



## Status of Food Safety Due to Bacterial Contaminants of Poultry Meat and Poultry Products in Khartoum State

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### Authors' contributions

This work was carried out in collaboration between all authors. Authors KAK and AMM designed the study, wrote the protocol. Authors EHM and KAK did the practical part of the study. Author KAK wrote the first draft of the manuscript and typed it. All authors read and approved the final manuscript.

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### ABSTRACT

The bacterial contaminants of poultry (Meat, Egg and poultry products) were investigated in three towns in Khartoum State (Khartoum, Khartoum North and Omdurman) to estimate the level of their safety for human consumption. The study was conducted within the period August 2011 – August 2013. A total 849 samples were collected from which 850 bacterial species were recovered. Of which 77.5% species were isolated from meat, 20.2% from eggs and 2.2% from processed products. From Khartoum town 293 bacterial species were recovered, Khartoum North 266 and from Omdurman 291 bacteria were isolated. *E. coli* represented the highest contaminants in Khartoum state with prevalence of 34.6% followed by *Proteus spp.* 32.2%, then *Citrobacter spp.* 13.5% and lastly *Salmonella spp.* 10.4%. Other bacteria of low incidence were also detected including *Klebsiella spp.* 5.9%, *Shigella spp.* 3.4% *Serratia spp.* 3.2% *Pseudomonas spp.* 2.2%, *Enterobacteria spp.* 1.3%, *Yersinia spp.* 0.7%, *Vibrio spp.* 0.7%, *Streptococcus spp.* 0.5%, *Staphylococcus spp.* 0.4% and *Aeromonas spp.* 0.1%. These findings highlighted and reflected the magnitude of bacterial contaminants of poultry meat, egg and products in Khartoum state specially most of them have public health impact. More epidemiological surveillance throughout the poultry productions chain all over Sudan with other related components is essentially needed. Well planned research and good hygienic practices will help in the control of zoonotic bacteria of poultry meat and products as well as in the implementation of eradication programme.

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## 1. INTRODUCTION

Food safety of poultry meat, egg and products remains a serious problem in many countries in the world. A Study by FAO\WHO [1] reported that food poisoning is one of the wide spread health problem which was considered as one of the reducing economic productivity both in developed and under developed countries. Estimation of 76 million people in the United States experienced food poisoning infection causing 325,000 hospitalizations and 5,000 deaths [2]. Poultry harbour various food borne pathogens such as bacteria that contaminate chicken carcasses in the slaughterhouses [3]. Also, it was found that 15.8% of foods borne illness were attributed to poultry meat and 3.5% were due to raw eggs consumption [4]. *Salmonella* and *Campylobacter* are the most known human food borne bacterial diseases related to poultry. It had been reported that 67% of food borne disease outbreaks associated with poultry were caused by *Salmonella* spp. [5]. It is frequently present in the gastrointestinal tracts of poultry, poultry products, eggs, egg products and also in other animal species and is transferred to humans via the food chain. Food borne illness from *Salmonella enteritidis* in egg alone were estimated to cause 182,060 cases in United States during the year 2000 [6]. Salmonellosis are implicated in two main clinical syndromes in humans: enterocolitis and enteric fever. *E. coli* Causes watery and dysenteric diarrhoea. Verocytotoxin-producing *E.coli* emerged as a major food-borne zoonotic pathogen in the 1980s-1990s [7]. Faecal contamination of water supplies and contaminated food handlers have been most frequently implicated in outbreaks caused by Enteropathogenic *E. coli* (EPEC) and Enterotoxigenic *E. coli* (ETEC). *Shigella* spp. also causes bacillary Diarrhea, *Vibrio* spp. Can cause cholera in human. *Staphylococcus* spp. as well an important pathogen, it causes abscess in the skin, brain, lung and joints or it can produce some toxins. Other bacteria are *Streptococcus* spp. which involved in throat infection and septicemia.

Sudan needs to intensify poultry sector and improve its management so as to satisfy the protein need of its ever increasing human population that estimated as 33.419.625. Profitable production of poultry will be impossible without effective regulatory disease control programme and hence control of public health [8].

The objective of this study was to identify the level of the known zoonotic bacterial contaminants of poultry and poultry products.

## 2. MATERIALS AND METHODS

### 2.1 Study Area and Types of Samples

Khartoum State was selected as the study area including three towns (Khartoum, Omdurman and Khartoum North). A total of 849 samples from poultry meat, eggs and poultry products were collected. Meat samples were randomly collected from slaughter plants and eggs and products from poultry markets .661 broiler thigh muscles, livers and ovaries, 168 eggs were also studied. While 20 poultry products including 18 samples of ready and home- made mayonnaise and 2 samples of processed poultry meat (chop poultry meat locally known as Shawerma) were examined Table 1.

## 2.2 Preparation of Samples

All samples were collected in sterile containers and treated as ISO 6579-2002; Thigh muscles of broilers were kept in selenite broth overnight. Egg shells were cracked in Selenite broth, incubated at 37°C overnight. Egg contents were prepared by disinfecting egg surfaces with 75% alcohol for two minutes. Then, egg contents were sucked, mixed thoroughly and incubated in Selenite broth at 37°C for 24hrs. The ready and home-made mayonnaise and the processed poultry meat (Shawerma) were incubated into buffer peptone water at 37°C for 24hrs, then inoculated into Rappaport medium to form 1/10 dilution.

**Table 1. Type, number of poultry samples collected from the three locations in Khartoum state**

Location	Poultry carcasses and organs	Eggs	Poultry processed products	Total
Khartoum	241	49	3*	293
Omdurman	211	69	10**	290
Khartoum north	209	50	7***	266
Total	661	168	20	849

\*2 Mayonnaise and one Shawerma; \*\* 9 Mayonnaise and one Shawerma; \*\*\* 7 Mayonnaise

## 2.3 Cultural Methods

Broiler meat, eggs and poultry products were plated into selective media (xylose lysine desoxycholate (XLD), *Shigella* and *Salmonella* media, Desoxycholate Agar (DCA) and Triple sugar Iron (TSI) for *Salmonella*. McConkey agar was used to isolate both gram negative and positive as well as Nutrient agar (Cowan and Steel 1999). All the plates were incubated at 37°C for 24hrs.

## 2.4 Bacteriological and Biochemical Examination

The morphology of colonies on agar media were examined microscopically, Gram stain was conducted by making smears in clean slide, and then fixed with heat, stained with Gram stain and examined under oil immersion. Biochemical tests were done by using Vitec 2 kits and API 20 E, (Biomeruax), method as described by [9,10].

## 3. RESULTS

A total of 850 bacteria were isolated from broiler meat, egg and products in Khartoum state. About 293 from Khartoum, 266 from Khartoum North and 291 from Omdurman Table 1. Out of 661 poultry carcasses, 659 (99.7%) bacterial species were isolated from meat, 172 (102.4%) from 168 egg samples, and 19 (95%) from 20 poultry product samples. *E. coli* was found to be the most contaminant of broiler meat, egg and products in Khartoum state, with prevalence of 294 species (34.6%), followed by *Proteus spp* 197 (32.2%), *Citrobacter spp.* 115 (13.5%) and lastly *Salmonella* with 88 (10.4%). Other species of low prevalence were recovered such as *Serratia spp*, *Pseudomonas spp.* and *Enterobacteria spp*, *Staphylococcus spp*, *Streptococcus spp.*, *Shigella spp.*, *Pseudomonas spp*, *Yersinia spp.*, *Vibrio spp.* and *Aeromonas spp.* Table 2. The most contaminant of meat and egg samples were *E. coli* (36.6%), (28.5%), *Proteus spp* (22%), (27.3%), *Citrobacter spp* (13.5%),

(14.5%) respectively. While, *Proteus spp* (25%), *E. coli* (20%), *Klebsiella spp* (15%) and *Pseudomonas spp* (15%) were the most pollutant of poultry products. The most dominant bacteria in Khartoum town and Omdurman were found to be *E. coli* (35.2%) and (34.8%), *Proteus spp.* (17.1%) and (27.6%) and *Citrobacter spp.* (15%) and (17.6%) respectively. In Khartoum North town, *E. coli* (33.8%), *Proteus spp.* (25.2%) and *Salmonella spp.* (12.8%) were the most reported bacteria Table 2.

**Table 2. Percentage and number of bacteria isolated from different samples in Khartoum State**

Bacterial isolated	Types of samples			Total
	Type of samples meat	Eggshell and content	Poultry product	
<i>E.coli</i>	241(36.6%)	49(28.5%)	4(21.1%)	294(34.6%)
<i>Proteus spp</i>	145 (22% )	47(27.3%)	5(26.3%)	197(23.2%)
<i>Citrobacter spp</i>	89(13.5.% )	25(14.5.% )	1(5.3%)	115(13.5%)
<i>Salmonella</i>	78(11.8.% )	10(5.8%)	0(0%)	88(10.4%)
<i>Klebsiella</i>	31(4.7%)	16(9.3%)	3(15.8%)	50(5.9%)
<i>Shigella spp</i>	20(3%)	8(4.7%)	1(5.3%)	29(3.4%)
<i>Serratia spp</i>	26(3.9%)	1(0.6%)	0(0%)	27(3.2%)
<i>Pseudomonas</i>	10(1.5%)	6(3.5%)	3(15.8%)	19(2.2%)
<i>Enterobactera</i>	9(1.4%)	2(1.2%)	0(0%)	11(1.3%)
<i>Yersinia spp</i>	3(0.5%)	2(1.2%)	1(5.3%)	6(0.7%)
<i>Vibrio spp</i>	2(0.3%)	3(1.7%)	1(5.3%)	6(0.7%)
<i>Streptococcus spp</i>	4(0.6%)	0(0%)	0(0%)	4(0.5%)
<i>Staphylococcus spp</i>	0(0%)	3(1.7%)	0(0%)	3(0.4%)
<i>Aeromonas spp</i>	1(0.2%)	0(0%)	0(0%)	1(0.1%)
Total	659(99.7%)	172(102.4%)*	20(95%)	850(100%)

\*Mixed infection

**Table 3. Prevalence of different bacteria in egg shell in three locations in Khartoum State**

Bacteria	Khartoum		Kh. North		Omdurman		Total
	Shell	Conte	Shell	content	Shell	Content	
<i>E.coli</i>	3	7	13	5	10	11	49(28.4%)
<i>Proteus spp</i>	6	5	5	4	19	8	47(27.3%)
<i>Citrobacter spp</i>	5	4	3	4	5	4	25(14.5%)
<i>Klebsiella spp</i>	3	4	3	2	1	3	16(9.3%)
<i>Salmonella spp</i>	3	1	2	3	1	0	10(5.8%)
<i>Shigella spp</i>	1	1	1	2	2	1	8(4.7%)
<i>Pseudomonas</i>	1	3	0	0	0	2	6(3.5%)
<i>Staphylococcus spp</i>	2	0	0	0	1	0	3(1.7%)
<i>Vibrio spp</i>	0	0	3	0	0	0	3(1.7%)
<i>Yersinia spp</i>	0	1	1	0	0	0	2(1.2%)
<i>Enterobacter spp</i>	1	0	0	0	0	1	2(1.2%)
<i>Serratia spp</i>	0	0	0	0	0	1	1(0.1%)
Total	25	26	31	20	39	31	172

As shown in Table 3 (above) unwashed egg shells yielded 92 bacterial species versus 77species recovered from egg contents. Omdurman recorded high prevalence (70) followed by Khartoum North (51) and Khartoum (51).

*Proteus spp.* (26.3%), *E. coli* (21.1%) *Klebsiella spp.* (15.8%) and *Pseudomonas spp.* (15.8%) were the most pollutant of poultry products. Besides *Yersinia spp.* (5.3%), *Vibrio spp.* (5.3%), *Shigella spp.* (5.3%) and *Citrobacter spp.* (5.3%) as in Table 2.

#### 4. DISCUSSION

Poultry carcasses are evaluated with their skin on and any bacteria that a chicken exposed to during the production chain has the chance to remain on the skin of the chicken. Broiler chickens at processing are highly exposed to contamination with bacteria among them are potential zoonotic ones such as *Salmonella* [11], *E. coli*, *Staphylococcus*, *Streptococcus*, *Vibrio* and others. Many factors could help this behavior such as the tropical climate in Sudan which favors the growth of microorganisms that spoil meat and make it unfit for human consumption. UN proper hygiene in traditional farms could play a role in dissemination of bacteria among the flocks so the resulting hazard analysis in poultry industry to the public health is tremendously important and it is necessary to monitor all steps of the process [12].

In this study it was found that *E. coli* was of high occurrence (34.6%) prevalence in contrast to prevalence of 50% of samples previously studied by other authors in Sudan [12-14]. Faecal contamination might be a cause of the large number of *E. coli* recovered [12]. Also it had been reported by many investigators that *E. coli* has a role of real pathogenicity in poultry alone or in combination with others. In Sudan limited data about the role of *E. coli* is available, in a recent studies in Sudan, revealed that *E. coli* is of wide distribution [15]. This might be due to the misuse of antibiotics which might develop resistance *E. coli* [16]. In other investigation [17] 19% of the total studied was contaminated by *E. coli*, 4% *Proteus* and 1% *Klebsiella spp* [17]. Egg shell samples yielded (92 bacteria) more bacteria than egg contents (77 bacteria), this results was in agreement with the result of other authors in some African countries [18-21] who found bacterial contaminants in shell membrane (54.4%) in comparison to 45.6% in egg yolk and at the same time in contrast to Musgrove et al. [22] who found that egg shell were less contaminated. Similarly they isolated *Citrobacter*, *Klebsiella*, *Proteus*, *Salmonella*, and *Serratia*. *Aeromonas*, *Pseudomonas* and *vibrio* in agreement to our finding in which the mentioned bacteria were isolated.

The persistence of food borne diseases as a result of zoonotic bacteria specially the genus *Salmonella* have been reported worldwide. During this study *salmonella* constituted (10.4%) of the total bacterial isolates in poultry meat, egg comparable to 5.56% that detected previously in Sudan [12]. In Iraq, prevalence of 9.2% was detected [23], while 17.53% *Salmonella* prevalence in broiler from market and 7.29% from poultry slaughter in the Kingdom of Saudi Arabia [24], 48.9% prevalence of *Salmonella* in Vietnam retail chicken meat [25]. 23% Overall prevalence of *Salmonella* in poultry products were recorded from Maryland [26], while no *Salmonella* were detected in products in the current study. Whereas overall percentage of 5.8% of *Salmonella* were detected in south and west region of Iran [27]. All the mentioned prevalence of *salmonella* species indicated the wide occurrence of *Salmonella* in most of the world and these results were higher than 5% which was hypothesized [28]. The role of other bacteria isolates in public health such as shigellosis outbreaks have been associated with the consumption of contaminated several kinds of foods, milk, poultry, and some dairy products [29]. In this study 3.4% the prevalence of *shigella* was detected.

And low prevalence 0.4% of *Staphylococcus aureus* was observed, in contrast to 33.33% that obtained in previous study in Sudan [12]. Poultry and poultry products yielded 22% of *Staphylococcus* food poisoning in human in United Kingdom [30].

In the current study *Pseudomonas auerginosa* represented (1.5%) in meat, and from eggs (3.5%) and (15.8%) from poultry products, in comparison to higher percentage of 67.3% from farm egg and 45.7% from market eggs [31].

## 5. CONCLUSION

On conclusion high prevalence of different bacteria in meat, egg and poultry product in Khartoum State constituted a major public hazard that have to be dealt with for proper control in the future. Although this study is limited as it is only from the veterinary side, integration of other related bodies would give another view which could be an ideal goal.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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