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Salmonella Saintpaul Outbreak: Export and Trade Economic Impact

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1. Introduction

Foodborne pathogens cause diarrhea and flu-like illnesses. An estimated 1.8 million children die each year associated with disease-causing organisms acquired via food consumption with the greatest number of cases occurring in developing countries (WHO 2008). In the United States, the burden of foodborne infections causes an estimated 48 million cases of sick people, from which 128,000 are hospitalized and 3,000 die annually (CDC, 2011). In addition, around 31 of the acquired pathogens known cause an approximated 9.4 million episodes of foodborne illnesses while additional episodes are caused by unspecified agents, known agents not yet recognized as causing foodborne illness, and substances known to be in food but unproven pathogenicity (Scallan *et al.*, 2011). According to Allos *et al.* (2004) and Imhoff *et al.* (2004) the economic burden of foodborne illnesses results in an estimated annual cost of \$6.9 billion USD because of work absenteeism, cost of medication and hospitalization, being the annual diarrheal burden of 0.72 episodes per person.

According to Buzby *et al.* (1996) and WHO (2008) the most common foodborne pathogens associated with outbreaks are bacteria like *Campylobacter jejunii*, *Escherichia coli* O157:H7, *Listeria monocytogenes* and *Salmonella*. Data from the CDC (2011) indicates the prevalence of *Salmonella* serotypes causing foodborne illnesses, which shows an increasing tendency from 2006 to 2011, involving several food as transmission vehicle, such as tomatoe, cantaloupe, egg, alfalfa sprout, peanut butter, pepper, and papaya. Therefore, the control of foodborne pathogens must be considered as one of the most important goals of authorities and producers. When a pathogen related outbreak is detected, the collaboration among Universities, Research Centers and health authorities from countries involved, is an essential step to source track the origin of the causative agent, and to seek for strategies for problem remediation.

The association of food with pathogens is a critical problem that requires special attention of the Mexican producers, since the presence of disease-causing organisms might provoke the close of borders of the destiny country. Therefore, the Mexican agricultural authorities have established mandatory regulations for fresh produce production and processing, which include Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) audit

programs that must be implemented in order to avoid the presence of both pesticides and pathogens on the final product (SAGARPA, 2011).

1.1 Fresh produce production in the state of Sinaloa

One of the main activities in Sinaloa is the agriculture. Sinaloa state is located at the northwest of Mexico ($27^{\circ} 7' - 22^{\circ} 20' N$, $105^{\circ} 22' - 109^{\circ} 30' O$) (Figure 1) with a population of 2,767,761 people (INEGI, 2011).



Fig. 1. Location of Sinaloa state.

During the agricultural season of 2006, Confederación de Asociaciones Agrícolas del Estado de Sinaloa (CAADES: Confederation of Agricultural Associations of the State of Sinaloa) reported a total agricultural surface of 1,267,636 ha and a total production worth \$1,711,816 USD. Tomato is the most important fresh produce for Sinaloa; from 1980 to 2006, CAADES reported a total of 719,383 ha for red tomato production and profits of \$3,098,412 USD, while for green tomato only 130,980 hectares were destined for its production, obtaining profits of \$306,662 U.S dollars. In the international trade, the production of tomato favors Mexican economy of America, with a total export of 298,292 t (Figure 2) and profits of \$279.7 million USD during the agricultural season of 2008-2009 (Figure 3) (CIDH, 2011).

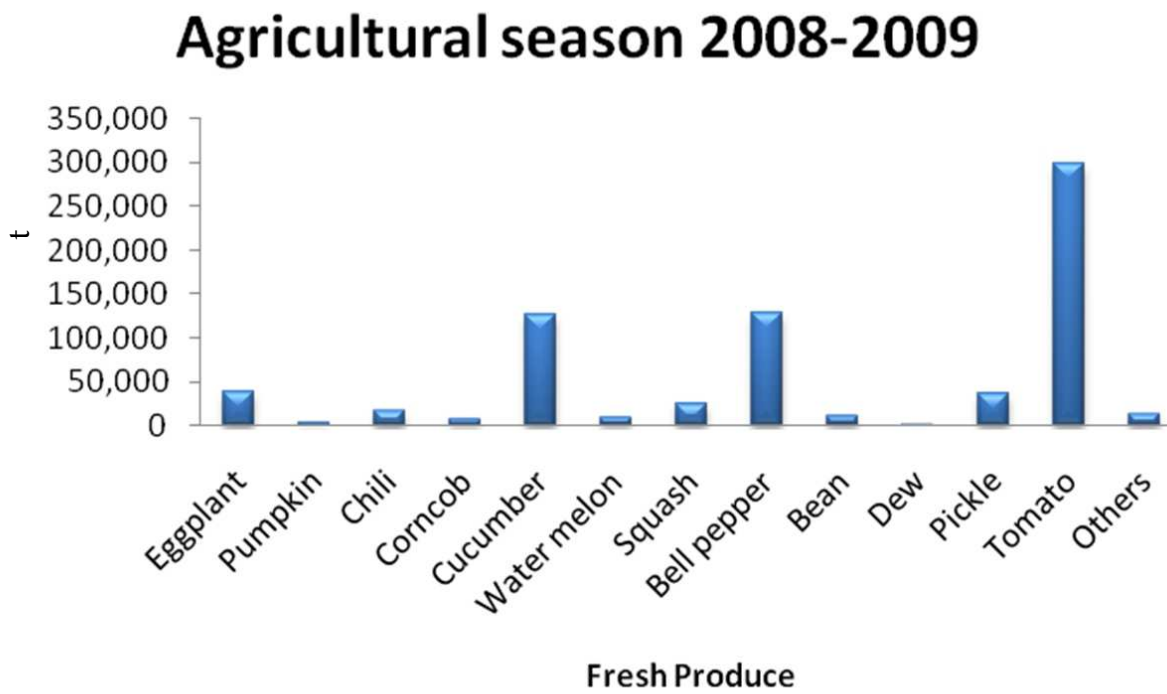


Fig. 2. Total horticultural production expressed in tons from 2008 to 2009 in Sinaloa state. Data from Committee for the Research and Defence of Vegetables, CIDH, 2011.

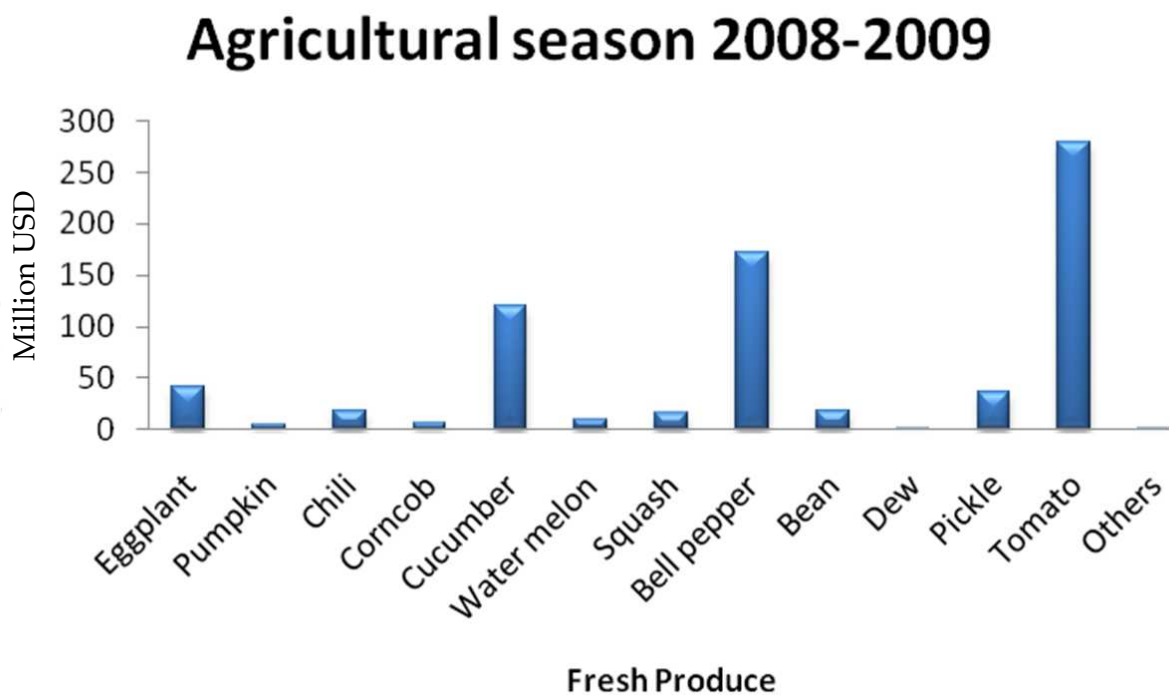


Fig. 3. Global value of horticultural exports from 2008 to 2009 in Sinaloa state expressed in Million USD. Data from CIDH, 2011.

The commercial relationship between Sinaloa state producers and the United States, is given in great majority for the exportation of Mexican fresh produce, which are extensively and carefully produced under strict guidelines of GAP and GMP, to prevent the misuse of pesticides and the presence of pathogens (SENASICA, 2011). As evidence of that, among the different foodborne outbreaks occurred in the United States of America, none of them had been associated to fresh produce grown in fields of Sinaloa.

1.2 *Salmonella* Saintpaul outbreak

From April to August of 2008, the US CDC Health Department confirmed the occurrence of a multistate *Salmonella* serotype Saintpaul outbreak affecting 43 US states, Columbia district and Canada (Figure 4). In August of 2008, a total of 1,442 cases and at least 286 hospitalizations and two deaths were reported. The US Health authorities argued high association (85%) of tomato and later jalapeño peppers as the pathogen transmission vehicles and pointed out Sinaloa tomato production as a possible source of the bacterial strain (CDC, 2008). The outbreak and the CDC call alerted both countries, which started to work together to source track the origin of the causative agent.

2. Searching the causative agent in Sinaloa fields

2.1 Sample collection

In order to confirm or discard the presence of *Salmonella* Saintpaul strain in Sinaloa fields, the U.S Food and Drug Administration (FDA), according to CDC statement, began the traceability of the strain in collaboration with Health and Agricultural Mexican authorities Comisión Federal para la Protección contra Riesgos Sanitarios (COFEPRIS, Federal Commission for Protection against Health Risks) and Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria (SENASICA, National Health Service, Agri-food Safety and Quality). COFEPRIS and SENASICA are Mexican government institutions responsible to promote the adequate food production and to prevent the microbial risk ensuring food safety. Along with Health and Agricultural authorities of both countries, scientists from the Centro de Investigación en Alimentación y Desarrollo, A.C. (CIAD, Research Center for Food and Development), Culiacán station began collecting samples in Sinaloa fields to search for the *Salmonella enterica* serotype Saintpaul.

The sampling collection was conducted from June 23rd to June 27th of 2008. The sampling areas were divided in agricultural fields and packinghouse's facilities. From the agricultural fields, canal water, reservoir water, water filtering equipment, soil, and tomato samples were collected; while from packinghouse's facilities conveyor belts, tomato washing area, drying area and packing lines were sampled.

Sampling procedure was conducted according to the established by the American Public Health Association (APHA, 1998). Water and sediments samples were placed in sterile polypropylene flasks (Nalgene, Miami USA), while hermetic bags and sterile pre-wetted sampling sponges with 15 mL of phosphate-buffered solution (Whirl-Pak, Fort Atkinson, WI, USA) were used for soil and fruit.

2.2 *Salmonella* isolation method

Salmonella isolation from the collected samples was performed according to the APHA (1998), which consists in the Most Probable Number (MPN) technique by the use of 3x

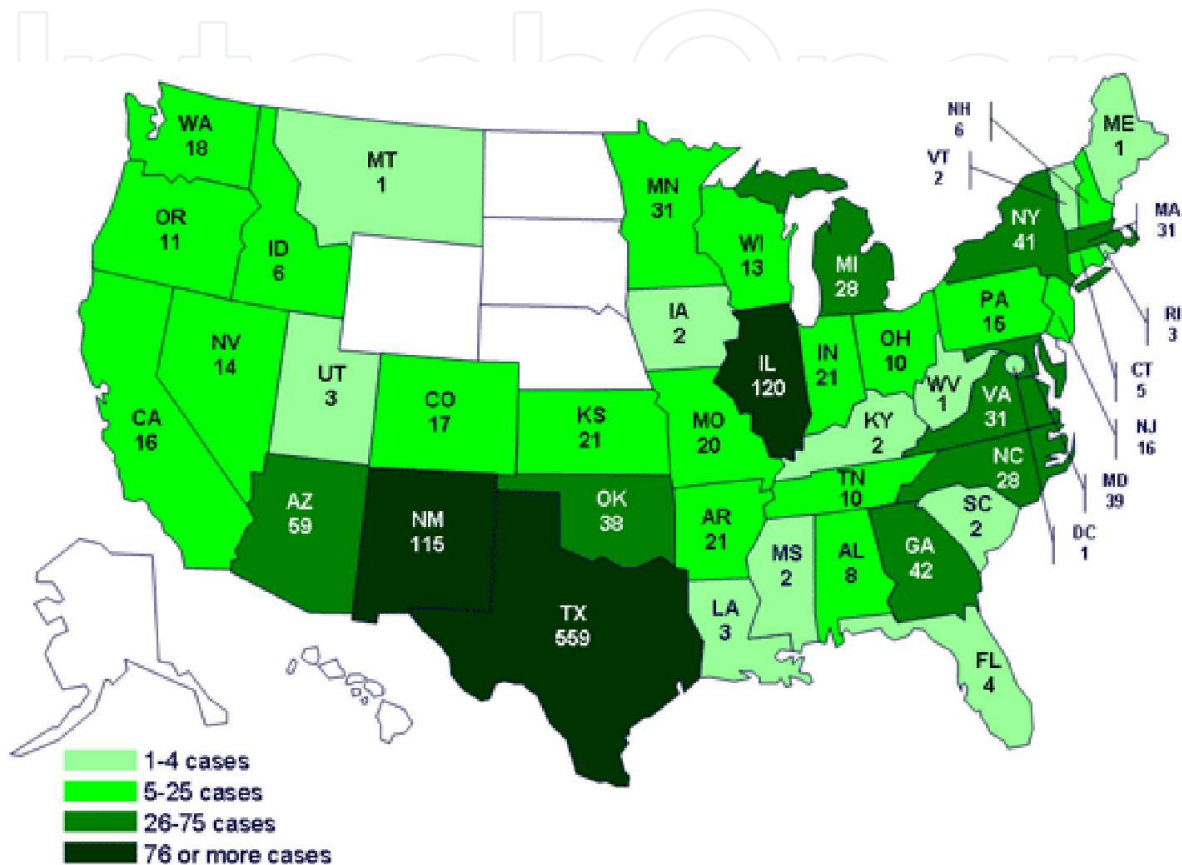


Fig. 4. Distribution and number of infected cases with *Salmonella* Saintpaul, in the United States (CDC, 2008).

Tripticase Soy Broth (3x TSB) (Bioxon, México), modified semi-solid Rappaport Vassiliadis (Difco, USA) and XLD agar (Bioxon, México) as pre enrichment, enrichment and selective isolation, respectively. The homogenized sample was diluted and distributed in 3 sets of 3 tubes each. Once inoculated the tubes were incubated at 37°C during 24 h. After incubation, aliquots were transferred to modified semi-solid Rappaport Vassiliadis (Difco, USA) and incubated at 42°C during 24 h. This process was done by triplicate. Finally a loop of the inoculated semi-solid medium was transferred to the XLD agar (Bioxon, México), which was incubated at 37°C during 24 h to identify presumptive colonies presenting round morphology, black central pigment and a well-defined

transparent border. Presumptive colonies were prepared to DNA extraction for confirmation assay by Polymerase Chain Reaction (PCR).

3. Results

During the monitoring of packinghouses and agricultural fields, a total of 124 samples were collected and analyzed. According to results, *Salmonella* Saintpaul was absent from any of the samples collected regarding its origin.

It is necessary to remark the absence of *Salmonella* in all the samples analyzed corresponding to packinghouses, which implies a strong evidence of the adherence and following to the GAP and GMP of growers from Sinaloa.

The Ministry of Agriculture announced the absence of *Salmonella* Saintpaul in Sinaloa fields supported by the microbiological traceability conducted by federal and CIAD personnel. During the inspection it was also corroborated the good situation of the horticulture in Sinaloa and that tomatoes from Sinaloa have no responsibility for the unfortunate public health problem occurred in the United States. These actions removed the name of México from the list of countries associated to fresh produce involved in the outbreak.

During this season, only 717,000 t of tomato were exported, a 9.6% less than the previous season due to the *Salmonella* Saintpaul outbreak generating an economic impact for the Sinaloa tomato industry worth \$134 million USD losses.

According to United States Department of Agriculture (USDA) 2009, in terms of consumption the tomato is one of the four more consumed fresh produce, as well as potato, lettuce and onion, while in terms of trade, the imports of Mexican tomato represent a strong source of profits. However, this outbreak produced a negative perception for the tomato consumption, not only for Mexican tomato but also to tomato grown in the USA. According to the Center of Agribusiness and Economic Development from The University of Georgia in 2008, the tomato demand decreased significantly during the outbreak, with an average impact of \$11,778 USD per acre for tomato not sold and a total of \$25.7 million USD only for Georgia State.

The economic impact in México caused by the presumptive responsibility of Mexican tomato as transmission vehicle of *Salmonella* Saintpaul promoted the emergence of the Coordinación Estatal de Inocuidad Hidroagrícola, Pecuaria, Acuícola y Pesquera (CEIHAPAP), which is governed by the State of Sinaloa to coordinate efforts among producers and scientific institutions for the development of methods to ensure the safety production of fresh produce, free of biological, chemical and physical agents that can represent risks for the consumer's health.

Results of the absence of *Salmonella* Saintpaul from Sinaloa tomatoes allowed the re-opening of the international trade for tomatoes, helping the economy and strengthening the commercial relationship between México and the United States of America.

4. Conclusions

According to the scientific evidence, it was demonstrated the consistent and effective adherence to the GMP and GAP by the Mexican growers, as well as the proper monitoring of fields to ensure microbiological quality of the fresh produce.

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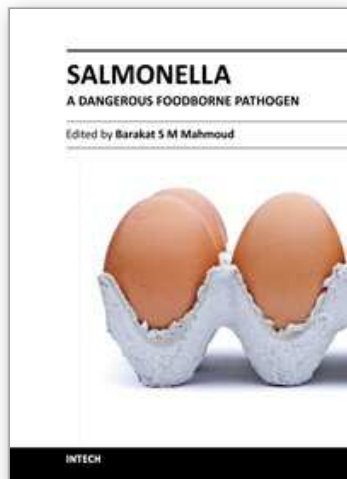
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Salmonella - A Dangerous Foodborne Pathogen

Edited by Dr. Dr. Barakat S M Mahmoud

ISBN 978-953-307-782-6

Hard cover, 450 pages

Publisher InTech

Published online 20, January, 2012

Published in print edition January, 2012

More than 2,500 serotypes of Salmonella exist. However, only some of these serotypes have been frequently associated with food-borne illnesses. Salmonella is the second most dominant bacterial cause of food-borne gastroenteritis worldwide. Often, most people who suffer from Salmonella infections have temporary gastroenteritis, which usually does not require treatment. However, when infection becomes invasive, antimicrobial treatment is mandatory. Symptoms generally occur 8 to 72 hours after ingestion of the pathogen and can last 3 to 5 days. Children, the elderly, and immunocompromised individuals are the most susceptible to salmonellosis infections. The annual economic cost due to food-borne Salmonella infections in the United States alone is estimated at \$2.4 billion, with an estimated 1.4 million cases of salmonellosis and more than 500 deaths annually. This book contains nineteen chapters which cover a range of different topics, such as the role of foods in Salmonella infections, food-borne outbreaks caused by Salmonella, biofilm formation, antimicrobial drug resistance of Salmonella isolates, methods for controlling Salmonella in food, and Salmonella isolation and identification methods.

How to reference

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Nohelia Castro-del Campo, Cristóbal Chaidez, José A. Medrano-Félix, J. Basilio Heredia, Josefina León-Félix, Gustavo González Aguilar and J. Fernando Ayala Zavala (2012). Salmonella Saintpaul Outbreak: Export and Trade Economic Impact, Salmonella - A Dangerous Foodborne Pathogen, Dr. Dr. Barakat S M Mahmoud (Ed.), ISBN: 978-953-307-782-6, InTech, Available from: <http://www.intechopen.com/books/salmonella-a-dangerous-foodborne-pathogen/salmonella-saintpaul-outbreak-export-and-trade-economic-impact>

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