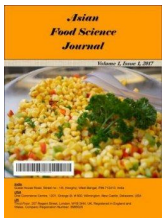

Asian Food Science Journal

7(2): 1-8, 2019; Article no.AFSJ.46979
ISSN: 2581-7752

Bacteriology Screening of Roasted and Raw Chicken Sold in Tripoli

Hend Shubar[1], Basma Doro[1*], Aida Ghalboun[1], Azher S. Ben Hamed[1], Aisha M. Atewa[1], Aya F. Ben Saleem[1], Fadia B. Aboud[1] and Asma Ramadan[1]

[1]Department of Microbiology and Immunology, Faculty of Pharmacy, University of Tripoli, Libya.

Authors' contributions

This work was carried out in collaboration between all authors. Authors BD and HS designed the study and carried the experiments. Authors ASBH, AG, AFBS and FBA managed the literature. Author BD did the analysis and wrote the first draft of the manuscript. Authors BD and AR contributed to the study design, the analysis of the results and writing the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AFSJ/2019/v7i229967
Editor(s):
(1) Essam A. Makky, Associate Professor, Universiti Malaysia Pahang (UMP), Faculty of Industrial Sciences & Technology (FIST), Malaysia.
Reviewers:
(1) Teresita Sainz-Espuñes, Universidad Autónoma Metropolitana- Xochimilco, UAM-Xochimilco, Mexico.
(2) Syed Umer Jan, University of Balochistan, Quetta, Pakistan.
(3) Luis Alberto Ramirez Camejo, Dept. Botany & Plant Pathology, Purdue University, USA.
(4) Baguma Andrew, Mbarara University of Science and Technology, Uganda.
Complete Peer review History: http://www.sdiarticle3.com/review-history/46979

Original Research Article

Received 23 October 2018
Accepted 06 February 2019
Published 25 February 2019

ABSTRACT

Aims: This work was carried out to screen for the presence of bacteria in roasted chicken sold in the market, poultries shop and restaurants in Tripoli.
Study Design: A total of 25 roasted chicken and 25 raw chicken parts randomly collected from different selling points in Tripoli.
Place and Duration of Study: Microbiology laboratory in microbiology and immunology department in the faculty of pharmacy in university of Tripoli, January 2013 to September 2013.
Methodology: Bacteriologically examined using the standard microbiological method according to Based on the colonial morphological and biochemical test, the following bacteria species were isolated.
Results: Prevalence of *Salmonella* was higher in raw chicken samples (100%) compared to the roasted one (28%), *E. coli* was detected in both raw and roasted chicken (32%), whereas *Shigella* and *E. coli O157:H7* were detected only in roasted chicken [(8%) and (24%)] respectively.

**Corresponding author: Email: basmadoro@yahoo.co.uk;*

Conclusion: The study found that the raw chicken samples were more susceptible to bacterial contamination than the roasted chicken samples, therefore special strategies are needed to decrease the prevalence of bacterial pathogens in chicken samples present in Tripoli area. Therefore good handling/hygiene in processing and preheating of roasted chicken before consumption is recommended.

Keywords: Raw chicken; roasted chicke; Shigell; E. coli O157:H7; bacteria; screening.

1. INTRODUCTION

Food-borne illnesses in human beings due to bacterial pathogens and their toxins are well documented worldwide [1]. Food-borne illness imposes a substantial economic and quality of life burden on society by way of acute morbidity [2]. Food is an important source of bacterial pathogens due to the high contents of proteins and carbohydrates, which represents an enriched media for growth and multiplication. Several pathogenic bacteria such as *Staphylococcus aureus*, *E. coli*, *Salmonella spp*. have been isolated from different foods. The most important are those transmitted by the faecal-oral route, which includes bacteria, viruses, and parasites[3].

The common ways in which bacteria and other microorganisms spread are by the air, contact, insect and other creatures, cross-contamination is a cause of food poisoning that is often overlooked. This occurs when harmful bacteria are spread between food surfaces and equipment [4,5].

Meat contamination could constitute human health hazard due to the production of toxins by some bacteria [6]. Data on food borne diseases are well documented worldwide. In United States, it has been estimated that seven pathogens found in animal products such as *Escherichia coli* 0157:H7, *Listeria monocytogenes*, *Campylobacter jejuni*, *Clostridium perfringne*s, *Salmonella spp*., *Toxoplasma gondii* and *Staphylococcus aureus* account for approximately 303.12.3 million cases of foodborne illness and a record of 39,000 each year [7]. Chicken is often contaminated with *Campylobacter* bacteria and sometimes with *Salmonella* and *Clostridium* bacteria [8].

The presence of bacteria in roasted and raw meat at times may be as a result of slaughtering of animals that are previously infected with a particular disease without proper treatment or as a result of surface contamination by the meat vendors, wind or by ingredient used in meat treatment such a barbecue, knife, sharp pointed sticks, charcoal, roasted trays, spoon, water [9]. Roasted meat being displayed uncovered by the meat vendors exposed the meat to bacteria contamination [10].

This study aimed to evaluate bacterial contamination in raw and roasted chicken samples collected from different areas in Tripoli, to Collect of raw and roasted chicken sample from markets, poultries shop and different restaurants in Tripoli and Isolation and identification of collected samples using routine microbiological technique, and then propose possible protection measures for problems developed from bacterial contamination in Tripoli markets and restaurants.

2. MATERIALS AND METHODS

The identification and control of food contaminations rely on a careful investigation using biochemical and microbiological techniques and the implementation of appropriate legal and management strategies. Bacteriological method for detecting pathogens typically involved in culturing the organism in selective media and identifying isolates according to their morphological, biochemical and immunological characteristics. This method is sensitive and permits the specific detection of microorganism of interest [11,12].

To perform this step, culture media of broth and agar media were prepared as indicated by the manufacturer. Prepared plates were left to dry before performing work. All preparation and drying process was performed using strict aseptic technique.

2.1 Sample Collection

Samples of raw chicken meat were collected from chicken slaughtered at poultries shop and markets, whereas each samples of roasted chicken meat were collected from a different restaurant in Tripoli. A total of 50 samples were examined. The samples were immediately

transported to the laboratories in a cool thermos and were processed for culture.

2.2 Cultivation and Isolation of *Salmonella* and *Shigella* from Collected Samples

Salmonella and Shigella was isolated according to standard methods. 25 g sample of chicken was added to 225 ml of buffered peptone water, and incubated for 24 hr at 37°C. One ml pre-enriched carcass culture was then transferred to selenite F broth and incubated for 24 hr at 37°C. after 24 hr of incubation, one loopful from each of enriched broths was streaked into plates of *Salmonella Shigella* (S.S) agar and xylose lysine deoxycholate (XLD) agar and incubated at 37°C for 24 hr.

The plates were examined for the presence of typical colonies of *Salmonella*, i.e transparent colonies with black center on S.S agar and pink colonies and black centre one XLD agar. Suspected colonies were confirmed by conventional biochemical methods TSI, API 20E, *Salmonella* latex kit [11].

2.3 Identification of *Salmonella* and *Shigella*

After cultivation and isolation of *Salmonella* and *Shigella* from collected samples, identification was confirmed by the following biochemical tests:

2.3.1 Triple Sugar Iron Agar (TSI) test for H2S production

This medium was originally designed as a multi-test medium. It is often required when differentiating members of the *Enterobacteriaceae*. The medium is used principally as a standard test for H2S.

Medium is prepared by dissolving a measured amount of dry powder in dissolving water as indicated by the manufacturer, solution was heated in a water bath, 10 ml of the dissolved medium was transferred to tubes before sterilization, placed into an autoclave for an 1hr, tubes were left to solidify after sterilization to create the slant at 45 angle.

Slant tubes were inoculated with pure culture by streaking over the entire surface of the slant (zig-zag to cover surface) and the stabbing deep into the butt, and then incubated at 37°C for 24 hr to allow H2S production.

2.3.2 API 20E (Analytical Profile Index)

These are now widely used by laboratories across the world for the definitive identification of many groups of organisms. The rapid 20E system allows the prompt identification of *Enterobacteria* by detection of preformed enzymes in suspension of the test organism and gives a result in 4 hr. they may be used manually, but automated technology allows standardization of inoculum, reads the results, analyses the date and provides a print –out.

A plastic strip holding twenty mini-test tubes is inoculated with a saline suspension of a pure culture (as per manufacturer's directions). This process also rehydrates the desiccated medium in each tube. A few tubes are completely filled (CIT, VP and GEL) and some tubes are overlaid with mineral oil such that anaerobic reactions can be carried out (ADH, LDC, ODC, H_2S, URE).

After incubation in a humidity chamber for 4 hours at 37°C, the colour reactions are read (some with the aid of added reagents), and the reactions (plus the oxidase reaction done separately) are converted to a seven-digit code which is called the Analytical Profile Index, from which name the initials "API" are derived. The code can be fed into the manufacturer's database via touch-tone telephone, and the computerized voice gives back the identification, usually as genus and species. An on-line database can also be accessed for the identification.

2.3.3 *Salmonella* latex kit

Is an agglutination test for the presumptive identification of *Salmonella spp*. additional investigation has shown it can be used to screen presumptive *Salmonella* colonies isolated on selective agar plates, from both food and clinical samples. The test allows the user to presumptively identify and confirm the presence of *Salmonella spp.*

Place 1 drop of saline on the surface of the reaction card, remove a typical looking colony from the plate using a loop and emulsify in the drop of saline, rock the card gently for 2 mins to check for agglutination, add 1 drop of test latex to the suspension, mix using a mixing stick, rock the card for up to 2 min and examine for agglutination.

Agglutination within 2 min is indicative for the presence of *Salmonella spp.* in the sample,

whereas the absence of agglutination is indicative for the absence of *Salmonella spp*.

2.4 Cultivation and Isolation of *E. coli and E. coli O157:H7* from Collected Samples

To perform this step, culture media of broth and agar media was prepared as indicated by the manufacturer. Prepared plated was left to dry before performing work. All preparation and drying process was performed using strict aseptic technique. As following 25 g sample of chicken was added to 225 ml of buffered peptone water, and incubated for 24 hr at 37°C after 24 hr of incubation of streaked onto plates of *MacConkey* agar (Mc) and sorbitol *MacConkey* agar (S.Mc) and incubated at 37°C for 24 hr. The plates were examined for the presence of typical colonies of *E. coli* and *E. coli O157:H7* respectively.

2.4.1 Identification of *E. coli* and *E. coli O157:H7*

After cultivation and isolation of E. *coli* from collected samples, identification was confirmed by TSI as previously mentioned.

2.4.2 Indole test

This test demonstrates the ability of certain bacteria to decompose the amino acid tryptophan to indole, which accumulates in the medium. Indole is then tested by colourimetric reaction with p-dimethyl amino benzaldehyde giving red ring that indicates the presence of *E. coli* and giving yellow ring that indicates the presence of *Klebsiella sp.* The test is positive for *E. coli* and negative for *Klebsiella sp*.

Pure bacterial culture must be grown in sterile tryptophan or peptone broth for 24-48 hr before performing the test. Following incubation, add 5 drops kovac's reagent (isoamyl alcohol, para-dimethylaminobenzaldhyde, concentrated HCL) to the culture and observed for the ring produced

2.4.3 *E. coli O157:H7* latex kit

The value of a latex agglutination test (*E. coli O157:H7* latex kit) for rapid presumptive detection of *E. coli* serotype *0157:H7* was determined by laboratory trials and during an outbreak of hemorrhagic colitis. The latex kit was found to be a simple, highly efficient and reliable test in detecting *E. coli O157:H7* with 100% sensitivity and specificity.

Place 1 drop of saline on the surface of the reaction card, remove a typical looking colony from the plate using a loop and emulsify in the drop of saline, rock the card gently for 2 mins to check for agglutination, add 1 drop of test latex to the suspension, mix using a mixing stick, rock the card for up to 2 min and examine for agglutination.

Agglutination within 2 min is indicative for the presence of *E. coli O157:H7* in the sample, absence of agglutination is an indicative for the absence of *E. coli O157:H7.*

3. RESULTS AND DISCUSSION

Roasted chicken is a popular meat product, which is prepared with fresh chicken that is garnished with hot spices and then roasted over fire. Roasted chickens as sources of food are frequently involved in food illnesses because they provide an ideal medium for the growth of disease-causing microorganisms [13].

In this study, we collected 50 chicken samples (25 Raw and 25 Roasted) from markets, poultries shop and restaurants from different areas in Tripoli. Samples were investigated for the bacteriological contamination using the routine microbiological technique.

From 25 samples collected from the different areas in Tripoli restaurants the results show that the presence of *Salmonella* and *Shigella spp.* in roasted chicken collected from 7 areas showed positive results for *Salmonella*, where they showed positive results for *Shigella* only in 2 other different areas. The presence and absence of *E. coli* and *E. coli O157:H7* in roasted chicken collected from restaurants in different areas in Tripoli, samples collected from 5 areas showed positive results of both *E. coli* and *E. coli O157:H7,* whereas other samples collected from another 2 area showed no growth of *E. coli O157:H7,* Table 1.

The presence and absence of *Salmonella* and *Shigella spp* in raw chicken samples collected from different poultries shops and markets in Tripoli. All samples collected showed positive results for *Salmonella spp.* and *Shigella* isolated from raw chicken Table 2.

There was high prevalence of these bacteria in roasted chicken sold in Tripoli as show in this study. The highest percentage was *E. coli* 32%, then *Salmonella* percentage 28% and *E. coli*

O157:H7 (24%) where for *Shigella* was 8%. Table 3 This finding agrees with the earlier publications of FAO/WHO, (2003) which stated that salmonellosis, shigellosis is prevalent due to people's feeding habit as well as unhygienic way of preparing and roasting of the meat. The presence of contamination in our study may be due to unhygienic and improper handling of the chicken during processing or selling [14,15].

In this study *E. coli* 32% was the highest percentage, *E coli* may also come from the water used in washing hands by the chicken sellers during processing and after roasting and these may include spoilage, Coliforms and pathogenic species [16]. *E. coli* O157: H7 can survive and even multiply in meat, poultry and vegetables [17,18]. *E. coli* 0157:H7 was isolated from a frozen raw beef patty of the kind implicated in outbreaks in 1982 the United State [18,19].

The illness caused by *Salmonella* is called salmonellosis, which is one of the most frequently reported foodborne pathologies worldwide [20,21]. In this study the *Salmonella* percentage 28%, *Salmonella* is the most significant pathogen transmitted by raw poultry to the kitchen [22]. In this study, the percentage of *salmonella 100%,* and *E. coli* were 32% and any *E. coli* 0157:H7 and *Shigella* in raw chicken Table 3.

E. coli was detected in both raw and roasted chicken samples (32% for each) indicating that this bacterial can resist both freezing and heating. Roasted chicken samples showed the presence of both *E. coli O157:H* (24%) and *Shigella* (8%) that could be attributed to the poor person and restaurant hygiene. The presence of bacteria in roasted and raw meat at times may be as a result of slaughtering of animals that are previously infected with a particular disease without proper treatment or as a result of surface contamination by the meat vendors, wind or by ingredient used in meat treatment such a barbecue, knife, sharp-pointed sticks, charcoal, roasted trays, spoon, water [9]. Roasted meat being displayed uncovered by the meat vendors exposed the meat to bacteria contamination [23].

Table 1. Biochemical and microbiological tests used to identify bacteria isolated from roasted chicken

No.	Detection of *Salmonella* and *Shigella* in roasted chicken					*E. coli* and *E. coli O157:H7* isolated from roasted chicken			
	Isolation media		Identification test			Isolation media		Identification test	
	S.S	XLD	TSI	API 20E	*Salmonella* latex kit	Mc	TSI	Indole test	*E. coli O157:H7* latex kit
1	-ve	-ve	/		/	-ve	-ve	/	/
2	-ve	-ve	/		/	-ve	-ve	/	/
3	-ve	-ve	/		/	-ve	-ve	/	/
4	-ve	-ve	/		/	+ve	+ve	+ve	-ve
5	-ve	-ve	/		/	+ve	+ve	+ve	+ve
6	+ve	+ve	+ve		+ve	+ve	+ve	+ve	-ve
7	+ve	+ve	+ve	*s. arizona*	+ve	+ve	+ve	+ve	+ve
8	-ve	-ve	/		/	-ve	-ve	/	/
9	+ve	+ve	+ve		+ve	+ve	+ve	+ve	+ve
10	-ve	-ve	/		/	-ve	-ve	/	/
11	+ve	+ve	+ve	*s. arizona*	+ve	-ve	-ve	/	/
12	-ve	-ve	/		/	+ve	+ve	-ve	-ve
13	-ve	-ve	/		/	-ve	-ve	/	/
14	+ve	+ve	+ve		+ve	+ve	+ve	+ve	+ve
15	+ve	+ve	+ve		-ve	-ve	-ve	/	/
16	-ve	-ve	/		/	-ve	-ve	/	/
17	-ve	-ve	/		/	-ve	-ve	/	/
18	-ve	-ve	/		/	-ve	-ve	/	/
19	-ve	-ve	/		/	+ve	+ve	+ve	+ve
20	-ve	-ve	/		/	+ve	+ve	+ve	+ve
21	-ve	-ve	/		/	-ve	-ve	/	/
22	+ve	+ve	+ve	*S. arizona*	+ve	+ve	+ve	-ve	-ve
23	-ve	-ve	/		/	-ve	-ve	/	/
24	+ve	+ve	+ve		-ve	-ve	-ve	/	/
25	+ve	+ve	+ve		+ve	+ve	+ve	-ve	-ve

Table 2. Biochemical and microbiological tests used to identify bacteria from raw chicken

No of sample	Detection of *Salmonella and Shigella*				*E. coli* and *E. Coli O157:H7* isolated from				
	Isolation media		Identification		Isolation media		Identification Test		
	S.S	XLD	TSI	*Salmonella* latex kit	Mc	S. Mc	TSI	Indole test	*E. coli O157:H7* latex kit
1	+ve	+ve	+ve	+ve	+ve	/	+ve	+ve	-ve
2	+ve	+ve	+ve	+ve	+ve	/	+ve	+ve	-ve
3	+ve	+ve	+ve	+ve	+ve	/	+ve	+ve	-ve
4	+ve	+ve	+ve	+ve	-ve	/	/	/	/
5	+ve	+ve	+ve	+ve	+ve	/	+ve	-ve	-ve
6	+ve	+ve	+ve	+ve	-ve	/	/	/	/
7	+ve	+ve	+ve	+ve	-ve	/	/	/	/
8	+ve	+ve	+ve	+ve	+ve	/	+ve	-ve	-ve
9	+ve	+ve	+ve	-ve	-ve	/	/	/	/
10	+ve	+ve	+ve	+ve	-ve	/	/	/	/
11	+ve	+ve	+ve	+ve	+ve	/	+ve	-ve	-ve
12	+ve	+ve	+ve	+ve	-ve	/	/	/	/
13	+ve	+ve	+ve	+ve	-ve	/	/	/	/
14	+ve	+ve	+ve	+ve	-ve	/	/	/	/
15	+ve	+ve	+ve	+ve	-ve		/	/	/
16	+ve	+ve	+ve	+ve	-ve	-ve	/	/	/
17	+ve	+ve	+ve	+ve	-ve	-ve	/	/	/
18	+ve	+ve	+ve	+ve	+ve	-ve	+ve	+ve	-ve
19	+ve	+ve	+ve	+ve	-ve	-ve	/	/	/
20	+ve	+ve	+ve	-ve	+ve	-ve	+ve	+ve	-ve
21	+ve	+ve	+ve	+ve	+ve	-ve	+ve	+ve	-ve
22	+ve	+ve	+ve	+ve	+ve	-ve	+ve	+ve	-ve
23	+ve	+ve	+ve	+ve	-ve	-ve	/	/	/
24	+ve	+ve	+ve	+ve	+ve	-ve	+ve	+ve	-ve
25	+ve	+ve	+ve	+ve	-ve	-ve	/	/	/

Table 3. The percentage of microorganisms isolated from raw and roasted chicken samples

Bacteria	Roasted chicken	Raw chicken
Salmonella	28	100
Shigella	8	0
E. coli	32	32
E. coli O157:H7	24	0

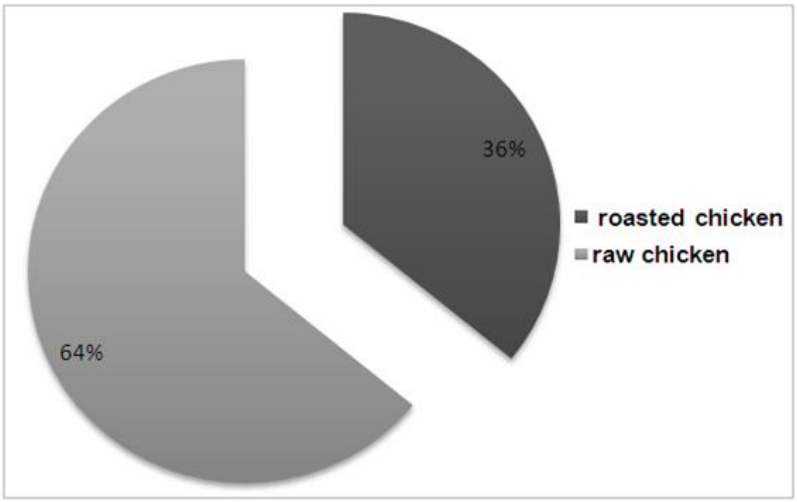

Fig. 1. The percentage of microbial contamination in raw and roasted chicken samples

In this study the bacterial contamination in roasted chicken samples was detected in percentage of (36%), whereas raw chicken samples showed bacterial contamination of 64%. Fig. 1 indicating that heating may be sufficient to kill any possible organism that could contaminate the chicken samples.

4. CONCLUSION

The presence of bacteria shown in the result may be that the organism were present in the raw chicken that was roasted or due to cross-infection during preparation, insufficient application of heat to the deep tissues and perhaps because of contamination from potential buyers, meat handlers, hands, trays and the open air environment.

The above bacteria organisms isolated in this study could be pathogenic or opportunistic pathogens and pose a health risk especially in infants or immune-compromised individual. Special strategies should be considered in order to avoid the spread of bacterial contamination such as hand washing, proper heating of food, holding food under appropriate condition disinfecting of equipment and food contact surfaces. This may indicate poor hygienic practice and suggest the risk of infection and health hazard to consumers. We, therefore, recommend good handling/hygiene in processing. More so, preheating of roasted chicken before consumption is recommended.

CONSENT

All authors declare that informed written consent was obtained from the participants for publication of this case report.

ETHICAL APPROVAL

The study protocol was reviewed and approved by the Ethical Committees of University of Tripoli of Libya.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Martinović T, Andjelković U, Gajdošik MŠ, Rešetar D, Josić D. Foodborne pathogens and their toxins. J. Proteomics; 2016.
2. Duff SB, et al. Cost-effectiveness of a targeted disinfection program in household kitchens to prevent foodborne illnesses in the United States, Canada, and the United Kingdom. J. Food Prot.; 2003.
3. Newell DG, et al. Food-borne diseases — The challenges of 20 years ago still persist while new ones continue to emerge. Int. J. Food Microbiol. 2010;139:S3–S15.
4. Borch E, Kant-Muermans ML, Blixt Y. Bacterial spoilage of meat and cured meat products. Int. J. Food Microbiol.; 1996.
5. Cecilia Hernández-Cortez, Ingrid Palma-Martínez, Luis Uriel Gonzalez-Avila, Andrea Guerrero-Mandujano, Raúl Colmenero Solís, Graciela Castro-Escarpulli. Food Poisoning Caused by Bacteria (Food Toxins); 2017. DOI: 10.5772/intechopen.69953
6. Marshall BM, Levy SB. Food animals and antimicrobials: Impacts on human health. Clinical Microbiology Reviews; 2011.
7. Newell DG, et al. Food-borne diseases - The challenges of 20 years ago still persist while new ones continue to emerge. Int. J. Food Microbiol.; 2010.
8. Rouger A, Tresse O, Zagorec M. Bacterial contaminants of poultry meat: Sources, species, and dynamics. Microorganisms. 2017;5(3):50.
9. Ali NH, Farooqui A, Khan A, Khan AY, Kazmi SU. Microbial contamination of raw meat and its environment in retail shops in Karachi, Pakistan. J. Infect. Dev. Ctries; 2010.
10. Dinçer AH, Baysal T. Decontamination techniques of pathogen bacteria in meat and poultry. Critical Reviews in Microbiology; 2004.
11. Riyaz-Ul-Hassan S, Verma V, Qazi GN. Rapid detection of *Salmonella* by polymerase chain reaction. Mol. Cell. Probes; 2004.
12. Adzitey F, Huda N, Ali GR. Molecular techniques for detecting and typing of bacteria, advantages and application to foodborne pathogens isolated from ducks. 3 Biotech. 2012;3(2):97-107.
13. Nissen B. Microtests for rapid identification of *Enterobacteriaceae* four-hour tests by use of substrate—impregnated paper discs. Acta Pathol. Microbiol. Scand. Ser. B Microbiol. 1984;92B(1-6):239–245.
14. Yousif EI, Ashoush IS, Donia AA, Hala Goma KA. Critical control points for preparing chicken meals in a hospital kitchen. Ann. Agric. Sci.; 2013.

15. FAO and WHO. Food and agriculture organization assuring food safety and quality. Food Nutr. Pap.; 2003.
16. Arias ML, Monge-Rojas R, Antill FN, Chaves C. Growth and survival of *Escherichia coli* O157: H7 in meat, poultry and vegetables mixed with different concentrations of mayonnaise. Rev. Biol. Trop.; 2001.
17. Nigeria E, Ifeyinwa C, Obinna V, Author C. Microbological quality of raw and roasted African palm weevil (*Rhynchophorus phoenicis*) consumed in the South. Anim. Res. Int.; 2015.
18. Arias ML, Monge-Rojas R, Antill FN, Chaves C. Growth and survival of *Escherichia coli* O157: H7 in meat, poultry and vegetables mixed with different concentrations of mayonnaise. Rev. Biol. Trop.; 2001.
19. De Oliveira DCV, et al. Ability of *Salmonella* spp. to Produce biofilm is dependent on temperature and surface material. Foodborne Pathog. Dis.; 2014.
20. Abdul-Raouf UM, Beuchat LR, Ammar MS. Survival and growth of *Escherichia coli* O157:H7 in ground, roasted beef as affected by pH, acidulants, and temperature. Appl. Environ. Microbiol. 1993;59(8):2364-LP-2368.
21. Chlebicz A, Śliżewska K. Campylobacteriosis, Salmonellosis, Yersiniosis, and Listeriosis as zoonotic foodborne diseases: a Review. International Journal of Environmental Research and Public Health. 2018;15(5): 863.
22. Forsythe SJ. The microbiology of safe food; 2007.
23. Ferens WA, Hovde CJ. *Escherichia coli* O157:H7: Animal reservoir and sources of human infection. Foodborne Pathogens and Disease. 2011;8(4):465-87.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle3.com/review-history/46979