميكروسكوب الضوئي ان معظم العينات التى تم فحصها تحتوي عل نسبه هائله من النسيج الضام، العظام،.الغضاريف، الجلد مما يؤثر سلباً على الجودة الحسية وكذلك المحتوي الميكروبي لهذا المنتج. وقد لخصت هذه الدراسه على ان معظم مصنعات لانشون الدجاج لا تطابق المواصفه القياسيه المصريه.