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Mycological Assessment of Cooked Beef Products

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ABSTRACT

A total of 130 samples of ready-to-eat beef products comprised luncheon, fried sausage, fried burger, grilled kofta and fried liver (26 each) were randomly purchased embedded in their sandwiches (with exception of luncheon's samples) from different supermarkets and restaurants having various sanitation levels at Mansoura city, Egypt –were analysed mycologically. Laboratory findings exhibited presence of moulds contaminants in 23 (88.5%) beef luncheon, 19 (73.1%) every of fried beef sausage and fried beef burger, 18 (69.2%) of grilled beef kofta plus 25 (96.2%) fried beef liver samples. Whereas, the yeasts were detected in 25 (96.2%) luncheon, 21 (80.7%) sausage, 23 (88.5%) burger, 22 (84.6%) kofta and 16 (61.5%) liver of the same samples. Enumeration plates of dichloran rose bengal chloramphenicol (DRBC) agar revealed the fungal populations in examined cooked beef products by maximum & mean \pm standard error levels every of moulds and yeasts in 26 tissue samples of each product as 1.3×10^3 & $1.7 \times 10^2 \pm 0.48 \times 10^2$ and 6.5×10^3 & $1.6 \times 10^3 \pm 0.34 \times 10^3$ cfu / g in beef luncheon, 1.1×10^3 & $1.6 \times 10^2 \pm 0.46 \times 10^2$ and 1.4×10^4 & $3 \times 10^3 \pm 0.67 \times 10^3$ cfu / g in fried beef sausage, 5×10^2 & $1.1 \times 10^2 \pm 0.22 \times 10^2$ and 7.8×10^3 & $2.02 \times 10^3 \pm 0.48 \times 10^3$ cfu / g in fried beef burger, 1.2×10^3 & $2.4 \times 10^2 \pm 0.65 \times 10^2$ and 8.2×10^3 & $2.15 \times 10^3 \pm 0.51 \times 10^3$ cfu / g in grilled beef kofta plus 9.5×10^2 & $2.3 \times 10^2 \pm 0.48 \times 10^2$ and 6×10^3 & $8.92 \times 10^2 \pm 3.09 \times 10^2$ cfu / g in fried liver, respectively. Data revealed the isolation of a sum of 472 mould strains from a whole 130 tissue samples of cooked beef products (26 each of kind); 88 (18.64%) strains of them recovered from luncheon, 85 (18%) from fried sausage, 57 (12.08%) from fried burger, 124 (26.27%) from grilled kofta, and 118 (25%) from fried liver samples. Generic level identification of the total mould strains categorized them as 170 (36.02%) *Aspergillus* strains, 103 (21.82%) *Cladosporium*, 76 (16.1%) *Penicillium*, 40 (8.47%) *Alternaria alternata* and 22 (4.66%) *Fusarium* strains which obtained from all kinds of tested beef products, in addition to 20 (4.24%) *Acremonium strictum* strains (18 from fried sausage and 2 from grilled kofta), 16 (3.39%) *Geotrichum candidum* (10 from fried sausage, 4 from fried burger and 2 from fried liver), 5 (1.06%) *Mucor* (2 from luncheon and 3 from grilled kofta), 4 (0.85%) *Rhizopus* (1 from luncheon, 2 from grilled kofta and 1 from fried liver), 3 (0.64%) *Rhizomucor* (from grilled kofta samples), 2 (0.42%) each of *Curvularia lunata* (from grilled kofta and fried liver) and *Trichothecium roseum* (from fried burger), 1 (0.21%) each of *Bipolaris* (from fried liver), *Cheatomium* (from fried burger), *Drechslera* (from one grilled kofta), *Endomyces fibuliger* (from fried burger), *Ulocladium botrytis* (from grilled kofta), besides 4 (0.85%) unidentified mould strains (3 from luncheon and 1 from fried liver samples). Data showed the identified groups of total obtained 170 *Aspergillus* strains as 73 (42.94%) of them were belonged to *Aspergillus niger* which were distributed in all types of tested samples and represented by 5 (6.85%) strains in luncheon, 3 (4.11%) in fried sausage, 10 (13.69%) in fried burger, 30 (41.09%) in grilled kofta and 25 (34.25%) in liver samples; followed by 23 (13.52%) strains of *Aspergillus fumigatus* group consisted of 2 (8.69%) strains recovered from luncheon, 10 (43.48%) from every of fried sausage and grilled kofta, besides 1 (4.35%) from fried burger; then 22 (12.94%) strains of *Aspergillus flavus* group, 3 (13.64%) of them isolated from luncheon, 4 (18.18%) from grilled kofta and 15 (68.18%) strains from fried liver samples; besides 17 (10%) isolates of *Aspergillus ochraceus* group, categorized as 6 (35.29%) strains determined in each of luncheon & grilled kofta, 1 (5.88%) in fried burger and 4 (23.53%) in liver; 10 (5.88%) strains of *Aspergillus terreus* group were found in grilled kofta, exclusively; 9 (5.29%) isolates of *Eurotium chevalieri*, composed of 1 (11.11%) strains from every of luncheon & fried sausage, 3 (33.33%) from grilled kofta, and 4 (44.44%) strains from fried liver samples; 6 (3.52%) strains of *Aspergillus parasiticus*, distributed as 1 (16.67%) of them recovered from each of fried sausage & fried liver and 2 (33.33%) from every of fried burger & grilled kofta samples; 5 (2.94%) isolates of *Aspergillus candidus*, 3 (60%) of them were found in grilled kofta and 2 (40%) in fried liver; 4 (2.35%) strains of *Eurotium amstelodami*, consisted of 1 (25%) strain recovered from every of luncheon & grilled kofta and 2 (50%) from fried sausage samples; in addition to a sole strain of *Aspergillus ustus* (0.58%) was found in a grilled kofta sample..

Keywords: Ready-to-eat beef products - Mycological Evaluation - *Aspergilli*

1. INTRODUCTION

Due to quick life style and lack of time for prepare proper meals, the demand to ready-to-eat meat products around the

world as the best alternative for fresh meat is increased (Blumenthal and Stier, 1991). The major reasons that fuel the demand for such products are their delicious taste, low cost,

nutritive value and easy serving. Ready-to-eat meat products are recognized as the food consumed directly at the point of sale without further re-heating (Adamolekun and Adamolekun, 1992 and Angelides et al., 2006). The progress of food technology and the utilization of meat in any available form of meat product render the processor to convert the different kinds of meat into identified products (Hammed, 2001 and Basyoni, 2003). Luncheon, fried sausage, fried burger, grilled kofta and fried liver are the most popular prepared beef meals in Egypt..

Beef luncheon usually manufactured by grinding of fresh or imported beef meat-free from tendons, nerves, cartilages and bones-with filling materials as salt; nitrite; carbohydrate substances; sugar; dried milk and spices, then the mixture heated to certain temperature and after heating cooled down, the final product packaged in polyethylene or cellophane bags. Fried beef sausage is processed by grinding a mixture of lean meat and fat with ice water, salting, seasoning and filler materials, then the emulsion is extruded into casing. The product is subjected to heat treatment (frying) before served to consumer. Fried beef burger made from mixing of lean meat with fat and other animal tissues as connective tissue /tendons can be used, then mincing with adding spices and salt. Burgers are stored frozen and individually pan-fried before consumption and served on bread rolls with slices of cheese or green salad. Grilled beef kofta prepared by mixing minced meat with refined wheat flour and fat to obtain an emulsion. Spices and condiments are added to the meat emulsion for an appetizing flavor and made into round shaped kofta manually, and then balls grilled on oiled, heated gas grill and served with flat or rounded thick bread. Fried beef Liver composed of small pieces of thawed imported liver placed in large pan contain hot oil and stirred until full cooking with some spices and vegetables and served inside a loaf of Egyptian bread .

Mould contamination of meat and meat products may occur at different stages at which the products are prepared. It may occur during slaughtering of animal under unhygienic condition, bad handling in butchers' shops and refrigerators, processing through using contaminated equipment or adding of contaminated meat-additives and spices, or during packing, handling, transportation and storage (Misra, 1983 and Abdel-Rahman, 1987). When the environmental conditions (temperature and relative humidity) are optimal after fungal contamination in the manufacturing rooms, stores, refrigerators and shops, the mould growth increased onto the beef products (Jesenská , 1987). Due to their beneficial chemical composition (water content, protein, peptides, amino acids, nucleotides, sugars, minerals and vitamins) , meat products are nutritious not only for humans but also for enhanced growth of microbes (bacteria and fungi) contaminating them (Ayres et al., 1980).

Street-vended cooked meat products are perceived to be a major public health risk due to lack of basic infrastructure and services, difficulty in controlling the large numbers of street food vending operations because of their diversity, mobility and temporary nature (Ghosh et al., 2007 and deSousa, 2008). Ready-to -eat meat products at factory and sale points are expected to be contaminated after processing due to recontamination phenomena through using contaminated slicing machines and cutting utensils (Vorst et al., 2006 and Pérez-Rodriguez et al., 2007).

Fungal contamination of meat products constitutes a real economic hazard as it affecting the quality of these meat products through production of proteolytic and lipolytic enzymes increasing the opportunity for its spoilage and deterioration. On the other hand, some mould species are capable of producing toxic metabolites termed mycotoxins causing cases of food poisoning, liver cancer and neurological disorders in human beings (Mossel, 1982 ; Foster et al., 1983 and Bhat et al., 2010). Yeast normally play a small role in spoilage because they constitute only a small portion of the initial population, because they grow slowly in a comparison with most bacteria and because their growth may be limited by metabolic substances which can produced by bacteria. Spoilage yeasts are those find their way into food being widely distributed into nature resulting in undesirable changes in physical appearance of food (Walker, 1977).

As, ready-to-eat meat sandwiches may be subjected to post -preparation microbial contamination and they do not subjected to further treatment to ensure their safety and the highest standards of quality before consumption , so the risk of contamination with fungi is must be considered. Therefore, the present study was planned to throw the light on the mycological risk in certain popular ready-to-eat meat products in Egypt comprising beef luncheon, fried beef sausage, fried beef burger, grilled beef kofta and fried beef liver, through:

- 1-Independent enumeration of moulds and yeasts populations in tissues of ready- to-eat beef products.
- 2- Generic identification of isolated moulds with further group characterization of the obtained aspergilli .

2. MATERIALS AND METHODS

Collection of samples

A total of 130 samples of ready-to-eat beef products comprised luncheon, fried sausage, fried burger, grilled kofta and fried liver (26 each) were randomly purchased embedded in their sandwiches (with exception of luncheon's samples) from different supermarkets and restaurants having various sanitation levels at Mansoura city, Egypt. Each samples type was separately and aseptically picked up then placed individually in clean polyethylene bags, marked and transferred - in icebox without undue delay- to the laboratory of Food Hygiene and Control Department, Faculty of

Veterinary Medicine, Mansoura University, where they subjected to mycological analyses.

Preparation of samples homogenate (AOAC, 1990)

Ten grams from each ready-to-eat beef sample were weighed aseptically into a sterile blender flask containing 90 ml of sterile peptone water 0.1% then homogenized for 2 minutes to obtain an original dilution of 10⁻¹.

Mycological tests

(1) Enumeration of mould and yeast population in the tissue of samples (King et al., 1979)

A fifth (0.2) ml from the previously prepared original dilution (1:10) was transferred and evenly spread over a dry surface of duplicated, previously prepared sterile Dichloran rose bengal chloramphenicol agar (DRCA) plates. The inoculated plates and the control one were incubated "upright position" at 25 °C for 5 days. After the incubation period, the average of mould and yeast colonies on the countable plates were enumerated and the mould counts and yeast counts per each gram of the examined tissue samples were then calculated and recorded. Each mould colony was picked up and delivered either onto a slope of Czapek yeast extract agar (CYA) (for hydrophilic moulds) or onto a slope of Czapek yeast extract agar with 20% sucrose (CY20S) (for xerophilic moulds) which incubated at 25 °C for 1-2 weeks and subjected for identification.

(2) Identification of the isolated moulds

Mould genera were identified according to Raper and Thom (1949), Arx (1967), Zycha et al. (1969), Barnett and Hunter

(1972), Samson et al. (1976), Schipper (1978), and Pitt and Hocking (1985), whereas *Aspergillus* groups were characterized according to Raper and Fennell (1965), and Samson (1979).

The isolated mould colonies were picked up from the agar slopes and subcultured on plates of Czapek yeast extract agar (CAY) and Czapek yeast extract agar with 20% sucrose (CY20S) by three points inoculation technique. The inoculated plates were incubated at 25 °C for 1-2 weeks.

The identification of both mould genera and *Aspergillus* groups was carried out by careful observation and measurements of the macro-and microscopical characteristics of their colonies.

Statistical analysis

The data obtained in this study were statistically analysed according to methods described by **Snedecor (1971)**. The mean value (\bar{X}) was obtained from the sum of individuals (X) divided on number of samples (N).

3. RESULTS

Table 1. Statistical analytical results of fungal populations / g (moulds - yeasts) in cooked beef products (* n = 26 each).

Types of beef products	Moulds counts / g			Yeasts counts / g		
	Min	Max	Mean ± S.E.	Min	Max	Mean ± S.E.
Luncheon	–	1.3×10 ³	1.7×10 ² ± 0.48×10 ²	–	6.5×10 ³	1.6×10 ³ ± 0.34×10 ³
Fried sausage	–	1.1×10 ³	1.6×10 ² ± 0.46×10 ²	–	1.4×10 ⁴	3×10 ³ ± 0.67×10 ³
Fried burger	–	5×10 ²	1.1×10 ² ± 0.22×10 ²	–	7.8×10 ³	2.02×10 ³ ± 0.48×10 ³
Grilled Kofta	–	1.2×10 ³	2.4×10 ² ± 0.65×10 ²	–	8.2×10 ³	2.15×10 ³ ± 0.51×10 ³
Fried liver	–	9.5×10 ²	2.3×10 ² ± 0.48×10 ²	–	6×10 ³	8.92×10 ² ± 3.09×10 ²

Table 2. Numbers and percentages of cooked beef products' samples contaminated with molds and yeasts (*n = 26 each)

Types of fungal contamination	Luncheon	Fried sausage	Fried burger	Grilled kofta	Fried liver
Moulds	23 (88.5%)	19 (73.1%)	19 (73.1%)	18(69.2%)	2 (96.2%)
Yeasts	2 (96.2 %)	21 (80.7%)	23 (88.5%)	22 (84.6%)	16(61.5%)

Table (3): Numbers and percentages of moulds strains isolated from cooked beef products (*n = 26 each).

Types of beef product	Luncheon	Fried sausage	Fried burger	Grilled kofta	Fried liver	Total
Isolated molds genera						
<i>Aspergillus</i>	18(10.59%)	17(10%)	14(8.24%)	70 (41.18%)	51 (30 %)	170 (36.02%)
<i>Cladosporium</i>	32(31.07%)	20(19.42%)	22(21.36%)	8 (7.77%)	21(20.39%)	103(21.82%)
<i>Penicillium</i>	24(31.57%)	11(14.47%)	5 (6.59 %)	26 (34.21%)	10 (13.16%)	76 (16.10%)
<i>Alternaria alternate</i>	5 (12.5 %)	2 (5 %)	2 (5 %)	6 (15 %)	25 (62.5%)	40 (8.47%)
<i>Fusarium</i>	3 (13.64 %)	5 (22.73 %)	8 (36.36 %)	1 (4.54 %)	5 (22.73%)	22 (4.66%)
<i>Acremonium strictum</i>	-	18 (90 %)	-	2 (10 %)	-	20 (4.24%)
<i>Geotrichum candidum</i>	-	10 (62.5 %)	4 (25 %)	-	2 (12.5%)	16 (3.39%)
<i>Mucor</i>	2 (40 %)	-	-	3 (60 %)	-	5 (1.06%)
<i>Rhizopus</i>	1 (25%)	-	-	2 (50 %)	1 (25 %)	4 (0.85%)
<i>Rhizomucor</i>	-	-	-	3 (100 %)	-	3 (0.64%)
<i>Curvularia lunata</i>	-	-	-	1 (50%)	1 (50%)	2 (0.42%)
<i>Trichothecium roseum</i>	-	-	2 (100 %)	-	-	2 (0.42%)
<i>Bipolaris</i>	-	-	-	-	1 (100%)	1 (0.21%)
<i>Cheatomium</i>	-	-	1 (100 %)	-	-	1 (0.21%)
<i>Drechslera</i>	-	-	-	1 (100%)	-	1 (0.21%)
<i>Endomyces fibuliger</i>	-	-	1 (100 %)	-	-	1 (0.21%)
<i>Ulocladium botrytis</i>	-	-	-	1 (100%)	-	1 (0.21%)
<i>Unidentified</i>	3 (75 %)	-	-	-	1 (25%)	4 (0.85%)
Total	88(18.64%)	85 (18 %)	57(12.08%)	124(26.27%)	118 (25%)	472 (100%)

Table (4): Numbers and percentages of identified strains of *Aspergillus* groups isolated from cooked beef products.

Isolated <i>Aspergillus</i> groups	Luncheon	Fried sausage	Fried burger	Grilled kofta	Fried liver	Total
<i>Aspergillus niger</i>	5 (6.85%)	3 (4.11%)	10 (13.69%)	30(41.09%)	25(34.25%)	73(42.94%)
<i>Aspergillus fumigatus</i>	2 (8.69%)	10 (43.48 %)	1 (4.35%)	10 (43.48%)	-	23(13.52%)
<i>Aspergillus flavus</i>	3 (13.64%)	-	-	4 (18.18%)	15(68.18%)	22(12.94%)
<i>Aspergillus ochraceus</i>	6 (35.29%)	-	1 (5.88 %)	6 (35.29%)	4 (23.53%)	17 (10%)
<i>Aspergillus terreus</i>	-	-	-	10 (100%)	-	10 (5.88%)
* <i>Eurotium chevalieri</i>	1 (11.11%)	1 (11.11%)	-	3 (33.33%)	4 (44.44%)	9 (5.29%)
<i>Aspergillus parasiticus</i>	-	1 (16.67%)	2 (33.33%)	2 (33.33%)	1 (16.67%)	6 (3.52%)
<i>Aspergillus candidus</i>	-	-	-	3 (60%)	2 (40%)	5 (2.94%)
* <i>Eurotium amstelodami</i>	1(25 %)	2 (50%)	-	1 (25%)	-	4 (2.35%)
<i>Aspergillus ustus</i>	-	-	-	1 (100%)	-	1 (0.58%)
Total	18(10.59%)	17(10 %)	14(8.24%)	70(41.18%)	51 (30 %)	170(100%)

* *Eurotium amstelodami*, the teleomorph name of *Aspergillus amstelodami*.

* *Eurotium chevalieri*, the teleomorph name of *Aspergillus chevalieri*.

* The percentages - in Tables 3&4- were calculated in relation to the sum of each correspondent category.

4. DISCUSSION

Laboratory findings arranged in both Table (1) exhibited presence of moulds contaminants in 23 (88.5%) beef luncheon, 19 (73.1%) every of fried beef sausage and fried beef burger, 18 (69.2%) of grilled beef kofta plus 25 (96.2%) fried beef liver samples. Whereas, the yeasts were detected in 25 (96.2%) luncheon, 21 (80.7 %) sausage, 23 (88.5%) burger, 22 (84.6%) kofta and 16 (61.5%) liver of the same samples. Differential evaluation for the prevalence of fungal contamination in surveyed cooked beef samples, the yeasts - contaminated samples were moderately higher than moulds - contaminated ones with an exception for the liver samples, the reverse was true.

By comparison, higher incidence for fungal contamination (moulds + yeasts) was obtained as 100% in raw hawawshy samples by Waffia and Hassan (2000); for moulds (only) were determined as 92.5% in raw beef sausage by Hassan and Ragheb (1996), as 80% in cooked beef sausage by Elshazly et

al. (2006), as 80% in raw beef sausage & 86.6% in raw beef burger & 93.3% in raw beef kofta by Hussein (2008), as 100% in meat additives and spices by El-Ghreeb et al. (2013), as 95% in cooked beef sausage & 85% in cooked beef burger & 90% in cooked beef kofta samples by Morshdy et al. (2015), as 86.8% in every of cooked beef burger & cooked beef kofta samples by Shokr (2016), as 80% in each of cooked beef burger & cooked beef kofta samples by Nabil et al. (2017); as well as higher prevalence for yeasts (only) was recorded by Hussein (2017) as 100% in 25 cooked beef samples each of luncheon & kofta & liver. On the contrary, lower occurrence of fungi (moulds + yeasts) was represented by 60% cooked hawawshy samples (Waffia and Hassan, 2000) and 83.34% in beef luncheon samples (Ebia, 2016).

Also, smaller percentages of moulds - contaminated samples of the correspondent beef products were literated by Ali et al. (2005), Hussein (2008), Sharaf and Sabra (2012), Morshdy et al. (2015) and Nabil et al. (2017) as 45%, 60%, 50%, 80% and 40% beef luncheon, successively, by Shokr

(2016) as 60% beef luncheon & 66.7 % cooked beef sausage, by Hussein (2017) as 64% cooked beef kofta & 76% cooked beef liver, in addition to the findings of Pamuk et al. (2013) who could not detect moulds contaminants in 49 samples of cooked beef kofta . Furthermore, yeasts – contaminated samples were also obtained among identical samples by lower percentages as 52.5% raw beef sausage by Hassan and Ragheb (1996), as 73.3% cooked beef sausage by Elshazly et al. (2006), as well as 65% & 28% beef luncheon by Sharaf and Sabra (2012) and Ismail et al. (2013), respectively. However, both Ismail et al. (2013) and Hussein (2017) recognized moulds- contaminated samples of beef luncheon as 92 % - besides Nabil et al. (2017) who detected moulds in 70% of hot dog samples nearly similar to that obtained in our study . The varying percentages of fungi - contaminated samples among the relevant meat products can be explained by the differences in their condition (raw or cooked), quality of both meat and their additives, sanitation during processing and packaging, maintenance of adequate refrigeration from the processor to the retail level and to the consumers, sanitation during handling at the retail stores, and finally the laboratory technique for detecting fungi contaminating tested meat products (Selvan et al., 2007) .

Enumeration plates of dichloran rose bengal chloramphenicol (DRBC) agar revealed the fungal populations in examined cooked beef products by maximum & mean \pm standard error levels every of moulds and yeasts in 26 tissue samples of each product as 1.3×10^3 & $1.7 \times 10^2 \pm 0.48 \times 10^2$ and 6.5×10^3 & $1.6 \times 10^3 \pm 0.34 \times 10^3$ cfu / g in beef luncheon, 1.1×10^3 & $1.6 \times 10^2 \pm 0.46 \times 10^2$ and 1.4×10^4 & $3 \times 10^3 \pm 0.67 \times 10^3$ cfu / g in fried beef sausage, 5×10^2 & $1.1 \times 10^2 \pm 0.22 \times 10^2$ and 7.8×10^3 & $2.02 \times 10^3 \pm 0.48 \times 10^3$ cfu/g in fried beef burger, 1.2×10^3 & $2.4 \times 10^2 \pm 0.65 \times 10^2$ and 8.2×10^3 & $2.15 \times 10^3 \pm 0.51 \times 10^3$ cfu / g in grilled beef kofta plus 9.5×10^2 & $2.3 \times 10^2 \pm 0.48 \times 10^2$ and 6×10^3 & $8.92 \times 10^2 \pm 3.09 \times 10^2$ cfu / g in fried liver, respectively (Table 2). Inspection of these results showed approximately and separately similar levels among each of moulds and yeasts contaminating the products with a permanent increase of yeasts populations than moulds ones. Additionally, the lowest yeasts intensities were recorded in fried liver samples, the findings that coordinated with their relevant prevalence in such samples which had a relatively low levels of meat additives and spices. The relatively higher yeasts counts in surveyed ready-to-eat beef products than the moulds may be explained by the literature of Fleet (1992) who mentioned that although yeasts occur in low numbers on freshly dressed carcasses of red and poultry meat, they can proliferate in ground meat and may reach 106 - 107 cfu / g. Furthermore, the highest maximum value of moulds counts found in beef luncheon samples, might reflect the poor hygienic status of slicing machines (Ehrampoush et al., 2017).

Concerning the moulds counts obtained by many researchers from correspondent raw and cooked beef and

camel products - in relation to our findings - an almost equal mean levels of such contaminants were recorded for raw products by Shaltout and Salem (2000) as 3.6×10^2 cfu/g in frozen beef liver, by Ouf (2004) as 1.4×10^2 & 2.7×10^2 cfu / g in ground camel meat & camel sausage, respectively and by El-Tabiy (2006) and Hussein (2008) as 2.9×10^2 and 2.26×10^2 cfu /g in beef sausage, successively. Similarly, approximate equal mean values of moulds populations were determined in cooked beef products as 3.53×10^2 and 1.92×10^2 cfu / g in kofta by Brr et al. (2004) and Hussein (2017) plus 10^2 , 1.6×10^2 , 1.86×10^2 and 2.12×10^2 cfu / g in luncheon by Hussein (2008), Ouf et al. (2010), Lubna and Ghada (2012) and Hussein (2017), consecutively .

Data arranged in Table (3) revealed the isolation of a sum of 472 mould strains from a whole 130 tissue samples of cooked beef products (26 each of kind); 88 (18.64%) strains of them recovered from luncheon, 85 (18 %) from fried sausage, 57 (12.08 %) from fried burger, 124 (26.27%) from grilled kofta, and 118 (25%) from fried liver samples. Generic level identification of the total mould strains categorized them as 170 (36.02%) *Aspergillus* strains, 103 (21.82%) *Cladosporium*, 76 (16.1%) *Penicillium*, 40 (8.47%) *Alternaria alternata* and 22 (4.66%) *Fusarium* strains which obtained from all kinds of tested beef products, in addition to 20 (4.24%) *Acremonium strictum* strains (18 from fried sausage and 2 from grilled kofta), 16 (3.39%) *Geotrichum candidum* (10 from fried sausage, 4 from fried burger and 2 from fried liver), 5 (1.06%) *Mucor* (2 from luncheon and 3 from grilled kofta), 4 (0.85%) *Rhizopus* (1 from luncheon, 2 from grilled kofta and 1 from fried liver), 3 (0.64%) *Rhizomucor* (from grilled kofta samples), 2 (0.42%) each of *Curvularia lunata* (from grilled kofta and fried liver) and *Trichothecium roseum* (from fried burger), 1 (0.21%) each of *Bipolaris* (from fried liver), *Cheatomium* (from fried burger), *Drechslera* (from one grilled kofta), *Endomyces fibuliger* (from fried burger), *Ulocladium botrytis* (from grilled kofta), besides 4 (0.85 %) unidentified mould strains (3 from luncheon and 1 from fried liver samples) .

Out of the whole 170 *Aspergillus* strains, 18 (10.59%) of them were found in luncheon , 17 (10 %) in fried sausage, 14 (8.24 %) in fried burger, 70 (41.18 %) in grilled kofta and 51 (30%) strains in fried liver samples. While, each of total 103 *Cladosporium* and 76 *Penicillium* strains were distributed as 32 (31.07 %) & 24 (31.57 %), 20 (19.42%) & 11 (14.47%), 22 (21.36%) & 5 (6.59%), 8 (7.77%) & 26 (34.21%) and 21 (20.39%) & 10 (13.16%) in these beef products, respectively . Similarly, a sum of 40 *Alternaria alternata* and 22 *Fusarium* strains were categorized as 5 (12.5%) & 3 (13.64%) in luncheon, 2 (5%) & 5 (22.73%) in sausage, 2 (5%) & 8 (36.36 %) in burger, 6 (15%) & 1 (4.54 %) in kofta and 25 (62.5%) & 5 (22.73%) in liver samples, successively (Table 3) .

Data arranged in Table (4) showed the identified groups of total obtained 170 *Aspergillus* strains as 73 (42.94%) of

them were belonged to *Aspergillus niger* which were distributed in all types of tested samples and represented by 5 (6.85%) strains in luncheon, 3 (4.11%) in fried sausage, 10 (13.69%) in fried burger, 30 (41.09%) in grilled kofta and 25 (34.25%) in liver samples; followed by 23 (13.52%) strains of *Aspergillus fumigatus* group consisted of 2 (8.69%) strains recovered from luncheon, 10 (43.48%) from every of fried sausage and grilled kofta, besides 1 (4.35%) from fried burger; then 22 (12.94%) strains of *Aspergillus flavus* group, 3 (13.64%) of them isolated from luncheon, 4 (18.18%) from grilled kofta and 15 (68.18%) strains from fried liver samples; besides 17 (10%) isolates of *Aspergillus ochraceus* group, categorized as 6 (35.29%) strains determined in each of luncheon & grilled kofta, 1 (5.88%) in fried burger and 4 (23.53%) in liver; 10 (5.88%) strains of *Aspergillus terreus* group were found in grilled kofta, exclusively; 9 (5.29%) isolates of *Eurotium chevalieri*, composed of 1 (11.11%) strains from every of luncheon & fried sausage, 3 (33.33%) from grilled kofta, and 4 (44.44%) strains from fried liver samples; 6 (3.52%) strains of *Aspergillus parasiticus*, distributed as 1 (16.67%) of them recovered from each of fried sausage & fried liver and 2 (33.33%) from every of fried burger & grilled kofta samples; 5 (2.94%) isolates of *Aspergillus candidus*, 3 (60%) of them were found in grilled kofta and 2 (40%) in fried liver; 4 (2.35%) strains of *Eurotium amstelodami*, consisted of 1 (25%) strain recovered from every of luncheon & grilled kofta and 2 (50%) from fried sausage samples; in addition to a sole strain of *Aspergillus ustus* (0.58%) was found in a grilled kofta sample.

Overviewing the obtained results revealed that an approximately a half of the whole *Aspergillus* strains were

identified as *Aspergillus niger*, followed by an almost equal numbers for every of *Aspergillus fumigatus* and *Aspergillus flavus* strains which constituted - together - two thirds of the *Aspergillus niger* ones. The highest *Aspergillus* strains as 70 (41.18%) were found in grilled kofta samples that contained all types of obtained aspergilla, followed by 51 (30%) strains determined in fried liver, then 18 (10.59%) & 17 (10%) & 14 (8.24%) *Aspergillus* strains isolated from luncheon & fried sausage & fried burger, respectively. The dominance of *Aspergillus niger* strains - found in tested samples - agreed with the literature emphasized that this fungus is more prevalent in warmer climates and its black spores provide protection from sunlight and UV light, providing a competitive advantage in such habitats (Valero et al., 2007). *Aspergillus niger* is very frequently isolated from spices (Elshafie et al., 2002 and Mandeel, 2005). Cereals and oilseeds are also frequent sources, especially maize (Magnoli et al., 2007). Meat products are another common source (Farghaly et al., 2004 and Hammad et al., 2006). Infections with this fungus in meat spices were also quite high (Pitt and Hocking, 2009).

Conclusion

Most of the examined ready-to-eat beef products samples were contaminated with different types of mould genera which considered as a major cause in the spoilage of these products, leading to great economic losses and constitute a public health hazards by production of wide variety of mycotoxins. So using of high quality raw materials (meat, spices and additives), efficient heat treatment, careful handling of the products, effective cleaning and sanitation, and finally prevention of cross contamination programs should be applied.

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