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Sensory, chemical and microbiological quality attributes of beef salami sold in Assiut city, Egypt

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Abstract
The objective of the present study was to evaluate the sensory, chemical parameters (moisture, fat, proteins, Ash, thiobarbituric acid (TBA) and pH) and microbiological characteristics (total bacterial count (TBC), yeast and mould count, detection of Salmonella, Shigella, *E. coli* 0157:H7 *Staph. aureus* and *Cl. perfringens*) of three-types of beef salami (cooked, smoked and dried) sold in Assiut city. The sensory evaluation revealed that the examined samples were of fairly good quality. The mean values of pH and TBA for the examined samples were within the typical range for beef salami in Egyptian Standard. The statistical analysis shows that the dried salami differ significantly from the cooked and smoked (p= 0.0006; p <.0001) for the ash and moisture content, respectively. However, there is no significant difference between three types of beef salami for the protein and fat content (p= 0.2254; p=0.1736). The results of this study show that only 30.33% (10/33) of salami samples meet the standards hygiene, with an average contamination of: 4.2 x10^5 for TBC; 3.5x10^2 for total yeast and 4.5x10^3 for total mould. Neither *Cl. perfringens* nor *Saph. aureus* were identified in any of the samples. *Shigella* spp. was isolated from one of each samples and *Salmonella* spp. was detected in one cooked beef salami sample (9%). *E. coli* 0157:H7was identified in one (9%) of both cooked and smoked beef salami and in two (18%) samples of dried beef salmai. In conclusion, the hygienic quality of beef salami is not satisfactory and not comply with the standards in 69.67% of all samples tested, therefore beef salami retailed in Assiut should considered to pose a possible risk to consumers and should be improved. There is a need for routine analysis regularly by researchers to attract the attention of both producers and consumers to meat quality.

Keywords: salami, quality, sensory, chemical, microbiological

1. Introduction
The general term "salami" indicates stuffed meat products, very diffused and largely consumed because of their textural, sensorial, and nutritional properties. Salami is classified as a cured, fermented, matured and dried meat product, consumed without thermal treatment. Thus, the production stages must ensure the safety of the product.

Different kinds of salami can be distinguished such as cooked, smoked and dried salami as a function of several factors, that is, fineness of the meat, formulation, consistency, addition of spices, different preservatives, drying methods and storage conditions (Latorre-Moratalla *et al.*, 2008; Söllner *et al.*, 2009) [27, 39].

Cooked salami are non-acidified and heat-treated meat products produced all over the world in a wide variety. Products are heat-treated to 70–72°C in the core making them a fully-cooked meat product. Smoked salami resembles cooked salami with smoking is most often part of the process. The process of producing cooked salami, compared to dried salami, is considerably shorter and products are generally vacuum packed and stored below +4°C when offered for sale (Feiner, 2016) [16].

Only few data are present regarding the characterization of salami and, to our knowledge, no study simultaneously treats the chemical and microbiological data. Thus, the objectives of this study was a) to determine the sensory, chemical and bacteriological status of different types of salami available on the Assiut market; b) to determine the compliance of manufactured salami to the Egyptian Standards.

2. Materials & Methods
2.1 Sample collection
Three different local beef salami products were involved in the study, namely, cooked, smoked and dried beef salami. A total of 33 beef salami samples (11 each) were randomly purchased from local supermarkets located in the city of Assiut, and were transported to the laboratory where, after the package integrity verification, the samples were stored under refrigeration (4°C) until the bacteriological and chemical analyses were performed.

2.2 Sensory analyses
Organoleptic test of samples of beef salami performed according to Banwart, (1981) [4] with slight modification. Organoleptic examination based on: (a) off-odor (b) color (c) texture and (d) taste was done by a panel of six persons chosen among the students of post-graduates, Food Hygiene department, Faculty of Vet. Med., Assiut Univ. Samples were examined visually for color change (from pink to dark red) and by smelling to detect any abnormal odor (meat, animal, spicy, other) based on the previous experience of the examiners with normally consumed-able meat. Tape water was available for the panelists use between testing samples to cleanse the palate.

2.3 Chemical analysis

2.3.1 pH Values (A.O.A.C., 1990) [1]

The pH value of salami samples were measured by electrometric processes using a portable pH meter (Gallenkamp pH stick electrode) directly in the sample after blended separately with 100 ml of distilled-deionised water. The pH meter was calibrated with standard buffers (7) before pH measurement was taken.

2.3.2 Proximate composition

The salami samples were ground and homogenized thoroughly. Moisture, Ash, protein and fat were estimated.

2.3.2.1 Determination of moisture (A.O.A.C., 1995) [2]

Five gm of beef salami samples were ground and placed in an oven at 105°C. Moisture content was calculated as the difference between the initial weight and the final weight of the sample (after reaching a constant weight).

$$\text{Moisture content\%} = \frac{\text{W1-W2}\times 100}{\text{Ws}}$$

Where:
W1 = weight of sample before drying.
W 2 = weight of sample after drying.
Ws = weight of sample

2.3.2.2 Determination of fat content (A.O.A.C., 2000) [3]

After moisture determination, the dried sample was used to obtain the fat content by direct extraction by Soxhlet method (gravimetric). One gm of each sample was weighted onto filter paper of known weight, wrapped and extracted with petroleum ether (BP 60-80°C) in the Soxhlet apparatus for 16-18 hrs. The extracted samples were then dried overnight in hot air oven at 65°C, transferred to desiccator and left to cool, then weighted. The loss in weight was used to calculate the fat percentage.

$$\text{Fat \%} = \frac{\text{Weight lost x 100}}{\text{Sample weight}}$$

2.3.2.3 Determination of ash content (A.O.A.C., 1995) [2]

Three grams of sample was weighed into a clean and dry porcelain crucible and placed in a muffle furnace (Thermolyne, USA) at 550°C until white or light gray ashes were obtained.

$$\text{Ash \%} = \frac{\text{(W1-W2) x 100}}{\text{Sample weight}}$$

Where:
W1= weight of crucible with ash.
W2 = weight of empty crucible.

2.3.2.4 Determination of crude protein content (A.O.A.C., 1995) [2]

The protein content of the samples was determined by the micro kjedahl technique. 0.2g of sample was weighed accurately into micro-kjedahl flask, two hundreds milligrams of catalyst mixture and 3.5 ml of concentrated sulphuric acid were added, the sample content were heated on an electric heater for about 2 hr until the digestion was completed and cooled, then the content was placed into the distillation apparatus. Twenty milliliters of 40% NaOH were added the ammonia evolved was received in 10 ml of 2% boric acid solution. The trapped ammonia was titrated against HCl (0.02N) using universal indicator (methyl red + bromo cresol green), the total nitrogen and protein were calculated using the following equation.

$$\text{N\%} = \frac{\text{Volume of HCl}\times\text{N}\times 14\times 100}{\text{Sample Weight}\times 1000}$$

$$\text{CP\%} = \text{N\%}\times 6.25$$

Where:
CP%= crude protein
N%= crude nitrogen.
N= normality of HCl.
14= equivalent weight of nitrogen.

2.3.3 Measurement of Thiobarbituric acid (Ismail *et al.*, 2008) [21]

Three grams of salami samples were weighted and homogenized with 50 ML butylated hydroxytoluene (BHT 7.2 %) dissolving in 90 % ethanol and 15 ml of deionized distilled water (DDW) using stomacher for 2 min. 1 ml of the homogenate was transferred to a disposable test tube, and Thiobarbituric acid / trichloroacetic acid (20 mM TBA /15% TCA) 2ml was added. The mixture was vortex mixed and incubated in a boiling water bath for 15 min. The samples were cooled in the ice-water for 10 min, mixed again by vortex, and centrifuged for 10 min at 3000 rpm at 4℃. The absorbance of the resulting supernatant solution was determined at 531 nm against a blank containing 1 ml of DDW and 2 ml of TBA/TCA solution. The mounts of TBARS were expressed as mg of malondialdehyde (MDA) per kg of salami sample. TBA standard curve were constructed using TEP (1, 1, 3, 3 -tetra-ethoxypropane).

2.3.3.1 TEP Standard Curve

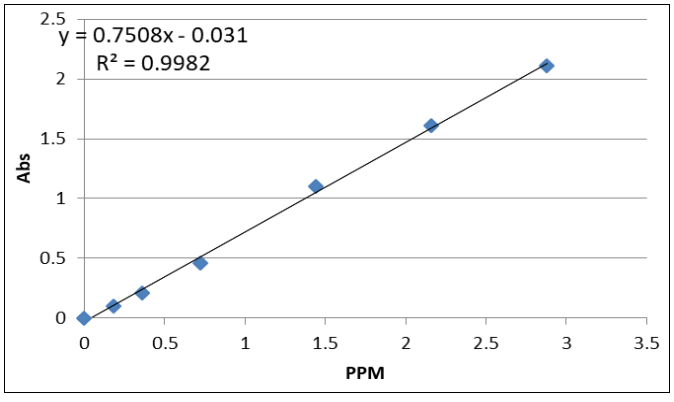

Fig 1: Diagram illustrated TEP standard curve

2.4 Microbiological analyses

2.4.1 Preparation of samples

The casing was aseptically removed; samples (10 g) were

aseptically removed from the interior and the external part of each salami sample using sterile knives and separately homogenized with 90 mL peptone water in a Stomacher (Seward® 400, BA 7021, UK). Then, decimal serial dilutions were prepared from this mixture.

1. Total bacterial count (T.B.C.) (ISO, 4833:2003) [22]:
   - Each sample was plated on Plate Count Agar (Oxoid, CM0463).
2. Mould and yeast count (FAO, 1992) [14]:
   - Each sample was plated on Malt Extract Agar (Himedia, M137).
3. Detection of *Salmonella* spp. (ISO-6579: 2002) [23].
4. Isolation of *Shigella* on DHL agar (ISO, 2004) [24].
5. Detection of *E. coli* 0157:H7 (De Boer and Heuvelink, 2000) [10].
6. Isolation of *Staph. aureus* (Quinn *et al.*, 2002) [34].
7. Isolation of *Cl. perfringens* (FDA, 2001) [15].

2.5 Statistical analysis

Mean ± standard deviation (SD) was calculated. Data were analyzed using the analysis of variance (ANOVA). Comparison of means was carried out by the Fisher's least significant difference test (LSD), and Duncan's multiple-range test with statistical significance being set at P<0.05. Analysis was performed using Microsoft office Excel (2016).

3. Results

Table 1: Results of some organoleptic characteristics of beef salami

Salami Samples	Organoleptic Test				
	Off odor	Color	Texture	Taste	Judgment
Cooked	Non	Red	Normal	Fleshy	fairly good
Smoked	Non	Red	Normal	Fleshy	fairly good
Dried	Non	Red	Normal	Fleshy	fairly good

Table 2: Statistics estimators for cooked, smoked and dried beef salami

Specification	Cooked salami (N=11)			Smoked salami (N=11)			Dried salami (N=11)		
	X	Min.	Max.	X	Min.	Max.	X	Min.	Max.
Moisture (%)	62.94	60.60	65.73	62.35	58.00	65.20	44.06	38.26	64.87
Fat (%)	19.75	14.5	27.30	18.51	13.66	22.70	16.89	12.90	24.00
Protein (%)	13.89	8.57	19.08	16.0	9.17	22.94	16.62	8.46	20.44
Ash (%)	3.24	2.33	4.00	3.72	3.00	5.00	5.62	2.33	7.66
pH	5.91	5.00	6.46	5.74	5.37	6.21	5.64	5.40	6.24
TBA	0.58	0.45	1.50	0.58	0.36	0.75	0.66	0.56	0.71

Table 3: Statistical analysis of the chemical parameters (mean±standard deviation) of cooked, smoked and dried beef salami

Type	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	pH	TBA
Cooked beef salami	62.94 [a] (±1.84)	19.76 [a] (±4.12)	13.89 [a] (±3.44)	3.24 [a] (±.42)	5.91 [a] (±.46)	0.58 [a] (±.30)
Smoked beef salami	62.35 [a] (±2.63)	18.51 [a] (±3.07)	16.0 [a] (±4.49)	3.72 [a] (±.67)	5.74 [a] (±.22)	0.58 [a] (±.10)
Dried beef salami	44.06 [b] (±9.72)	16.89 [a] (±3.35)	16.62 [a] (±3.44)	5.62 [b] (±2.18)	5.64 [a] (±.31)	0.66 [a] (±.04)
F value	36.33**	1.86 [NS]	1.57 [NS]	9.72**	1.69 [NS]	0.63 [NS]

*a-b: Means in the same column with different superscripts differ significantly at p<0.05.
**= highly significant
[NS] = not significant

Table 4: Results of the chemical analyses (mean±standard deviation) of cooked, smoked and dried beef salami in comparison with Egyptian Standards (E.S., 2005) [11].

Type	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	pH	TBA
Cooked, smoked beef salami and Standard						
Standard#	**Max.65 [a]**	**Max.20 [a]**	**Min.15 [a]**	**Max.3.5 [a]**	**Max.6.4 [a]**	**Max.0.9 [a]**
Cooked beef salami	62.94 [b] (±1.84)	19.76 [a] (±4.12)	13.89 [a] (±3.44)	3.24 [b] (±.42)	5.91 [b] (±.46)	0.58 [b] (±.30)
Smoked beef salami	62.35 [b] (±2.63)	18.51 [a] (±3.07)	16.0 [a] (±4.49)	3.72 [c] (±.67)	5.74 [b] (±.22)	0.58 [b] (±.10)
F value	36.33**	1.86 [NS]	1.57 [NS]	9.72**	1.69**	0.63**
Dried beef salami and Standard						
Standard#	Max.55 [a]	Max.25 [a]	Min.15 [a]	Max.3.5 [a]	Max.6.4 [a]	Max.0.9[a]
Dried beef salami	44.06 [b] (±9.72)	16.89 [b] (±3.35)	16.62 [a] (±3.44)	5.62 [b] (±2.18)	5.64 [b] (±.31)	0.66[b] (±.04)
F value	13.95**	64.54**	2.44 [NS]	10.44**	64.28**	315.12**

*a-c: Means in the same column with different superscripts differ significantly at p<0.05.
**= highly significant
[NS] = not significant
#Values according to Egyptian Standards (E.S., 2005) [11].

Table 5: Statistical analysis of microbiological evaluation of cooked, smoked and dried beef salami

Specification	Positive samples		Statistics estimators		
	No.	%	X (±SD)	Min.	Max.
Cooked beef salami					
TBC	11	100	4.5x105ab*(±6x105)	1x104	2x106
Total yeast	3	27.3	8x102(±8x102)	1x102	2x103
Total mould	4	36.4	5x103(±7x103)	2x102	1x104
Salmonella spp.	1	9	-	-	-
Shigella	1	9	-	-	-
E. coli 015:H7	1	9	-	-	-
Staph aureus	0	0	-	-	-
Cl. perferengens	0	0	-	-	-

Smoked beef salami					
TBC	11	100	4.6x105a*(±3x105)	7x104	1x106
Total yeast	4	36.4	1.6x102(<102)	1x102	2x102
Total mould	6	54.5	7.6x103(±1.6x104)	1x102	4x104
Salmonella spp.	0	0	-	-	-
Shigella	1	9	-	-	-
E. coli 015:H7	1	9	-	-	-
Staph aureus	0	0	-	-	-
Cl. perferengens	0	0	-	-	-
Dried beef salami					
TBC	11	100	3.5x105b*(±6x105)	1x104	2x106
Total yeast	2	18.2	1x102	1x102	1x102
Total mould	5	45.5	1x104(±1.5x104)	1x102	3x104
Salmonella spp.	0	0	-	-	-
Shigella	1	9	-	-	-
E. coli 015:H7	2	18.2	-	-	-
Staph aureus	0	0	-	-	-
Cl. perferengens	0	0	-	-	-

Values are expressed as means ± standard deviation. *Means with different letters are significantly different P < 0.05.

Table 6: Compliance percentage according to Egyptian Standard limits for Salami, 2005.

Microbiological parameters	Standard limit	Cooked salami (no.11) Compliance %		Smoked salami (no.11) Compliance %		Dried salami (no.11) Compliance %		Total Compliance % (no. 33)
		No	%	No	%	No	%	
TBC	$<1x10^4$	5	45.5	1	9.1	4	36.4	30.3
Yeasts	Free	6	54.5	7	63.6	8	72.7	
Moulds	Free	5	45.5	5	45.5	4	36.4	
Salmonella	Absent in 25 g	10	90.9	11	100	11	100	
Shigella	Absent in 25 g	10	90.9	10	90.9	10	90.9	
E. coli 015:H7	Free	10	90.9	10	90.9	9	81.8	
Staph aureus	Free	11	100	11	100	11	100	
Cl. perferengens	Free	11	100	11	100	11	100	

4. Discussion

Sensory analyses

The Results of organoleptic tests are given in Table 1. No obvious differences have been found in sensory analysis between the salami. All samples qualified as fairly good by the panelists according to criteria given in materials and methods. This result was quite similar to that achieved by Siham- Alamin and Ahmed (2015) [38]. Also, Haouet *et al.* (2017) [18] emphasized that no differences were highlighted for odour, texture, aroma and appearance of end products.

pH values

The ANOVA analysis of the pH of the cooked, smoked and dried beef salami showed significant differences with standard but no statistical differences ($p > 0.05$) among the means of them, which ranged from 5 to 6.46 (Table 2). However, as shown in Table 3, the pH values were within the typical range for salami in Egyptian Standard.

These relatively high pH values were likely due to increased proteolytic activity, with the formation of peptides, amino acids and non-protein nitrogen compounds and were consistent with findings in other studies of Italian salami (Garcia *et al.*, 2000) [17]. Also, Castro *et al.* (2000) [8] emphasized that a slight increase of pH may be related to a reduction of electrolyte dissociation, an increase of protein buffer concentration and formation of ammonia due to degradation of lactic acid by fungi.

Thiobarbituric acid (TBA)

TBA values of all examined beef salami were shown in Table 2. In this experiment, TBA values were ranged within 0.36 to 0.75 mg MDA/kg that was within the acceptance limit of TBA for rancidity (0.9 mg MDA /kg) established by Egyptian Standards (E.S., 2005) [11] (Table 3).While no significant ($P>0.05$) differences in TBA occurred between cooked, smoked and dried beef salami, the values were within the Standard limits. With exception, one sample of cooked beef salami recorded 1.5 mg MDA/kg which was above the permissible limit (Table 2). Similar findings were recorded by Kameník *et al.* (2012) [25]. This low value of TBA may be attributed to addition of preservatives especially nitrite which is used in cured meat products as salami because it delays the development of oxidative rancidity (Rahman, 2007) [36].

Lipid oxidation is an important quality deteriorating determinant for meat and meat products, as it may lead to rancidity of lipid (Nolsøe and Undeland, 2009) [31]. The monitoring of oxidation changes in salamis is absolutely essential to the assessment of their quality and shelf life, as these products are characterized by high microbial stability, and when they go off, it is practically always a consequence of oxidation of the fats they contain. Determining the content of malondialdehyde is a suitable method for comparing samples of the same type at various phases of oxidation (Kameník *et al.*, 2012) [25].

Proximate composition

The results of moisture, lipid, protein and ash analyses were listed in Table 2. The statistical analysis demonstrated in Table 3 showed that the dried beef salami differ significantly from the cooked and smoked beef salami (p= 0.0006; p <.0001) for the ash and moisture contents, respectively. However, there is no significant difference between three types of beef salami for the protein and fat contents (p= 0.2254 p=0.1736).

With regard to cooked and smoked salami, they had significantly different moisture contents (P<0.05) comparing to the standard, the average moisture contents ranged between 58.00 and 65.73% (Tables 2, 4) indicating a relatively lower variation among the moisture values of beef salami samples. All of the examined cooked and smoked salami samples had moisture values comply with the standards of Egypt for salami except one cooked beef salami sample had moisture value (65.73%) above Egyptian Standard which states that cooked and smoked beef salami should have a moisture content of less than 65% (E. S., 2005) [11].

Similar results of salami samples available at retail in Adana were recorded by Benli (2017) [5]. This result was also found by Tussi *et al.* (2008) [40] and Caccioppoli *et al.* (2006) [6] who observed that moisture content was one of the parameters showing the most frequent noncompliance with legal limits in industrial salami from different regions of Brazil.

Concerning dried salami, two samples with percent 18.18% (2⁄11) of the moisture contents of dried salami were over the standard of 55 % (E.S., 2005) [11] indicating insufficient drying.

Several studies have reported that the higher moisture content in meat products were due to decreased fat content (Pelser *et al.*, 2007) [33]. In addition, higher moisture content reported in Italian-type salami could come from water (Utrilla *et al.*, 2014) [41].

With respect to Ash content, two with percent 18% (2⁄11), 7 (64%) (7⁄11) and 9 (81.8%) (9⁄11) of cooked, smoked and dried beef salami, respectively were exceeded the permissible limit stated by the Egyptian Standard Specification (E.S., 2005) [11]. Much higher ash content in dried and smoked beef salami compared with cooked beef salami, possibly resulted from salt and others additives added (Malti, and Amarouch, 2008) [29].

The protein contents of most the salami types were within the legal limit of Egyptian standard; with the protein content set at a minimum of 15% for cooked, smoked and dried beef salami (E.S., 2005) [11]. Whilst, 6 with incidence 54% (6⁄11) and 5 with incidence 45% (6⁄11) and 3 with incidence 27% (3⁄11) protein content of cooked, smoked and dried beef salami, respectively were lower than the permissible limit stipulated by the Egyptian Standard Specification (E.S., 2005) [11].

The range of values (8.46- 22.94%) of protein content estimated in the present study was lower than the results found by Caccioppoli *et al.* (2006) [6], who reported a range of values from 22.61 to 27.86% in Italian-type salami. Among all examined salami samples, cooked beef salami was observed with low protein content with mean value of 13.89 (Table 2).

The fat contents of most the salami types were within the legal limit of Egyptian standard; with the fat content set at a maximum of 20% for cooked and smoked salami and 25% for dried salami (E.S., 2005) [11]. Whilst, 4 with percent 36% (4⁄11) and 3 with percent 27% (3⁄11) fat content of cooked and smoked salami, respectively were slightly exceeded the permissible limit stated by the Egyptian Standard Specification (ES, 2005) [11]. Among all examined salami samples, cooked beef salami was observed with high fat content with mean value of 19.76 (Table 2). Also, the same result was found by Caccioppoli *et al.* (2006) [6] and Tussi *et al.* (2008) [40].

In comparison with cooked and smoked salami, there was slight decreases in fat contents of the dried salami were observed but within limits of Egyptian Standards (Table2, 3).

Microbial Analysis

Total bacterial counts (TBC)

As demonstrated in Table 5, TBC for the salami samples were significantly different and higher (P < 0.05) compared to the standard. Average TBC of cooked, smoked and dried salami were $4.5x10^5(\pm 6x10^5)$, $4.6x10^5(\pm 3x10^5)$ and $3.5x10^5$ $(\pm 6x10^5)$ cfu⁄g, respectively (Table 5). As shown in Table 6, evaluating the microbiological quality of cooked, smoked and dried salami revealed that five (45.5%), one (9.1%) and four (36.4%) samples, respectively were classified as compliance (acceptable) for TBC according to Egyptian standards specification which establishes maximum counts of $1x10^4$ cfu⁄g for TBC in Egyptian salami (E.S., 2005) [11]. Also, higher results of TBC were reported by other studies as that conducted by Huang *et al.* (2014) [20]. On the contrary, low bacterial counts reported by other investigators as Elbazidy *et al.* (2017) [12] who explained that the generally low bacterial counts might be due to heat treatment. Also, Huang *et al.* (2014) [20] emphasized that a reason for these low microbial counts might be due to these types of salami contain preservatives, and thus may prevent bacterial growth on products.

Poor microbiological quality of this product may be associated with inadequate temperature storage, infrequent cleaning of slicing equipment and poor control of practices that may lead to cross contamination (Elson *et al.*, 2004) [13]. In general, microbial ecology of meat products mainly depends on the environment, kind of meat and raw materials, equipment handling practices, processing, packaging and storage temperature.

Yeasts and Moulds

Average total Yeasts and moulds counts of cooked, smoked and dried salami were no significantly different (P>0.05) (Table 5).

The counts of yeasts were satisfactory in 54.5%, 63.6% and 72.7% of cooked, smoked and dried beef salami samples, respectively (Table 6). With respect to the mould counts, 45.5%, 45.5% and 36.4% for cooked, smoked and dried salami samples respectively were compliance according to Egyptian standard (Table 6). On the contrary, the level of yeasts and moulds were acceptable for all salami examined from the Canterbury region of New Zealand (Huang *et al.*, 2014) [20].

Salmonella

Regarding Salmonella, it was detected in one (9%) sample of

cooked salami tested. Clearly, the presence of Salmonella in finished RTE products is a significant public health concern, and research is necessary to assess the ability of process parameters in the manufacture of salami to reduce or eliminate foodborne pathogens from the finished products (Nightingale *et al.*, 2006) [30]. While, *Salmonella* spp. was not isolated from neither smoked nor beef dried salami as recommended by Egyptian Standards Specification which establishes absence of *Salmonella* in 25g of beef salami samples (E.S., 2005) [11]. Similarly, Huang *et al.* (2014) [20] pointed out that *Salmonella* was negative in Italian salami. Also, Yörük and Güner (2017) [42] failed to detect *Salmonella* in salami examined in Turkey.

Based on our results and on the results found in other studies, the presence of this pathogen can be considered infrequent in cured meat products (Casquete *et al.*, 2012) [7]. However, there are documented outbreaks of salmonellosis associated with cured meat products, especially with salami (CDC, 2010) [9]. Survival of *Salmonella* in ready to-eat products has the potential to cause illness and salami has on several occasions been identified as the food vehicle for *S.* Typhimurium (Hjertqvist *et al.*, 2006 and Luzzi *et al.*, 2007) [19] [28]. A recent multistate outbreak of S. Montevideo in the United States was shown to have been caused by salami products containing contaminated red and black pepper, additionally highlighting the importance of post-processing contamination of ready-to-eat products (CDC, 2010) [9].

***Shigella* spp.**

Shigella spp. was isolated from one sample from each of cooked, smoked and dried beef salami with percentage 9%, respectively. Nearly similar results were reported by related studies as in Isfahan province where frequency of *Shigella* spp. in salami presented was 10% (Rahimi *et al.*, 2015) [35].

***E. coli* 0157:H7**

E. coli 015:H7 was detected in one sample of both cooked and smoked beef salami with incidence 9% and from two samples of dried beef salami with percent 18%. The possibility that the salami was contaminated with *E. coli* 0157:H7 during the slicing and packaging process could not be ruled out. On the other hand, no *E. coli* O157:H7 was isolated in any samples of salami purchased from different butcher shops and markets in the Elazig Province of eastern Turkey (Ozbey *et al.*, 2017) [32]. Also, Yörük and Güner (2017) [42] failed to detect *E. coli* O157:H7 in salami in Turkey.

Staph. aureus* and *Cl. perfringens

Neither the cooked beef salami or smoked salami nor dried salami were found to be positive for *Staph. aureus* nor *Cl. perfringens*. This may attributed to the formulation and processing conditions of these salamis were able to prevent growth of these microorganisms. Also, the absence of these pathogens might be due to that these types of salami contain preservatives, and thus may prevent bacterial growth on products (Huang *et al.*, 2014) [20]. Furthermore, Krause *et al.* (2011) [26] emphasized that under anaerobic environmental conditions, nitrite can control *Cl. botulinum* germination and the growth *Cl. perfringens*

Also, this obtained result was in consistent with other researchers as Huang *et al.* (2014) [20] who pointed out that absence of *Staph. aureus* in Italian salami. In contrast, other studies concluded that the presence of *Staph. aureus* in this type of cured meat product was frequent (Rosa-Menéndez *et al.*, 2018) [37].

5. Conclusions

The results of this study indicate that the chemical control of commercial beef salami is necessary, particularly moisture and Ash contents, because only 30.33% of the samples analyzed met the requirements of Egyptian Standard. With regards to microbiological characteristics, the result of microbiological analysis classifies 69.67% of salami sold in Assiut city (Egypt) do not meet the microbiological standards. The high counts of total aerobes and the presence of yeast and mould indicate that an inadequate control of the raw matter quality and of the process hygiene, storage or handling; and/or low quality ingredients may be used for its production. The presence of Salmonella and *E. coli* 0157:H7 indicate that eating of beef salami retailed in Assiut City might pose potential health hazard to consumers. So, in order to protect public health, it is important that adequate heat treatment must be applied to salami and they must be protected from recontamination. Also, it is mandatory that they must be produced using proper technology in hygienic conditions, good quality raw material must be used and qualified personnel must be employed at every stage in the production. Strict inspections and routine analysis must be conducted regularly by researchers to attract the attention of both producers and consumers to meat quality.

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