Safety and quality of some chicken meat products in Al-Ahsa markets-Saudi Arabia

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Abstract One hundred samples of 10 poultry meat products were collected from AL-Ahsa markets (Kingdom of Saudi Arabia). The samples were ranked from carcass cuts (chilled, frozen, fillet and thigh) to minced meat or further processed products as burger, nuggets, frankfurter and meat paste loaf. Samples were collected in triplicate for sensory, chemical and microbiological analysis to assure their quality and safety.

The obtained results revealed variation in chemical composition; some products with high fat percentage had a high thiobarbituric acid value, which resulted in the appearance of an unacceptable flavor.

Bacteriological analysis revealed that the mean total bacterial count was ranged from $2.7 \times 10^4$ cfu/g for nuggetsA to $3.3 \times 10^7$ cfu/g for burgerB and the other products in the range of $10^5$–$10^6$ cfu/g. While Staphylococcus aureus mean count ranged from less than $10^2$ cfu/g for all samples, accept $10^4$ and $10^6$ cfu/g for minceB and frankfurter samples, respectively. Escherichia coli isolated from 70% of the samples and Salmonella arizonali was isolated at once from thigh samples. Thirty percentages of samples not comply with Saudi Standards due to sensory unacceptability and 21% of samples nonconforming with bacteriological specifications.

1. Introduction

The first consumer right is to have a product of good quality and not constituting any health hazard. Poultry meat products are highly desirable, palatable, digestible and nutritious for all ages. In addition, they are low in price in comparison to beef and mutton.

Quality products are those that meet some need or expectation of consumers and are safe and wholesome as well. Further processing of poultry meat involves conversion of raw poultry carcasses into value added products, e.g., cold cuts, reconstructed products, or breaded products. Advantages of further processing of poultry meat are improving juiciness, flavor, shelf life and water holding capacity (Sahoo et al., 1996). Poultry meat is comprised of about 20–23% protein. Comminuted products, such as frankfurters, bologna and sausages typically contain about 17–20% protein, 0–20% fat, and 60–80% water (Smith, 2001).

El-Khateib et al. (1988) found that the total bacterial count of chicken products as sausage, burger, luncheon and

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frankfurter was $10^5$, $10^7$, $10^8$ and $10^9$ cfu/g, respectively, while *Staphylococcus aureus* was isolated from the same products at incidence of 40%, 70%, 20% and 40%, respectively. The mean pH values for the same products were 6.1, 6.3, 6.3 and 5.5, respectively, while the chemical analysis of the aforementioned products revealed percentages of 59.4, 63.8, 66.9 and 61.2 for water, 18.2, 18.2, 19.9 and 17.8 for protein and 20.3, 15.3, 10.0 and 17.1 for fat, respectively.

Unfortunately, such products offer ideal medium for microbial growth because they are highly nutritious, have a favorable pH, and are normally lightly salted or not salted at all (Johnston and Tompkin, 1992). Ready to eat meat or poultry products in which the level of *S. aureus* or *Clostridium perfringens* have reached $10^6$ cfu/g may cause illness, while the presence of Salmonellae is considered to be a potential hazard (Tompkin 1983).

Food safety aspects of poultry industry were discussed by Hunton (1997), in sections which consider: the growing awareness of food safety issues during the last two decades; the importance of food inspection services, risk assessment and management is increasing life expectancy in developed countries. In addition to the potential dangers from food poisoning, as related to the shift in emphasis from carcass inspection to microbiological criteria and the increasing sensitivity of many quality tests; establishment of standards, etc. These affected by political considerations; as the significance of quality of poultry meat products to all involved in their production, handling and consumption; and the role of communication and education in improving the situation (Altabari, 2009).

Sockeyt (1995) estimated the socio-economic cost of salmonellosis in European countries. Results revealed that *Salmonella* spp. were the most commonly reported etiology of infection, although the relative importance of other agents varied. Factors contributing to the increase in food poisoning are related to both foods eaten and their preparation. The implication of foods of animal origin as principle vehicles of infection was strengthened by reports associating these foods with outbreaks of human illness, and reports of *Salmonella* infections in animals and poultry. The increase in *Salmonella* infection associated with poultry products suggests that reducing infection in, or contamination of, poultry could significantly decrease human illness. Trends in the incidence of salmonellosis are linked to intrinsic factors (microbiological quality of the food and standards of preparation) and extrinsic factors (such as ambient temp.), which amplify the intrinsic effects (Corry et al., 1995).

Minimizing the risks of food poisoning due to Salmonellae, *Campylobacter* spp. and similar pathogens in poultry products were discussed by many authors (Humphrey, 1991; Mulder, 1995; Aulik and Mourer, 1995). The prevention and control of contamination of chicken carcasses could be achieved through optimal rearing, transport and slaughter conditions. While the use of carcass decontamination techniques should only be considered as supplementary to measures taken in the production chain.

Processed raw poultry meat naturally harbors bacteria, most of which are responsible for the spoilage of poultry meat. However, poultry products can harbor food-borne pathogens, like *Salmonella* stereotypes, *Campylobacter jejuni*, *Listeria monocytogenes*, *C. perfringens* and *S. aureus* (Waldroup, 1996). Poultry and poultry products rank first or second in foods associated with disease in most of the countries all over the world which in the USA ranked third of the reported food-borne disease outbreaks (Bean and Griffin, 1990).

In the Kingdom of Saudi Arabia incidence of food poisoning due to food of animal origin were 76.80% in comparison to 23.2% due to food of plant origin. Poultry ranked first as cause in food poisoning with incidence of 29.32%, followed by meat and cream with an incidence of 15.33 and 8.78, respectively. In Eastern region of the kingdom, such incidence record a total of 96.27% for food of animal origin and 37.77% for poultry and their products.

The food poisoning microorganisms causing outbreaks were mainly Salmonellae and *S. aureus* with an incidence of 8.99 and 11.54, respectively, while incidence of other food poisoning microorganisms causing 4.07% of the cases (Altabari and Al-Dughaym, 2002).

The present work aimed to examine the marketed chicken meat products, for its quality and safety for human consumption through assessment for bacteriological quality with special reference to food poisoning microorganisms. In addition, the sensory parameters and chemical composition will be analyzed to assure quality in the aspects of consumer acceptability, degree of freshness and nutritive value.

### 2. Materials and methods

Hundred samples of poultry meat products were collected at random from Al-Ahsa tow markets.

From each market, 30 samples of meat products of minced poultry meat, burger, nuggets, frankfurter and meat past loaf, were taken.

Samples of poultry meat products were collected in triplicate for sensory (10 samples), chemical (10 samples) and microbiological (10 samples) analysis.

Also 10 samples each of chilled, frozen chicken, fillet and thigh were taken from tow markets in Al-Ahsa for analysis.

The products were selected in accordance to their popularity, and because every producing company has its own formula for each poultry product; therefore for most of examined products, two companies were selected for each product to compare the differences in their composition and quality. For each sample ($n = 10$) different production date, patch number and place of collection were taken in consideration. Chicken fillet, samples were chilled, while other samples were frozen. Collected samples in its packages were transferred immediately to the laboratory in an icebox. The samples kept over night in refrigerator at 4 $\degree$C for thawing of the frozen products.

#### 2.1. Sensory evaluation

The sensory evaluation was carried out on the poultry meat products using trained panelists (Staff members of the Department of Veterinary Public Health, which are frequently used to do such test), where the products were prepared according to the methods recommended by the manufacturer and AMSA (1995). Each panelist recorded the results in special cheat using a 7-point descriptive category scale for each estimated parameter, in which one indicating very poor and 7 indicates excellent.

#### 2.2. Chemical analysis

All samples were examined for chemical composition to estimate their compatibility with the Saudi Arabian Standards.
The pH and total volatile base (TVB) were analyzed according to the methods recommended by Kirk and Sawyer (1991). Thiobarbituric acid (TBA) values were estimated as an indicator for the degree of products freshness after. Main chemical components (water, protein, fat and ash) were analyzed in accordance to the methods of AOAC (1995).

2.3. Bacteriological examination

All the samples were bacteriologically examined in accordance to the methods for the microbiological examination of foods recommended by the American public Health Association “APHA” (1992).

2.4. Statistical analysis

Obtained data were subjected to the proper analysis of variance (ANOVA) according to Snedecor and Cochran (1980) and Pietri and Watson (2006). Least significant difference (LSD) at 0.05% level of significance was used to compare the treatment means. Computation was done using SAS (2001).

3. Results and discussion

KSA food markets in the last decades had an intensive expansion in chicken meat production, which developed in response to consumer demand. Consumers are interested in quality parameters; in particular, those meet their needs or expectations, in addition to the concern of safety and wholesomeness.

3.1. Sensory and chemical analysis

Table 1 reflects the results of sensory evaluation of the examined poultry meat product. The samples were ranked from carcass cuts “Filet and thigh” to minced meat or further processed products as burger, nuggets, frankfurter and meat paste loaf “sampsas”. The processed products subjected to reformulation of the poultry meat by addition of different additives, which virtually had a great influence on the quality of the final product (Keeton, 2001; Radhakrishnan and Rajesh Kumar, 2006).

Table 1 Mean results of sensory evaluation of poultry meat products* (n = 10).

<table>
<thead>
<tr>
<th>Products</th>
<th>Appearance</th>
<th>Odor</th>
<th>Taste</th>
<th>Consistency</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filet</td>
<td>4.86a</td>
<td>5.475</td>
<td>5.885</td>
<td>5.505</td>
<td>5.04a</td>
</tr>
<tr>
<td>Thigh</td>
<td>5.12a</td>
<td>5.625</td>
<td>5.565</td>
<td>5.655</td>
<td>5.84a</td>
</tr>
<tr>
<td>MinceB</td>
<td>4.30a</td>
<td>4.465</td>
<td>4.835</td>
<td>3.025</td>
<td>4.36a</td>
</tr>
<tr>
<td>MinceA</td>
<td>5.25a</td>
<td>3.155</td>
<td>3.875</td>
<td>5.655</td>
<td>3.22a</td>
</tr>
<tr>
<td>BurgerA</td>
<td>5.43a</td>
<td>5.965</td>
<td>5.855</td>
<td>5.755</td>
<td>5.755</td>
</tr>
<tr>
<td>BurgerB</td>
<td>4.86a</td>
<td>3.255</td>
<td>2.355</td>
<td>4.265</td>
<td>3.35a</td>
</tr>
<tr>
<td>NuggetsA</td>
<td>5.86a</td>
<td>5.895</td>
<td>5.605</td>
<td>5.835</td>
<td>5.755</td>
</tr>
<tr>
<td>NuggetsB</td>
<td>5.25a</td>
<td>2.455</td>
<td>2.255</td>
<td>5.365</td>
<td>2.855</td>
</tr>
<tr>
<td>Meat paste loaf</td>
<td>5.14a</td>
<td>5.055</td>
<td>5.285</td>
<td>5.225</td>
<td>5.42a</td>
</tr>
<tr>
<td>Frankfurter</td>
<td>5.53a</td>
<td>4.755</td>
<td>5.255</td>
<td>5.855</td>
<td>5.15a</td>
</tr>
</tbody>
</table>

**Means within columns having different superscripts are significantly different (P < 0.05).

* Different manufacturers.

* 7-Point descriptive category scale for each estimated parameter, where one indicating very poor and 7 indicates excellent.

The further processed poultry products as minced meat, burger, nuggets, loaf and frankfurter, have a great variation in chemical composition (Table 2), this is due to the reformulation of such products by the manufacturers to get the most benefit in the market. In such products, having a high fat content it was noticed that, there was a high TBA value with a detectable unacceptable flavor and lower degrees of acceptability. In products such as minceB, burgerA and nuggetsA, this resulted from fat oxidation due to prolonged storage or due to the use of low quality meat in the processing of such defective products (Froning et al., 1971; Mulla, 2002; Sallam et al., 2004).

Flavor is a complex sensation. It involves odor and taste (Naveena et al., 2005). MinceA, burgerA and nuggetsA significantly had lower flavor scores, where the panelists were recognized a flavor of beginning of rancidity to rancid flavor. These products have high fat percentage and TBA values (Table 2). Development of off-flavors (rancidity) is due to lipid oxidation (Owens, 2001), which can be determined by sensory evaluation and measurement of the degradation products such as TBA (Cheng and Ockerman, 1998; Mulla, 2002). Many researchers reported a significant increase on TBA values due to prolongation of storage time (Cheng and Ockerman, 1998; Sun et al., 2001).

Consistency in poultry meat products influenced by several factors such as age of bird at slaughter time (Lawrie, 1979) forming of meat products from ground and comminuted meat with various ingredients. Some other factors as genetics, physiology, nutrition, management, and disease, in addition to those that occur before slaughtering dealing with fasting, transport and handling are more significant. All aforementioned factors have direct influence on pH of muscles, which virtually affecting the meat tenderness (Kotula and Wang, 1994). MinceA had a lower grade of consistency (3.02 points from 7); this may be due to the use of low quality meat or improper processing of the product.

Table 2 shows the chemical compositions of the examined products, the filet and thigh constitutes the main material used for further processing of poultry products. Mead (2000) stated that there are two main kinds of poultry muscles, white (breast) and red (leg). There have structural and physiological differences, as well as different pH value (5.6–5.8 for breast muscle and 6.1–6.4 for leg muscle).

The chemical analysis (Table 2) reflects the status of the poultry products in the market. The raw products “filet and thigh” have about 20% proteins and from 4.72 to 6.41 fat. Smith (2001) stated that poultry meat is comprised of about 20–23% protein, while the fat content of leg meat is higher than that of breast and the moisture content of breast muscle is higher than that of leg. The mean pH value for breast and leg muscle was 5.84 and 6.63, respectively. Mead (2000) stated that breast muscle has a pH value in the range of 5.6–5.8, and leg muscle pH is 6.1–6.4, and added that both types of muscle are relatively susceptible to microbial spoilage when stored in the unfrozen state.

3.2. Bacterial analysis

Chicken is rich in protein and easily spoiled. According to USDA, the bacteria associated with chicken include: Salmonella enteritidis, S. aureus, C. jejuni, and Listeria monocytogenes (USDA, FISIS, 2000).
Most food-borne outbreaks are a result of contamination from food handlers. Sanitary food handling and proper cooking and chilling can prevent food-borne illness. Before chickens are shipped to the market or to the further processing plants for cooking, they may have already passed through various stages of processing. Some stages are very critical to the microbial quality of chicken, such as immersion scalding and irradiation. According to the Saudi Arabia standards Organization for microbial levels of foodstuffs (SASO, No 1556, 1998), the required microbial level in poultry meat varies according to the type of product. In chicken filet, the total counts of bacteria should not exceed $10^6$ cfu/g; $S. aureus$ and $E. coli$ counts are less than $10^2$ cfu/g and $Salmonella$ should be negative. Thus, the product was complying with the SASO specifications (Table 3). On other hand the total bacterial counts in chicken thighs was $5.1 \times 10^5$ cfu/g; $S. aureus$ and $E. coli$ were isolated in counts less than $10^2$ cfu/g. $Salmonella arizona$ was also isolated and thus makes the product not fitting with the SASO due to presence of $Salmonella$ species.

In the case of minced chicken meat$^{A,B}$, the mean total bacterial count was $4.5 \times 10^6$ and $5.2 \times 10^6$ cfu/g, respectively; this was complying with the SASO. While $S. aureus$ counts were $10^4$ and $10^5$ cfu/g for minced meat$^{A,B}$, respectively, $E. coli$ were detected in 70% of samples and no $Salmonella$ was isolated. It is worth mentioning that the SASO did not specify the total bacterial and $S. aureus$ counts allowed in frozen minced meat and other frozen products as compared to chilled meat where the total bacterial counts allowed was stated as $5.0 \times 10^6$ cfu/g and should not exceed $10^5$ cfu/g.

It is well known that minced meat is an ideal medium for growth of various types of microorganisms. It is reported that other microflora present in meat have an adverse effect on the growth of staphylococci and that staphylococci grow better in cooked meat and in fresh meat treated with salt. The latter kills or suppresses the growth of saprophytic microflora normally present in meat ($Altabari, 1984$).

Concerning the chicken burger$^{1,2}$, the total bacterial counts conform to the SASO. The latter did not determine the limits for total bacterial count in frozen chicken burger, which reached $1.6 \times 10^5$ and $3.3 \times 10^6$ cfu/g in frozen burger$^{1,2}$, respectively. $S. aureus$ was detected only in mince$^3$ and Frankfurter$^2$ at mean counts of $10^5$ and $10^6$ cfu/g, respectively, while the other samples (80%) have a mean values less than $10^5$ cfu/g and $E. coli$ were isolated from 60% of samples; SASO allows up to $10^5$ cfu/g for each bacterial type. $Altabari$ ($1984$) stated that food poisoning with $S. aureus$ enterotoxin could occur when minced meat, already contaminated by large number of the bacteria during processing, is preserved at temperatures higher than 14 °C. To avoid this attention should be given to the initial bacterial contamination and meat should be kept at temperatures lower than 9 °C. It is common practice to keep minced meat at room temperature in hours and this predisposes for poisoning with $S. aureus$.

The total bacterial loads in nuggets$^{1,2}$ were $2.7 \times 10^5$ and $3.0 \times 10^6$ cfu/g, respectively, and they conforming to SASO. The $S. aureus$ counts were less than $10^5$ cfu/g and $E. coli$ was isolated from nuggets$^2$ in incidence of 60%, while $Salmonella$ was not detected.

In case of chicken loaf the total bacterial count reached $3.0 \times 10^6$ cfu/g and that of $S. aureus$ was less than $10^5$ cfu/g; the level specified for the latter in SASO is $10^5$ cfu/g and no $Salmonella$ or $E. coli$ were accepted.

### Table 2 Mean results of chemical analyses of poultry meat products ($n = 10$).

<table>
<thead>
<tr>
<th>Products</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>pH</th>
<th>TVB**</th>
<th>TBA***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filet</td>
<td>73.4*a</td>
<td>20.32*a</td>
<td>4.72*a</td>
<td>0.90*a</td>
<td>5.84*a</td>
<td>15.6*a</td>
<td>0.56*a</td>
</tr>
<tr>
<td>Thigh</td>
<td>71.62*a</td>
<td>20.01*a</td>
<td>6.41*a</td>
<td>1.05*a</td>
<td>6.63*a</td>
<td>14.3*a</td>
<td>0.48*a</td>
</tr>
<tr>
<td>MinceA</td>
<td>72.17*a</td>
<td>18.86*a</td>
<td>5.77*b</td>
<td>0.99*a</td>
<td>5.95*a</td>
<td>12.8*a</td>
<td>0.42*a</td>
</tr>
<tr>
<td>MinceB</td>
<td>69.22*a</td>
<td>17.01*a</td>
<td>11.17*b</td>
<td>1.97*b</td>
<td>6.37*b</td>
<td>14.1*a</td>
<td>3.01*b</td>
</tr>
<tr>
<td>BurgerA</td>
<td>66.01*a</td>
<td>16.82*b</td>
<td>8.26*b</td>
<td>2.05*b</td>
<td>6.20*b</td>
<td>11.5*a</td>
<td>0.44*a</td>
</tr>
<tr>
<td>BurgerB</td>
<td>68.60*a</td>
<td>15.07*b</td>
<td>11.13*b</td>
<td>2.10*b</td>
<td>6.20*b</td>
<td>10.8*a</td>
<td>2.86*a</td>
</tr>
<tr>
<td>NuggetsA</td>
<td>69.99*a</td>
<td>14.62*a</td>
<td>6.40*b</td>
<td>1.90*b</td>
<td>5.87*a</td>
<td>15.4*a</td>
<td>0.53*a</td>
</tr>
<tr>
<td>NuggetsB</td>
<td>61.65*b</td>
<td>12.58*b</td>
<td>6.67*a</td>
<td>2.02*b</td>
<td>6.03*a</td>
<td>13.5*a</td>
<td>2.09*a</td>
</tr>
<tr>
<td>Meat paste loaf***</td>
<td>57.56*c</td>
<td>14.99*b</td>
<td>6.46*c</td>
<td>2.45*c</td>
<td>5.70*c</td>
<td>15.6*a</td>
<td>0.55*a</td>
</tr>
<tr>
<td>Frankfurter</td>
<td>70.27*a</td>
<td>14.82*c</td>
<td>8.77*a</td>
<td>2.97*a</td>
<td>6.13*b</td>
<td>10.6*a</td>
<td>0.62*a</td>
</tr>
</tbody>
</table>

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$^a$–c Means within columns having different superscripts are significantly different ($P < 0.05$).

$^{A,B}$ Different manufacturers.

** Total volatile bases estimated as mg N/100 g sample.

*** The meat paste contains vegetable mix of high fiber, which not estimated.

### Table 3 Mean bacterial counts and incidence of isolated microorganisms from poultry meat products.

<table>
<thead>
<tr>
<th>Products</th>
<th>Mesophiles</th>
<th>$S. aureus$</th>
<th>$E. coli$</th>
<th>Salmonela</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filet</td>
<td>$6.2 \times 10^{6a}$</td>
<td>$&lt; 10^2a$</td>
<td>70 –</td>
<td>– –</td>
</tr>
<tr>
<td>Thigh</td>
<td>$5.1 \times 10^{6a}$</td>
<td>$&lt; 10^2a$</td>
<td>60 $10^7$</td>
<td>– –</td>
</tr>
<tr>
<td>MinceA</td>
<td>$4.5 \times 10^{6a}$</td>
<td>$&lt; 10^2a$</td>
<td>70 –</td>
<td>– –</td>
</tr>
<tr>
<td>MinceB</td>
<td>$5.2 \times 10^{6a}$</td>
<td>$10^8b$</td>
<td>70 –</td>
<td>– –</td>
</tr>
<tr>
<td>BurgerA</td>
<td>$1.6 \times 10^{6a}$</td>
<td>$&lt; 10^2a$</td>
<td>60 –</td>
<td>– –</td>
</tr>
<tr>
<td>BurgerB</td>
<td>$3.3 \times 10^{6a}$</td>
<td>$&lt; 10^2a$</td>
<td>– –</td>
<td>– –</td>
</tr>
<tr>
<td>NuggetsA</td>
<td>$2.7 \times 10^{6a}$</td>
<td>$&lt; 10^2a$</td>
<td>60 –</td>
<td>– –</td>
</tr>
<tr>
<td>NuggetsB</td>
<td>$3 \times 10^{6a}$</td>
<td>$&lt; 10^2a$</td>
<td>– –</td>
<td>– –</td>
</tr>
<tr>
<td>Meat paste loaf***</td>
<td>$2.5 \times 10^{6a}$</td>
<td>$&lt; 10^2a$</td>
<td>– –</td>
<td>– –</td>
</tr>
<tr>
<td>Frankfurter</td>
<td>$1.2 \times 10^{6a}$</td>
<td>$10^8c$</td>
<td>60 –</td>
<td>– –</td>
</tr>
</tbody>
</table>

$^a$–c Means within columns having different superscripts are significantly different ($P < 0.05$).

$^{A,B}$ Different manufacturers.

* $S. arizona$. 
In Frankfurter, the mean total bacterial and S. aureus counts were 1.2 × 10^6 and 10^4 cfu/g, respectively, while E. coli was isolated in the incidence of 60%. This product does not comply with the SASO, as the level allowed for S. aureus is not more than 10^3 cfu/g and Salmonella should not be present. El-Khateib et al. (1988) recorded a total bacterial count of 10^4 cfu/g for the same product and 10^5 cfu/g for burger.

It is clear from the aforementioned data that the total number of bacteria ranged from 2.7 × 10^4 to 3.3 × 10^5 cfu/g in nuggets and burger respectively. According to the SASO (No 1556, 1998), the total microbial number allowed in frozen and chilled chicken meat and its products should not exceed 10^6 cfu/g and should be Salmonella and E. coli 0157:H7 free. In this respect, S. arizona was isolated at once from chicken thigh samples.

In all samples investigated S. aureus count was less than 10^4 cfu/g except in minced meat and Frankfurter, where the count was 10^5 and 10^6 cfu/g, respectively. These high counts may indicate bacterial contamination during handling and packing.

Conclusively the study revealed that 30% of samples not comply with Saudi Standards due to sensory unacceptability, while burger samples (10%) and frankfurter samples (10%) not comply due to high mesophilic bacterial and S. aureus counts, respectively. One thigh sample not conformed due to presence of Salmonella.

Acknowledgment

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Safety and quality of some chicken meat products in Al-Ahsa markets-Saudi Arabia 41