Incidence and Characterization of Salmonella Isolated From Poultry Meat and its Products

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ABSTRACT

Key words: Salmonella, poultry products, PCR, virulence Gene

This study was conducted on some poultry products include breast, thigh, shish tawook, shawarma, nuggets and luncheon (35 of each) collected from different supermarkets at El Menofiya Governorates for isolation and identification of Salmonella on XLD agar and S.S agar. The incidence on XLD were 11.4%, 14.3%, 11.4%, 11.4%, 14.3% and 8.6% from breast, thigh, nuggets, shish tawook, shawerma and luncheon, respectively and the incidence of serologically identified Salmonella serotypes were Salmonella Enteritidis, Salmonella Typhimurium, Salmonella Kentucky and Salmonella Virchow. The incidence of Salmonella on S.S agar were 11.4%, 14.3%, 8.6%, 14.3%, 11.4% and 5.7% from breast, thigh, nuggets, shish tawook, shawerma and luncheon, respectively and the incidence of serologically identified Salmonella serotypes were Salmonella Enteritidis, Salmonella molade, Salmonella Kentucky, Salmonella Typhimurium and Salmonella Heidelberg. PCR results showed that fimH gene detected in Salmonella Molade, while hilA and fimH genes detected in Salmonella Heidelberg. And stn, hilA and fimH genes detected in Salmonella Typhimurium, Salmonella Enteritidis, Salmonella Kentucky and Salmonella Virchow.

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1. INTRODUCTION

Frozen chicken products have been identified recently as a cause of Salmonellosis. At least eight Salmonellosis outbreaks from 1998 to 2008 have implicated in undercooked frozen chicken nuggets, strips, and entrees as infection vehicles. Thus, the presence of Salmonella in frozen poultry products may pose an infection risk if the product is improperly cooked (Dominguez and Schaffner 2009).

Salmonella incidence in luncheon is lower this could be due to heat treatment during manufacture and presence of chemical preservatives. Cutting boards, surfaces used for preparation and equipments like meat grinders, mincers, blenders are considered an important source for contamination by Salmonella (Hosein et al., 2008; Kuhn et al., 2011). The thigh muscle had a higher Salmonella contamination rate compared to that of breast muscle which might be due to during evisceration process the thigh / leg because of its proximity to point of evisceration are highly prone for contamination from the gut content in case of improper procedure (Eyigor et al., 2003).

Many researchers have reported that poultry meat and its products were contaminated by several pathogenic bacteria (Basaran Kahraman and Ak 2012 and Urumova2014).

Salmonella is an important pathogen in the food industry and has been frequently identified as the etiological agent of food borne outbreaks (Siqueira et al., 2003). Salmonella spp. cause one of the most important foodborne diseases in the world called Salmonellosis which described as a zoonotic disease (Martin et al., 2008). It had been estimated that annually there are about 1.3 billion cases of acute gastroenteritis as result of non-typhoidal salmonellosis, resulting in 3 million deaths (Malorny...
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The major sources of human Salmonellosis are foods from animal origins and their products for example raw eggs, poultry, meat and pork (FAO/WHO, 2002). *S. Typhi* and *S. Paratyphi* A, B and C are causing typhoid and typhoid-like fever in humans (Forsythe, 2000). Salmonellosis is a leading cause of enteric illness, with symptoms ranging from mild gastroenteritis to systemic illness such as septicemia and other longer-term conditions. A wide range of foods has been implicated in food-borne salmonellosis. However, as the disease is primarily zoonotic, food of animal origin has been consistently implicated as the main source of human salmonellosis (FAO/WHO, 2002). The most common manifestations of salmonellosis are diarrhea, abdominal cramps, and fever within eight to 72 hours. Additional symptoms may be chills, headache, nausea, vomiting myalgias (muscle pain), and arthralgias (joint pain) are often reported as well. That can last up to seven days. Acute gastroenteritis represents a public health problem in all countries regardless to their level of development.

The hygienic quality of poultry products depends on the personal hygiene of the handlers, the production method, the qualities of all of the ingredients and the raw meat used (Colak et al., 2011). Processing of poultry products requires a severe microbiological quality control, considering they are one of the main sources of food borne infections. Where ever Salmonella was selected as the largest pathogenic microorganism because it is one of the most common causes of food poisoning, it present at varying frequencies on all types of poultry products (Rose et al., 2002). In processing plants, contamination of poultry meat products can occur throughout ideal processing, packaging and storage until the product is sufficiently cooked and consumed. Heavy bacterial loads enter the processing operations with the living birds and these bacteria can be disseminated throughout the plant during processing. Diseases can also results when these products are not properly cooked and post-processing contaminated (Zhang et al., 2001).

Polymerase Chain Reaction (PCR) based methods have been identified as a powerful diagnostic tool for the detection of pathogenic microorganisms (Malorny et al., 2003). Compared to other methods of detection, these methods are rapid, highly specific and sensitive in the identification of target organisms (Wang et al., 2007).

The aim of the present study was to determine the occurrence, serovars and virulence gene profile of salmonella isolated from poultry meat (thigh and breast) and some of its product (shawerma, shish tawook, nuggets and luncheon).

2. MATERIAL AND METHODS

2.1. Collection of Samples: A total 210 random samples of fresh raw chicken cuts (breast and thigh), some half cooked chicken products as ( shawerma, nuggets and shish tawook) and Cooked Products as (luncheon) (35 of each) collected from different supermarkets at El Menofiya Governorates.

2.2. Preparation of Samples according to (APHA, 1992)

2.3. Isolation and identification of Salmonella (ISO, 1993):

Primer sequences used for PCR identification system: Application of PCR for identification of virulence factors including Enterotoxin (*stn*), hyper-invasive locus (*hilA*) and fimbrial (*fimH*) genes of the identified Salmonella species was performed essentially by using Primers (Pharmacia Biotech) as shown in the following table (1):

<table>
<thead>
<tr>
<th>Target gene</th>
<th>Oligonucleotide sequence (5’ → 3’)</th>
<th>Product size (bp)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>stn</em>(F)</td>
<td>5’ CTTTGGTCGTAATAAATAGGCG ’3</td>
<td>260</td>
<td>Makino et al.(1999)</td>
</tr>
<tr>
<td><em>stn</em> (R)</td>
<td>5’TGCCCAAGCAGAGAGATTC ’3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>hilA</em> (F)</td>
<td>5’ CTGCCCGCAGTGTAAAGGATA ’3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>hilA</em> (R)</td>
<td>5’ CTGTGCCTTAATCGCATGT ’3</td>
<td>497</td>
<td>Guo et al., (2000)</td>
</tr>
<tr>
<td><em>fimH</em> (F)</td>
<td>5’ GGA TCC ATG AAA ATA TAC TC ’3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>fimH</em> (R)</td>
<td>5’ AAG CTT TTA ATC ATA ATC GAC TC ’3</td>
<td>1008</td>
<td>Menghistu (2010)</td>
</tr>
</tbody>
</table>
2.4 DNA Extraction using QIA amp kit (Shah et al., 2009)

2.5 DNA amplification for the selected virulent genes (Singh et al., 2013):

The amplification was performed on a Thermal Cycler (Master cycler, Eppendorf, Hamburg, Germany) using 25 μl of PCR mixture. The reaction mix invariably consisted of 5 μl of the bacterial lysate, 5 μl of 10x assay buffer for Taq polymerase containing 1.5 mM MgCl2, 2 μl of 10mM dNTP mix 1 μl each of forward and reverse primer (10 pmol) and 1.25 U of Taq DNA polymerase made up to 50 μl using sterile distilled water. The PCR cycling protocol was applied as following: An initial denaturation at 94°C for 60 sec, followed by 35 cycles of denaturation at 94°C for 60 sec, annealing at 64°C for 30 sec and extension at 72°C for 7 min. Subsequently, 5 μl of each amplicon was electrophoresed in 1.5 % agarose gel (Sigma –USA, stained with ethidium bromide and visualized and captured on UV trans illuminator. A 100 bp DNA ladder was used as a marker for PCR products.

3. RESULTS

3.1 prevalence of Salmonella isolated from poultry meat and some of its products on XLD agar:

Table (2): Incidence of identified Salmonella serotypes isolated from the examined samples of chicken cuts and some products using XLD agar (n=35 of each):

<table>
<thead>
<tr>
<th>Isolated Bacteria</th>
<th>Row Products</th>
<th>Cooked Products</th>
<th>Group Antigenic structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Breast</td>
<td>Thigh</td>
<td>Nuggets</td>
</tr>
<tr>
<td>Salmonella Typhimurium</td>
<td>2</td>
<td>3%</td>
<td>1</td>
</tr>
<tr>
<td>Salmonella Enteritidis</td>
<td>2</td>
<td>8.3%</td>
<td>1</td>
</tr>
<tr>
<td>Salmonella Kentucky</td>
<td>2</td>
<td>3%</td>
<td>1</td>
</tr>
<tr>
<td>Salmonella Virchow</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>11.4%</td>
<td>5</td>
</tr>
</tbody>
</table>

incidence of Salmonella were 11.4%, 14.3%, 11.4%, 11.4%, 14.3% and 8.6% from breast, thigh, nuggets, shish tawook, shawarma and luncheon, respectively.

3.2 prevalence of Salmonella isolated from poultry meat and some of its products on S.S agar:

incidence of Salmonella were 11.4%, 14.3%, 8.6%, 14.3%, 11.4% and 5.7% from breast, thigh, nuggets, shish tawook, shawarma and luncheon, respectively.

3.3 Results of PCR amplification of the stn, hilA and fimH genes of Salmonella species:
The genomic DNA of Salmonella species were tested using 3 sets of primers for detection of 3 virulence genes that play a role in virulence of Salmonella the genes were Enterotoxin gene (stn), hyper-invasive locus gene (hilA) and fimbrial gene (fimH) it was applied on random isolated Salmonella species (S. Molade) from breast, (S. Enteritidis) from thigh, (S. Typhimurium) from luncheon, (S. Kentucky) from nuggets, (S. Virchow) from shawarma, (S. Heidberg) from shish tawook. PCR results showed that fimH gene detected in (S. Molade). While hilA and fimH genes detected in (S. Heidberg). And stn, hilA and fimH genes detected in (S. Typhimurium), (S. Enteritidis), (S. Kentucky) & (S. Virchow).
Table (3): Incidence of identified Salmonella serotypes isolated from the examined samples of chicken cuts and some products on S.S agar (n=35 of each).

<table>
<thead>
<tr>
<th>Isolated Bacteria</th>
<th>Samples</th>
<th>Raw Products</th>
<th>Cooked Products</th>
<th>Group</th>
<th>Antigenic structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Breast</td>
<td>Thigh</td>
<td>Nuggets</td>
<td>Sheishtawook</td>
</tr>
<tr>
<td>Salmonella Typhimurium</td>
<td>2</td>
<td>5.7%</td>
<td></td>
<td>2.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Salmonella Enteritidis</td>
<td>2</td>
<td>5.7%</td>
<td></td>
<td>2.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Salmonella Heidelberg</td>
<td>2</td>
<td>5.7%</td>
<td></td>
<td>2.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Salmonella Kentucky</td>
<td>1</td>
<td>2.9%</td>
<td></td>
<td>2.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Salmonella Molade</td>
<td>1</td>
<td>2.9%</td>
<td></td>
<td>2.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Salmonella Virchow</td>
<td>1</td>
<td>2.9%</td>
<td></td>
<td>2.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>11.4%</td>
<td>5</td>
<td>14.3%</td>
<td>8.6%</td>
</tr>
</tbody>
</table>

The genomic DNA of Salmonella species were tested using specific primer for the hilA gene. The hilA gene was amplified in (S. Heidelberg), (S. Typhimurium), (S. Enteritidis), (S. Kentucky) & (S. Virchow), which giving product at (497 bp) as showing in Photograph 1. The genomic DNA of Salmonella species were tested using specific primer for the stn gene. The stn gene was amplified in (S. Typhimurium), (S. Enteritidis), (S. Kentucky) & (S. Virchow), which giving product at (260 bp) as showing in Photograph 1.

Photograph (1): Agarose gel electrophoresis of multiplex PCR of stn (260 bp), hilA (497 bp) and fimH (1008 bp) virulence genes for characterization of Salmonella species.

Lane M: 100 bp ladder as molecular size DNA marker.
Lane C+: Control positive strain for stn, hilA and fimH genes.
Lane C-: Control negative.
Lane 5(S. Heidelberg): Positive strains for hilA and fimH genes.

Table (4): Occurrence of virulence genes of different Salmonella strains isolated from the examined samples of chicken meat products.

<table>
<thead>
<tr>
<th>Virulence factors</th>
<th>sal</th>
<th>hilA</th>
<th>fimH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella Serovars</td>
<td>stn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Typhimurium</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>S. Enteritidis</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>S. Kentucky</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S. Molade</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>S. Heidelberg</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>S. Virchow</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

4. DISCUSSION

4.1 The incidence of salmonella on XLD agar in poultry meat and some of its product:

Result revealed that incidence of isolation of Salmonella on XLD agar in the examined samples of (breast, thigh, shish tawook, chicken shawerma, chicken nuggets and chicken luncheon), respectively, was (11.4 % (4), 14.3% (5), 11.4% (4), 14.3% (5), 11.4% (4) and 8.6% (3), respectively. Incidence of isolation of Salmonella in the examined samples of thigh and breast 14.3% (5) and 11.4% (4), respectively. Lower incidence from thigh and breast reported by Purabi and Joshi (2010) who found number of positive sample in each thigh and breast (1). Also lower incidence from thigh reported by Khaled et al., (2015) isolated salmonella with percentage of 3.3% and Mahmoud – Nahed (2016) with percentage of 6.6%.

On the other side higher incidence from thigh and breast reported by Edris-Shimmaaet al., (2011) isolated Salmonella from both thigh and breast with percentage of 16% also higher incidence from breast reported Zhao et al., (2008) isolated salmonella with percentage of 36.9%. Also higher incidence from thigh reported by Ibrahim-Hemmat et al., (2014), Irfaan et al.,(2015) and Saad et al., (2015) isolated Salmonella with percentage of 33.3%, 20-80% and 24%, respectively. But Khaled et al., (2015)and Mahmoud – Nahed (2016) failed to isolate Salmonella from breast.

Incidence of isolation of Salmonella in the examined Shawerma was 14.3% (5) these results nearly agreed with other authors Ahmed – Amany, et al.,(2015)and Mahmoud (2010) isolated salmonella with percentage of 15% and 13.3%, respectively. Also higher incidence reported by Saad et al.,(2015) and Hassanin et al., (2014) isolated salmonella with percentage of 30% and 20%, respectively.

Incidence of isolation of Salmonella in the examined nuggets was 11.4% higher incidence reported by Saad et al.,(2015) isolated salmonella with percentage of 25%. Also lower incidence reported by Ibrahim-Hemmat et al., (2014) isolated salmonella with percentage of 6.67%.

Incidence of isolation of Salmonella in the examined shish tawook was 11.4% (4). A higher incidence reported by Hassanin et al., (2014) and Mohamed Karmi (2014) isolated salmonella with percentage of 33.3% and 20%, respectively. But Saiid – Nagah et al.,(2014) failed to isolate salmonella from shish.

Incidence of isolation of Salmonella in the examined luncheon was 8.6%. But Mohamed Karmi (2014), Ibrahim-Hemmat et al., (2014) and Saad et al.,(2015) failed to isolate salmonella from luncheon.

The incidence of Salmonella on S.S agar in poultry meat and some of its product: Result revealed that incidence of isolation of Salmonella on S.S agar in the examined samples of (breast, thigh, shish tawook, chicken shawerma, chicken nuggets and chicken luncheon), respectively, was (11.4 % (4), 14.3% (5), 14.3% (5), 11.4% (4), 8.6% (3) and 5.7% (2), respectively.

Incidence of isolation of Salmonella in the examined samples of thigh and breast 14.3% (5) and 11.4% (4), respectively. Lower incidence from thigh and breast reported by Purabi and Joshi (2010) who found number of positive sample (2) in thigh and (1) in breast, respectively. Also lower incidence from breast reported by Chaiba Abdellah et al.,(2009) isolated Salmonella with percentage of 6.25%.
Incidence of isolation of Salmonella in the examined shawerma was 11.4% (4) A higher incidence reported by Nimri –laila et al., (2014) and Hanin and Tarek(2016) isolated salmonella with percentage of 26.3% and 30% , respectively. But Elsanusi Mustafa(2014) failed to isolate salmonella from cooked shawerma and shish tawook. also Datta et al., (2012) failed to isolate salmonella from shawerma.

4.2 The incidence of identified salmonella serotypes on XLD agar in poultry meat and some of its product:

Result given in table (2) revealed that incidence of isolated serotypes of Salmonella on XLD agar in the examined samples of thigh Salmonella Typhimurium 2(8.7%) , Salmonella Enteritidis2(8.7%) and Salmonella Kentucky1(4.3%) These result agree with Ibrahim-Hemmat et al., (2014) who isolated S. typhimurium, S. enteritidis, S. Kentucky, S. heidelberg, S. muenster, and S. anatum and. Khaled et al.(2015) who isolated S. Typhimurium also Mahmoud - Nahed (2016) isolated Salmonella enteritidis and Salmonella typhimurium was 2.7% and Salmonella Kentucky 1.3%.

incidence of isolated serotypes of Salmonella on XLD agar in the examined samples of breast Salmonella Enteritidis 2(8.7%) and Salmonella Kentucky2(8.7%) These result agree with Ibrahim-Hemmatet al., (2014) who isolated S. typhimurium, S. enteritidis, S. Kentucky, S. heidelberg, S. muenster, and S. Anatum.

incidence of isolated serotypes of Salmonella on XLD agar in the examined shawerma salmonella Typhimurium 2(8.7%) , Salmonella Enteritidis1(4.3%) and Salmonella Kentucky1(4.3%) and Salmonella Virchow1(4.3%) . These result agree with Saad et al.,(2015) isolated S. typhimurium, S. enteritidis, S. kentucky S. anatum, S. muenster and S. Virchow and Ahmed – Amany, et al.,(2015) isolated S. typhimurium and S. enteritidis.

incidence of isolated serotypes of Salmonella on XLD agar in the examined nuggets Salmonella Typhimurium1(4.3%) , Salmonella Enteritidis1(4.3%), Salmonella Kentucky1(4.3%) and Salmonella Virchow1(4.3%) . These result agree with Ibrahim-Hemmat et al., (2014) isolated S. typhimurium, S. enteritidis, S. heidelberg, S. muenster, S. kentucky and S. anatum, and Saad et al.,(2015) isolated S. typhimurium, S. enteritidis, S. kentucky S. anatum, S. muenster and S. Virchow.

incidence of isolated serotypes of Salmonella on XLD agar in the examined samples of shish tawook Salmonella Typhimurium 2(8.7%) , Salmonella Enteritidis1(4.3%) and Salmonella Kentucky1(4.3%) These result agree with Mohamed Karmi (2014) isolated S. Kentucky with incidence of 12.5%.

4.3 The incidence of identified salmonella serotypes on S.S agar in poultry meat and some of its product: Result given in table (3) revealed that incidence of isolated serotypes of salmonella on S.S agar in the examined samples of breast sal. Enteritidis 2(5.71%)sal Kentucky1 (2.9%), sal.molade1 (2.9%). These result not agree with Chaiba Abdellah et al., (2009) who isolated S. typhimurium (40.35%) and S. newport (26.31%) then S. montevideo (17.54 %) and S. heidelberg (15.78%) from breast.

incidence of isolated serotypes of Salmonella on S.S agar in the examined samples of shawerma S. Typhimurium 1( 2.9%), S. Enteritidis1( 2.9%), S. Kentucky 1( 2.9%), S. virchow1( 2.9%). These result not agree with Nimri –laila et al., (2014) who isolated S. paratyphi A , S. Cholerasuis and S. Pullorum with percentage of 43% , 37% and 20% respectively.

The thigh muscle had a higher Salmonella contamination rate compared to that of breast muscle which might be due to during evisceration process the thigh / leg because of its proximity to point of evisceration are highly prone for contamination from the gut content in case of improper procedure( Eyigor et al.,2003).

Lower incidence of Salmonella spp. in luncheon could be due to heat treatment during manufacture and presence of chemical preservatives. Cutting boards, surfaces used for preparation and equipment like meat grinders, mincers, blenders are considered an important source for contamination by Salmonella (Hosein et al.,2008 ; Kuhn et al., 2011).

The presence of Salmonella species in chicken nuggets reflects the degree of sanitation in the processing plant and will harm the consumer health (Frenzen et al., 2005; Amela et al., 2009). Addition of certain spices during manufacture of products may lead to marked increase in bacterial population(Sharaf, 1999).

The presence of Salmonella in chicken meat may be attributed to contamination during slaughtering and/or processing from workers’ hands (Carraminana et al., 1997). The leading source of contamination of carcasses by Salmonellae is the evisceration step at the slaughterhouse (Bouchrif et al., 2009). As well as poor hygiene conditions, regarding the temperature of storage, the equipment and the employees' personal hygiene. The cutting tables were seldom washed or disinfected before use. These benches could therefore
be reservoirs from which Salmonellae could spread to other equipment through flies or direct contact (Stevens et al., 2006).

Also the present study was directed to recognize some virulence genes that may play a role in virulence of Salmonella by using one of the recent development molecular biological techniques (PCR). The genes were Enterotoxin gene (stn), hyper-invasive locus gene (hilA) and fimbrial gene (fimH) it was applied on random isolated Salmonella species: (S. Molade) from breast, (S. Enteritidis) from thigh, (S. Typhimurium) from luncheon, (S. Kentucky) from nuggets, (S. Virchow) from Shawerma, (S. Heidelberg) from shish tawook.

PCR results showed that fimH gene detected in (S. Molade) while hilA and fimH genes detected in (S. Heidelberg). And stn, hilA and fimH genes detected in (S. Typhimurium), (S. Enteritidis), (S. Kentucky) & (S. Virchow) as showing in Photograph (1). fimH is lectin-like adhesion, located on the tip of the fimbrial shaft, is directly responsible for bacteria binding to oligomannosidic structures carried by many eukaryotic membrane-bound and secreted glycoprotein (Krogfelt et al., 1990). One important Salmonella virulence trait is the ability to adhere to host intestinal tissue, which is mediated by several fimbrial types in different serovars of Salmonella. These include type I fimbriae, long polar fimbriae, plasmid-encoded fimbriae, and thin aggregative fimbriae. Interestingly, long-polar fimbriae have been shown to mediate binding to Peyers patches overlying lymphoid follicles within the intestine (Darwin and Miller, 1999). This may be important, as serovar S. Typhimurium has been observed to preferentially invade and destroy M cells of Peyers patches in the murine model of Salmonella infection (Penheiter et al., 1997) these genes are required for the initial invasion of the intestinal epithelium that is essential for Salmonella to cause localized gastroenteritis (McBeth and Lee, 1993).

The hilA gene (hyper-invasive locus A) was first identified as a locus that renders the bacteria non-responsive to high-oxygen repression of invasion when overexpressed (Lee et al., 1992). The hilA gene is located in Salmonella Pathogenicity Island I (SPI-1) which encodes structural components, chaperones, and secreted effectors of the type III secretion system necessary for invasion (Darwin and Miller, 1999). Expression of hilA appears to be crucial for the invasive phenotype, as mutations in hilA decrease invasion ~150-fold (Bajaj et al., 1995; Penheiter et al., 1997). The hilA gene encodes the central regulator hilA, which is necessary for the expression of the Type three secretion system (TTSS) components. hilA is also required to invade epithelial cells and induce apoptosis of macrophages (Bajaj et al., 1996).

It has been proposed that Salmonella enterotoxin (Stn) is a putative virulence factor and causes an entero-toxic effect on epithelial cells, leading to enteric disorder (Chopra et al., 1994; Asten and Dijk, 2005). Interestingly, it has been shown that the stn gene is specifically distributed in Salmonella spp. irrespective of their serotypes (Lee et al., 2009). This second finding indicates that the stn gene might be useful for the identification or detection of Salmonella and that Stn might be involved in functions unique to Salmonella. Salmonella induced diarrhea is a complex phenomenon on involving several pathogenic mechanisms, including production of enterotoxin. This enterotoxin production is mediated by the stn thus it plays a significant role in causing gastroenteritis by producing enterotoxin (Chopra et al., 1987).

These result agree with Amin- Heba and Abd El-Rahman (2015) who recorded that S. typhimurium, S. Kentucky and S. enteritidis harbored the stn gene in all examined serotypes.

These result go parallel with Gharieb -Rasha et al., (2015) S. typhimurium (1 isolate, each) were harboring stn genes. And Ahmed - Heba et al., (2016) who recorded that S. typhimurium, harbored the stn gene in all examined isolates.

REFERENCE


