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Original Research Article

Microbiological evaluation of chicken meat products

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ABSTRACT

The aim of the present study was to compare the microbiological quality and safety of chicken products collected from a poultry processing plant and from the retail market. The collected samples represented 120 chicken product samples (mortadella, frankfurters, burgers, nuggets, fillet and fajita); 60 samples were collected from a poultry processing plant and 60 samples were from retail markets. For assessing the microbiological quality of these products, total bacterial count (TBC), most probable number (MPN) of coliforms and total mold and yeasts were determined. While, for evaluating the safety of collected products, *Staphylococcus aureus*, *Salmonella*, *E. coli* and *Listeria monocytogenes* were investigated. As well as, sensory evaluation of collected products was carried out. It was found that the bacterial counts in samples collected from processing plants were lower than corresponding samples collected from retail market. For instance, the obtained mean values of TBC in processing plant samples were 1x10, $4x10^2$, 2x10, 2x10, 3x10 and 6x10 CFU/g in case of chicken mortadella, chicken frank, chicken nuggets, chicken burger, chicken fillet and chicken fajita, respectively. While for retail market samples, TBC mean values were 2x10, 2x10, 3x10, 3x10, 4x10 and 3x10 CFU/g in chicken mortadella, chicken frank, chicken nuggets, chicken burger, chicken fillet and chicken fajita, respectively. It was evident that most of examined chicken product samples either from processing plant or retail markets were contaminated with investigated foodborne pathogens, namely; *Staphylococcus aureus*, *Salmonella*, *E. coli* and *Listeria monocytogenes*, in addition to contamination with mold and yeasts. In conclusion, the rate of contamination of chicken products from retail markets was higher than corresponding products obtained from processing plant, which is attributed to contamination of chicken products through bad handling during transportation, storage and marketing, as well as growth of contaminants as a result of improper storage conditions including temperature and humidity.

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1. Introduction

The changes in consumer eating habits have increased the demand for a wide variety of raw, frozen, pre-cooked and further processed chicken items. As a result, poultry industry has continued to seek ways to increase acceptability, shelf-life, and ensure optimum flavor, texture and overall product quality (Sahoo et al., 1996). Chicken burgers, nuggets, fillet …etc. are chicken meat products which create a demanding market due its highly desirable, palatable, and nutritious value for all ages. Moreover, they are quick and easily prepared. On the other side, chicken meat products offer an 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). Poultry meat and their products are considered as a major vehicle of most food-borne diseases. Presence of potential microbial hazards as *Staphylococcus aureus* and *Salmonellae* in ready-to-eat meat and poultry meat products is considered a significant issue (Tompkin, 1983 and Fratianni et al., 2010).

Chicken meat products may be contaminated with microorganisms from handlers, during the processes of manufacturing, and marketing. Improper cooking, refrigeration or storage may lead to meat-borne illness. Food-borne pathogens are the leading causes of illness and death, costing billions of dollars in medical care, medical and social costs **(**Fratmico et al., 2005).

Microbial pathogens in food cause an estimated 6.5 to 33 million cases of human illness and up to 9000 deaths annually (Council for Agricultural Science and Technology, 1994). Frequent reports of food poisoning outbreaks in the developed world have increased the public concern in relation to the potential presence of microbial hazards in food. Changes in eating habits, mass catering, unsafe food storage conditions and poor hygiene practices are major contributing factors to food associated illnesses**.** Therefore, the objective of this study is to determine the quality of different types of chicken products (Mortadella, Frank, Burgers, Nuggets, Fillet and Fajita) that collected from processing plant and retail markets either fully cooked, semi cooked or raw. The first consumer right is to have a product of a good quality and not constituting any health hazard.

2. Materials and methods

2.1. Collection of samples

A total of 120 frozen chicken meat product samples, 800 grams each, within their shelf-life. Frozen products were randomly collected from poultry processing plant and retail markets (60 each) and kept frozen till examination :

a. Fully cooked products were represented by chicken mortadella and chicken frankfurters (10 each).
b. Semi cooked products were represented by chicken nuggets and chicken burgers (10 each).
c. Raw products were represented by chicken fillets and chicken fajitas (10 each).

2.2. Organoleptic examination:

Color, odor, taste and consistency of the samples were evaluated by human senses, as well as boiling and roasting test. A panel of judges experienced in chicken sensory evaluation acted as panelists for this experiment. Acceptability scale ranged according to the nature of each product and its standard parameters, afterwards, the results had been recorded.

2.3. Microbiological examination

2.3.1. Preparation of samples

Samples were prepared according to the technique recommended by (APHA, 2001) as follows:

A mass of 25 grams of the samples was taken under aseptic condition and put in a sterile stomacher bag. A volume of 225 mL sterile maximum recovery diluents (MRD) solution (OXOID-CM733), were aseptically added. The contents were homogenized by stomacher for 2 minutes at 300/rpm using stomacher 400 lab

blender (Seward medical, London UK) to provide a homogenate of 1/10 dilution from which decimal dilutions were prepared up to 10^{-7}.

2.3.2. Microbiological techniques

2.3.2.1. Determination of total bacterial count (TBC)

Using pouring plate technique, according to the method reported by APHA (2001).

2.3.2.2. Determination of MPN of coliforms:

Using the most probable number (MPN) method, according to APHA (2001). A series of fermentation tubes that contain lauryl tryptose broth were inoculated with the sample and incubated for 24 hours at 35 ° C.

2.3.2.3. Determination of *Staphylococcus aureus* count (APHA, 2001)

Using a sterile pipette, 0.1 mL of prepared food homogenate of the first dilution was transferred and spread with sterile bent glass rod onto the surface of previously dried Baired Parker agar plates

2.3.2.4. Detection of *E. coli*

The samples were examined by fluorogenic assay for the rapid screening according to (Cruckshank et. al., 1975).

Serological identification of *E. coli*

The isolates were serologically identified according to (Kok et al. 1996) by using rapid diagnostic *E. coli* antisera sets (Denka Seiken Co., Japan) for diagnosis of the Enteropathogenic types.

2.3.2.5. Detection and isolation of *Salmonella*

Twenty five grams was initially inoculated into the pre-enrichment broth (buffered peptone water). The enrichment broth (Rappaport Vassiliadis) was inoculated onto selective differential agars (XLD medium) for the isolation of Salmonellae (Hodges et al. 1981).

Serological identification of *Salmonella*:

The isolates were serologically identified according to (Durham's 1896).

2.3.2.6. Detection of *Listeria monocytogenes*

Primary enrichment was conducted with *Listeria* enrichment broth, followed by a secondary enrichment in UVM modified *Listeria* enrichment broth according to method recommended by USFDA/BAM/CFSAN and streaked onto polymyxin-acriflavin-lithium chloride-ceftazidime-aesculin-mannitol (PALCAM) agar (Difco).

2.3.2.7. Determination of total yeast and mold count (APHA, 2001)

One hundred microliter from each of the previously prepared serial dilutions was inoculated into duplicate Petri dishes of Sabouraud dextrose agar medium supplemented with chloramphenicol and tetracycline.

3. Results

Table 1. Microbiological status of chicken products obtained from poultry processing plant

	Products	TBC	*Staph. aureus* count	MPN of coliforms	*E. coli* count	*Salmonella*	*Listeria monocytogenes*	Mold and yeast count
Fully Cooked	Chicken Mortadella (10)	$10^3 \pm 30$	$3x10^2 \pm 16$	<3	<3	-ve	-ve	<10
	Chicken Frank (10)	$4x10^2 \pm 10$	$3 x10^2 \pm 24$	<3	<3	-ve	-ve	<10
Semi Cooked	Chicken Nuggets (10)	$2x10^3 \pm 40$	$4 x10^2 \pm 28$	<3	25 ± 12	-ve	-ve	<10
	Chicken Burger (10)	$2x10^3 \pm 30$	$4 x10^2 \pm 47$	<3	10 ± 5	-ve	-ve	<10
Raw	Chicken Fillet (10)	$3x10^3 \pm 40$	$5 x10^2 \pm 22$	$2x10^2 \pm 85$	$2x10^2 \pm 42$	+ve	-ve	<10
	Chicken Fajita (10)	$6x10^3 \pm 90$	$5 x10^2 \pm 41$	$1.5x10^2 \pm 71$	$1x10^2 \pm 30$	-ve	-ve	10 ± 5

Table 2. Microbiological status of chicken products obtained from obtained from retail market

	Products	TBC	*Staph. aureus* count	MPN of coliforms	*E. coli* count	*Salmonella*	*Listeria monocytogenes*	Mold and yeast count
Fully Cooked	Chicken Mortadella (10)	$2x10^3 \pm 30$	$4 x10^2 \pm 2.8x10$	10 ± 5	<3	-ve	-ve	20 ± 9
	Chicken Frank (10)	$2x10^3 \pm 30$	$4 x10^2 \pm 3.0 x10$	10 ± 5	10 ± 5	+ve	-ve	<10
Semi Cooked	Chicken Nuggets (10)	$3x10^3 \pm 50$	$4 x10^2 \pm 2.6 x10$	15 ± 6	50 ± 18	+ve	-ve	20 ± 12
	Chicken Burger (10)	$3x10^3 \pm 40$	$5 x10^3 \pm 4.2 x10$	15 ± 7	15 ± 7	+ve	-ve	20 ± 12
Raw	Chicken Fillet (10)	$4x10^3 \pm 50$	$5 x10^2 \pm 52$	85 ± 41	73 ± 22	+ve	-ve	20 ± 9
	Chicken Fajita (10)	$3x10^3 \pm 40$	$6 x10^3 \pm 6.1 x10$	$2x10^2 \pm 85$	37 ± 14	+ve	+ve	25 ± 15

Table 3. Incidence of isolated bacterial spp. from the examined chicken meat products from Factory

	Serotypes	Fully Cooked				Semi Cooked				Raw			
		Chicken Mortadella		Chicken Frank		Chicken Nuggets		Chicken Burger		Chicken Fillet		Chicken Fajita	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
E-coli	O_2:H_6	-	-	-	-	-	-	-	-	1	10	2	20
	O_{157}:H_7	-	-	-	-	-	-	-	-	-	-	1	10
	O_{78}	-	-	-	-	1	10	-	-	1	10	-	-
	O_{119}:H_4	-	-	-	-	1	10	-	-	-	-	-	-
	O_{128}:H_2	-	-	-	-	-	-	1	10	-	-	-	-
Staph.	*Staph. aureus*	2	20	1	10	1	10	4	40	2	20	3	30
	Staph capitis	-		-		1	10	-	-	-		1	10
	Staph. epidermidis	1	10	1	10	-	-	-	-	2	20	1	10
	Staph. saprophyties	-	-	-	-	-	-	1	10	2	20	-	-
	Micrococcus species	-	-	-	-	-	-	1	10	-	-	2	20
Salmonella	*S.typhimurium*	-	-	-	-	-	-	-		1	10	-	-
	S. enteritidis	-	-	-	-	-	-	-		-	-	-	-

Table 4. Incidence of isolated bacterial spp. from the examined chicken meat products from Market.

	Serotypes	Fully Cooked				Semi Cooked				Raw			
		Chicken Mortadella		Chicken Frank		Chicken Nuggets		Chicken Burger		Chicken Fillet		Chicken Fajita	
E-Coli	O_2:H_6	-	-	-	-	2	20	1	10	-	-	1	10
	O_{157}:H_7	-	-	-	-	1	10	1	10	1	10	-	-
	O_{78}	-	-	1	10	-	-	-	-	2	20	1	10
	O_{26}:H_{11}	-	-	-	-	-	-	-	-	-	-	2	20
	O_{55}:H_7	-	-	-	-	1	10	-	-	-	-	-	-
Staph.	Staph. aureus	4	40	4	40	2	20	5	50	3	30	2	20
	Staph capitis	-	-	2	20	1	10	-		1	10	1	10
	Staph. epidermidis	1	10	1	10	-	-	1	10	1	10	-	-
	Staph. saprophyties	-	-	-	-	1	10	1	10	-	-	-	-
	Micrococcus species	2	20	1	10	-	-	1	10	3	30	2	20
Salmonella	S.Typhimurium	-	-	1	10	2	20	2	20	1	10	2	20
	S. Enteritidis	-	-	-	-	1	10	-	-	1	10	-	-

4. Discussion

4.1. Total bacterial count (TBC)

The mean value of TBC for factory products were $1x10^3 \pm 3x10^1$, $4x10^2 \pm 1 x10^1$, $2x10^3 \pm 4x10^1$, $2x10^3 \pm 3x10^1$, $3x10^3 \pm 4x10^1$, and $6x10^3 \pm 9x10^1$ (cfu/g) in Chicken Mortadella, Chicken Frank, Chicken Nuggets, Chicken Burger, Chicken Fillet and chicken Fajita, respectively. , while For market products, they were $2x10^3 \pm 3x10^1$, $2x10^3 \pm 3x10^1$, $3x10^3 \pm 5x10^1$, $3x10^3 \pm 4x10^1$, $4x10^3 \pm 5x10^1$ and $3x10^3 \pm 4x10^1$ in Chicken Mortadella, Chicken Frank, Chicken Nuggets, Chicken Burger, Chicken Fillet and chicken Fajita, respectively.

Regarding to the Raw samples, the result of TBC were nearly similar to those recorded by AL-Dughaym and Altabari, (2010) and Ibrahim et al., (2014) and higher than those mentioned by Hassan, (2007).

Concerning to the results of APC recorded for Semi cooked samples, the results were lower than that reported by AL-Dughaym and Altabari, (2010). Meanwhile, lower counts were displayed by El-Deeb et al., (2011), and similar to Ibrahim et al., (2014) and Eid et al., (2014).

For Fully cooked samples, the results of TPC were in agreements with those obtained by Shawish, (2011) and Ibrahim et al., (2014) but exceeded those cited by Sharaf and Sabra, (2012). The variation in the count may be attributed to the difference in the hygienic level between freshly produced products and market handled products.

4.2. *Staph. aureus* count

Mean value of Staph. count for factory tested products were 3 ± 0.16, 3 ± 0.24, 4 ± 0.28, 4 ± 0.47, 5 ± 0.22, and 5 ± 0.41 in Chicken Mortadella, Chicken Frank, Chicken Nuggets, Chicken Burger, Chicken Fillet and chicken Fajita, respectively. While for market products they were 4 ± 0.28, 4 ± 0.30, 4 ± 0.26, 5 ± 0.42, 5 ± 0.52 and 6 ± 0.61 in Chicken Mortadella, Chicken Frank, Chicken Nuggets, Chicken Burger, Chicken Fillet and chicken Fajita, respectively.

Concerning to *Staph. aureus* count in the examined raw samples, such count was coincided with that mentioned by Javadi and Safarmashaei, (2011), and higher than that recorded by Hassan, (2007). Meanwhile, a higher value was declared by Nossair et al., (2015).

The *Staph. aureus* count recorded in the examined semi cooked sample was in accordance with that reported by Eid et al, (2014) and Amin, (2015) and exceeded than cited by Farag, (2004) and AL-Dughaym and Altabari, (2010). Regarding to fully cooked samples, the total *Staph. aureus* count was nearly similar to obtained by Essa et al, (2004), lower than by Al-Ghamdi, (2012) and higher than which cited by Shawish, (2011) and Sharaf and Sabra, (2012). Staphylococcus spp. identified from the examined factory chicken samples was *Staph. aureus* 11 (18.8%), Staph. epidermidis 5 (8.3%), Micrococcus spp. 5 (8.3%), then Staph. saprophyticus 3 (5%) and with the lowest incidence 2 (3%) was Staph. capitis. it was evident that Staphylococcus spp. identified from the examined factory chicken samples was *Staph. aureus* 20 (33.3%), Micrococcus spp. 8 (13.3%), Staph. capitis. 5 (8.3%), then Staph. epidermidis 4 (6.6%) and with the lowest incidence 2 (3%) was Staph. saprophyticus.

The highest occurrence of Staph. aureus in factory results was 3 (30%) in chicken fajita, 2 (20%) in chicken mortadella, burger and fillet followed by 1 (10%) in chicken frank and nuggets.

The highest occurrence of *Staph. aureus* in market results was 5 (50%) in chicken burger , 4 (40%) in chicken mortadella and frank followed by 3 (30%) in chicken fillet and then 2 (20%) in chicken nuggets and chicken fajita then 8 (32%) in chicken luncheon and 6 (24%) in chicken fillet. High *Staph. aureus* counts are indicators of poor

personal hygiene, poor handling and temperature control failure**.** The high count of *Staph. aureus* could be due to the neglected hygienic practices of the workers and the technique used for evisceration. Besides, the pre and post slaughtering sources of *Staph. aureus* such as feed, feces, feather, air scald water and defeathering machine (in the cracks of the rubber fingers) and employees (Soliman et at, 2009, AL-Dughaym and Altabari, 2010).

4.3. MPN of coliforms

The MPN of factory chicken fillet was varied from 1.0 x 10^2 to 3.0 x 10^2 with mean 2x10^2 ± 85 while in market chicken fillet 2.0 x 10^1 to 2.0 x 10^2 with a mean value of 85 ± 41 In factory chicken fajita, it varied from 1.0 x 10^2 to 2.0 x 10^2 with a mean value of 1.5x10^2 ± 71, while from market 1.0 x 10^2 to 3.0 x 10^2 with mean 2x10^2 ± 85 and in market chicken nuggets and burger was varied from 1.0 x 10^1 to 2.0 x 10^1 with a mean value of 15 ± 5 and 1.0 x 10^1 to 2.0 x 10^1 with a mean 15 ±7 and in market chicken mortadella and frank the range of MPN mean was 10±5

MPN of the raw samples was in agreement Shawish, (2011), lower than which had been recorded by Rady et al., (2011). While, it was higher than cited by Ibrahim et al., (2015) and Mohammed, (2015).

The results of MPN expressed for the examined semi cooked samples were in consonance with those published by Bkheet et al. (2007), and Eid et al., (2014). Higher values were obtained by Farag, (2004), while a lower value was confirmed by Abd El-Rahman et al., (2010). Regarding to the examined fully cooked samples, the MPN was resembled to that obtained by Bkheet et al., (2014).

4.4. Occurrence of *E. coli*

The presence of *E. coli* in high numbers indicates fecal pollution. This is due to improper slaughtering techniques, contaminated surfaces and/or handling of the meat by infected food handlers.

E. coli was isolated from factory samples in 3 (30%) from chicken fajita, 2 (20%) from chicken nuggets and chicken fillet, 1 (10%) from chicken burger and from market samples *E. coli* was detected 4 (40%) chicken fajita, 3 (30%) chicken fillet and nuggets, 2 (20%) in chicken burger and 1 (10%) in chicken frank .In the current study, the occurrence of E. coli in raw samples was lower than that had been cited by Samaha et al, (2012) (68%), Mohammed, (2015) (60%) and Nossair et al., (2015) (80%). While it exceeded than those mentioned by Rady et al., (2011) (32%) and Ibrahim et al., (2014) (13.33%).

Concerning to the examined semi cooked samples, the occurrence of E. coli was lower than those obtained by Abd El-Rahman et al, (2010) (10.6%), and Samaha et al., (2012) (12%) but higher than those recorded by Abou Hussein, (2007), Ibrahim et al., (2014) and Abd El-Fattah, (2014) whom failed to isolate E. coli. regarding fully cooked, the occurrence of E. coli was exactly as what had been reported by Samaha et al., (2012) (8%), lower than those estimated by Rady et al., (2011) (24%) and exceeded than Abd EI-Fattah, (2014) and Ibrahim et al., (2014) whom failed to detect E. coli.

4.5. Occurrence of *Salmonella*

It was isolated from factory samples only in chicken fillet 1 (10%), while in market samples it was 3 (30%) chicken nuggets, 2 (20%) in chicken fillet, fajita and burger, 1 (10%) in chicken frank.

The obtained results is lower than those recorded by El- Hoti (2006); Bucher et al., (2007); Eglezos et al., (2008) and Abd El- (2013), but nearly similar to those been recorded by Abd El- Hamid (2005) ; El-Shrek and Ali (2012) and Ashraf and Shimamoto (2014), and higher than those recorded by Abd El- Hamid (2005); Ashraf and Shimamoto (2014).

4.6. Occurrence of *Listeria monocytogenes*

Contamination of ready to eat meat products poses special threats to public health because

of the organism's ability to grow at refrigeration temperatures and its pathogenicity within certain segments of the populatic confirmed by (Johnson et al., (1990), 2005) and Khalafalla et al. (2016). In this respect, CDC (2001 & 2002) estimated 2500 cases of Listeriosis that result in 500 deaths in the United States each year based on data from 1996 and 1997; the mortality rate approaches 28%.

A report of Listeriosis cases indicated that there were 3 cases per million people in 2000 and 2001. However, Lidija et al. (2006) stated that the incidence of listeria contamination in fresh beef was very high (62.3%) in meat. it is difficult to avoid cross-contamination or more steps of the food chain n from production to distribution because the organism is widespread in meat plant environments.

4.7. Mold and yeast count

The mean value of TMC of the examined chicken meat products samples were 10 ± 5 in chicken fajita from factory. In market samples TMC were 20 ± 9, 20 ± 12, 20 ±12, 20 ± 9 , 25 ± 15 for chicken nuggets, chicken burger, chicken fillet and chicken fajita, respectively.

Concerning to Raw samples, the TMC was relatively lower than obtained by Saleh et al., (2013) and higher than which cited by El-Diasty et al., 2013), and Morshdy et al., (2015), meanwhile the results of TMC of semi cooked samples were lower than Saleh et al., (2013) and higher than Mohamed, (2004). Moreoverthe TMC in fully cooked was nearly similar to Zayed, (1999) and El-Dias e t al., (2013), lower than Hassan, (2007) and Saleh et al., (2013) and exceeded that reported by Gamal, (2013) and Morshdy et al., (2015).

Total Mold Count (TMC) in chicken mortadella and frank was attributed to the variations in the amount and types of additives used for the manufacturing of products; the time /temperature exposure of the products and the hygienic measure adopted during processing (Morshdy et al., 2015). Generally, mold growth liberates variety of secondary metabolites including aflatoxins, ochratoxins and others in meat products which pose toxic effect leading to a serious public health issue.

5. Conclusions

Most of examined chicken products were contaminated with foodborne pathogens such as *Staph. aureus* and *E. coli*. The rate of contamination of chicken products from retail markets was higher than corresponding products obtained from processing plant, which is attributed to contamination of chicken products through bad handling during transportation, storage and marketing, as well as growth of contaminants as a result of improper storage conditions including temperature and humidity.

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