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Research Article
Questionnaire Survey on Salmonellosis and the Egg Industry in the English-Speaking Caribbean

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Abstract

Background and Objective: The burden of foodborne illness in the Caribbean countries is unknown because reporting systems do not exist. The study was conducted to obtain information on foodborne and table egg-borne outbreaks and the causative agents during the period 2000-2010 in the Caribbean region. **Materials and Methods:** An electronic questionnaire was disseminated to each regional chief veterinary officer of the 27 countries. **Results:** Questionnaires were returned by 40.7% (11/27) of the Caribbean countries. Of the countries that responded 6 (54.5%) reported having experienced foodborne illnesses. None of the 11 countries reported having experienced foodborne illnesses associated with table eggs during the study. The prevalent pathogens associated with foodborne outbreaks were Rotavirus, *Salmonella* Enteritidis, *Salmonella* Typhimurium and *Shigella* spp. Four (36.4%) of the countries were able to access laboratory services to conduct bacteriological assay for *Salmonella* spp., however only two countries conduct routine screening. The products commonly imported by the 11 countries were table eggs (81.8%), hatching eggs (54.5%) and day-old chicks (45.5%) and 10 (90.9%) countries imported eggs and egg products from North America while 27.3% imported from the United Kingdom. **Conclusion:** There is a need to improve the diagnostic capacity in the region and surveillance programmes must be established. It is also important for the countries that import day-old chicks, hatching eggs and eggs products from countries outside the Caribbean to be aware of the risk of introduction of *Salmonella* spp. and other pathogens into the region.

Key words: Caribbean, egg production, foodborne illness, layer farms, *Salmonella*, table eggs

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The English-speaking Caribbean region comprises 27 countries and an estimated population of 43 million people. Eggs are widely used to prepare many dishes in the region and it is known to be the main vehicle for the transmission of *Salmonella* spp. In the Caribbean region, *Salmonella* spp. are the most common cause of foodborne illnesses[1]. There is a dearth of information on documented foodborne illnesses, including egg-borne outbreaks and the causative agents, in the Caribbean region.

Foodborne pathogens are responsible for an increasing burden of disease worldwide and they are estimated to cause more than 2 million deaths per year[2,3]. Many countries, especially developing countries, do not have systems in place that make it mandatory for clinicians to notify government health officials of cases and epidemics of foodborne outbreaks. The implication is that it is impossible to estimate the burden of foodborne illness globally[4]. Additionally, the total number of foodborne outbreaks is grossly under-estimated because most illnesses are self-limiting and consumers who become sick following consumption of contaminated foods generally do not seek medical attention[4]. *Salmonella* is an important cause of foodborne disease in humans throughout the world and is a significant cause of morbidity, mortality and economic loss[5]. Eggs are considered the predominant source of human salmonellosis in many parts of the world[6-8]. *Salmonella* Enteritidis (SE) is considered the serovar mostly implicated in *Salmonella* egg-related foodborne illness primarily because the pathogen could contaminate the egg contents through vertical transmission. It is known that other *Salmonella* serovars mostly contaminate eggs horizontally through egg shells[9].

In January 2005, the Ministry of Health and the Centers for Disease Control reported a *Salmonella* Enteritidis outbreak in a major hotel in Trinidad and Tobago and an outbreak of salmonellosis at the Beaches Sandy Bay Resort in Jamaica. Several hotel outbreaks of salmonellosis were also reported in Barbados between 1990 and 2000[10].

In the Caribbean region, *Salmonella* spp. was considered the most common cause of foodborne illness and SE was determined to be the most prevalent serovar (25%) with *Salmonella* Typhimurium (ST) being the second most common (14%). The majority of isolates serotyped were reported to have originated from Barbados (33%) and Trinidad and Tobago (33%)[1]. Additionally, although most of the reports on the detection of SE and ST has been associated with egg-borne outbreaks, few published studies exist on the frequency of isolation of these pathogens from table-eggs and layer birds in the Caribbean. Indar *et al.*[11] reported that the prevalence of *Salmonella* on egg shells (4.7%) was significantly higher than that found in egg contents (1.2%) from layer farms in Trinidad and Tobago. Adesiyun *et al.*[12] determined that SE accounted for 58.3% (14 of 24) of the isolates of *Salmonella* from composite eggs (shells, egg content or both) collected from layer farms and supermarkets in Trinidad. In that study, an overall frequency of isolation of *Salmonella* spp. of 13.0% was reported. On layer farms, *Salmonella* spp. were recovered from egg shell surfaces at a frequency of 12.5% in pooled egg shells in Trinidad and Tobago[13].

Considering the limited information available on the foodborne outbreaks, causative agents and the food vehicles of these pathogens in the Caribbean region, the current study was conducted to obtain data, retrospectively, on foodborne (including table egg-borne) outbreaks and the identified causative agents in the Caribbean region.

MATERIALS AND METHODS

Salmonellosis was reported to have been on an increase since 1986 in Trinidad and Tobago, followed by Jamaica and Barbados[14]. Although, all serotypes of *Salmonella* have the potential to cause egg-borne salmonellosis, *Salmonella* Enteritidis (SE) has globally emerged as the serotype most frequently associated with most human epidemics[15].

The study was conducted in 27 countries in the Caribbean region with a total population of over 43 million people. Questionnaires were administered to the chief veterinary officers (CVOs) or their designates via email and phone calls to elicit information for the period 2000-2010 regarding the following: Documented foodborne/egg-borne outbreaks and agents implicated, importation of eggs (table or hatching), egg products and day-old chicks (country of origin), distribution of imported eggs (hatcheries, supermarkets, local markets or hotels) or chicks (layer or broiler farms) and microbial testing of table eggs (local or imported), birds (layers or broilers) and pathogens isolated.

RESULTS

Questionnaire response rate: Overall, 40.7% (11 of 27) of the countries contacted responded to the questionnaire survey.

Foodborne Illnesses: Six (54.5%) of the 11 responding countries reported having experienced foodborne illnesses. No data on foodborne illnesses were provided by Trinidad and Tobago and Haiti. None (0.0%) of the countries reported table eggs as being the food responsible for the food borne

Table 1: Foodborne cases documented in six caribbean counties, 2000-2010

	No. of foodborne cases by year										
Country*	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Aruba	-	-	-	1	-	1	-	-	1	-	1
Cayman Islands	13	13	16	4	2	10	5	0	13	2	3
Dominica	-	-	-	-	-	-	2150	1300	1150	550	1600
Grenada	35	37	55	73	74	66	-	-	57	108	94
St. Lucia	-	-	-	-	-	-	-	-	12	-	-
Suriname	-	5	12	1	7	4	5	-	4	2	4

*Only 6 of the 11 countries documented foodborne cases during the study period

outbreaks. Table 1 displays the annual number of reported foodborne cases in the 6 countries that documented foodborne cases of gastroenteritis.

Causative agents: Based on the information provided in the completed questionnaires, the causative agents of the foodborne illnesses varied greatly. Only 4 (36.4%) of the 11 countries conducted any bacteriological work to determine the causative agents in the reported foodborne outbreaks. In Aruba, the pathogens identified at a national laboratory were *Salmonella* Enteritidis and *Salmonella* Oranienburg. Dominica isolated *Salmonella* Enteritidis, *Salmonella* Typhimurium, *Campylobacter jejuni*, *Shigella* spp., Norovirus and Rotavirus whereas Suriname isolated *Salmonella* Typhimurium and *Shigella* spp. The causative agents for both Dominica and Suriname were identified by the Caribbean Epidemiology Center (CAREC). *Salmonella* spp. and *Shigella* spp. were the causative agents of foodborne illnesses in the Cayman Islands and the identification was performed at an extra-regional laboratory.

Importation of eggs and egg products: Ten (90.9%) of the 11 countries (Antigua and Bermuda, Aruba, Barbados, Cayman Islands, Grenada, Haiti, St. Lucia, St. Vincent, Suriname and Trinidad and Tobago) imported eggs and egg products from North America, specifically the United States of America (USA), as shown in Fig. 1. Six (54.5%) countries imported eggs from the USA alone. In addition, to the USA, Barbados imported eggs from Canada and Holland; Haiti from Dominican Republic; Aruba and Suriname imported eggs from many countries including The Netherlands, France, United Kingdom, China, Hong Kong, Canada, Barbados, Brazil, Venezuela, Costa Rica and Dominican Republic. Dominica was the only country that did not import eggs or egg products. Figure 2 shows that of the 11 countries, the most common products imported were table eggs in 9 (81.8%) countries, hatching layer eggs in 6 (54.5%) countries and day-old chicks in 5 (45.5%) countries. Other products imported by St. Lucia, Suriname and Trinidad and Tobago include broiler day old chicks, hatching broiler

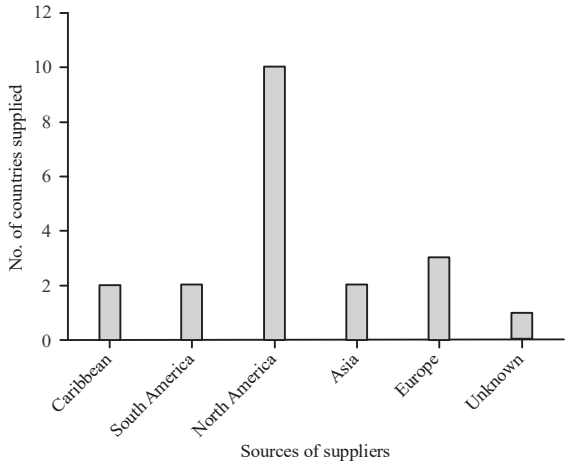

Fig. 1: Importation of eggs into the Caribbean region by origin

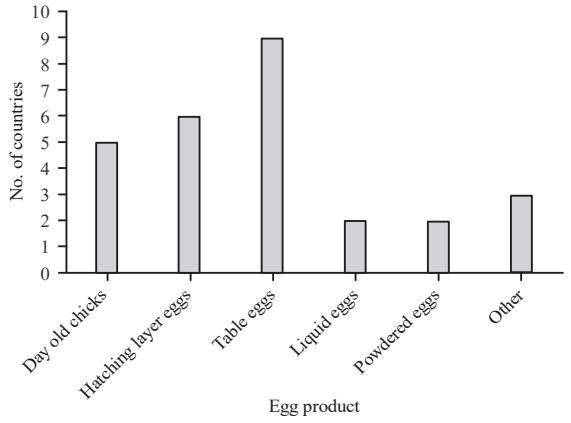

Fig. 2: Types of eggs, egg products and birds imported into the Caribbean

eggs and hatching duck eggs. Aruba, Cayman Islands, Grenada, St. Lucia and Trinidad and Tobago imported day-old chicks. Barbados, Grenada, Haiti, St. Vincent, Suriname and Trinidad and Tobago import hatching layer eggs and all the countries, except for Barbados and Dominica, imported table eggs. None (0.0%) of the respondents reported having identified *Salmonella* spp. in any eggs imported into their

Table 2: Size of layer farms in the 11 Caribbean countries

	Percent of farms in categories		
Country*	Small layer farms (<1000 birds)	Medium layer farms (1000-5000)	Large layer farms (>5000 birds)
Antigua and Barbuda	30	50	20
**Aruba	NA	NA	NA
Barbados		100	
Cayman Islands	100		
Dominica	60	40	
Grenada	57	43	
Trinidad and Tobago	5	20	75
St. Lucia	40	48	12
St Vincent and the Grenadines	60	40	

*Two countries, Suriname and Haiti, did not categorize their layer farms. **NA: Both farms in Aruba were classified as having less than 5,000 birds

countries. However, of the 11 countries only St. Lucia and Trinidad and Tobago do routine sampling and testing of eggs and egg products imported into their country.

Hatcheries: Eight (72.7%) countries had hatcheries for either broilers and/or layers. The countries with hatcheries were Trinidad and Tobago, St. Lucia, Aruba, Barbados, Grenada, St Vincent and the Grenadines, Haiti and Suriname. The hatcheries in Barbados and Suriname were relatively large. In Barbados, two (50%) of the four hatcheries hatched more than 1 million eggs per year while in Suriname, four (80%) of the five hatcheries hatched more than 416,000 eggs annually. The other countries with hatcheries hatched on an as needed basis.

Layer farms: Layer farms were reported to exist in all the 11 countries that participated in the study but most of the farms were classified as small to medium-sized (Table 2). Suriname and Haiti did not categorize their farms. In all the countries, the eggs were usually distributed to supermarkets and shops where they were purchased by the consumer.

DISCUSSION

In most cases, foodborne illnesses and not outbreaks, were reported. Dominica reported the highest number of foodborne illnesses but no foodborne illness was reported in Antigua and Barbuda, Barbados, Haiti, Trinidad and Tobago and St. Vincent and the Grenadines during the study period. However, it is difficult to compare data because of the different public health monitoring systems in the region and the different methods used for analysis[4]. Also, the total number of foodborne illnesses is sorely underestimated[16] because most illnesses are self-limiting and ill consumers generally do not seek medical attention[4]. Based on the questionnaire survey, none of the 11 countries reported having experienced foodborne illnesses associated with table eggs during the study period (2000 to 2010). This observation was in agreement with Adesiyun *et al.*[13] who reported that table eggs appeared to pose minimal risk to consumers. It was also reported that *Salmonella* spp. was not isolated in these countries but only two countries (Trinidad and Tobago and St. Lucia) conduct routine screening. This does not agree with reports by others which indicated that *Salmonella* is a leading cause of foodborne illness and poultry products and table eggs are regular sources of human salmonellosis[6,7,17,18]. Also, Majowicz *et al.*[19] reported an estimated number of non-typhoid salmonellosis cases per year as 43,000 in the Caribbean region. The microbiological agents documented to be responsible for foodborne illnesses in the Caribbean are similar to those reported elsewhere; even though the dominant pathogen may vary from country to country[16, 20-22].

The availability of laboratory support to conduct bacteriological assay for *Salmonella* spp. is limited in the region with only 4 (36.4%) of the countries with access to laboratory services. This limitation is expected to have resulted in the under-reporting of reported detection of *Salmonella* spp. in foods suspected as vehicles of foodborne illnesses. More laboratories capable of conducting basic bacteriological work to isolate and identify *Salmonella* spp. should be available in the region. There is therefore a need to improve the diagnostic capacity in the region since this is a major limitation in the identification of etiologic agents in an efficient surveillance programme.

Growing international trade has led to an increased risk of the transfer of microbes from one country to another[17]. To reduce the incidence of foodborne infections, emphasis should be placed on pre- and post-processing stages of food processing. Pre-processing stages include importation of eggs and egg products. In the current study, based on the questionnaire generated data, for the 11 counties, a majority, 10 (90.9%) imported eggs and egg products. The products

commonly imported by the 11 countries were table eggs (81.8%), hatching eggs (54.5%) and day-old chicks (45.5%) and some Caribbean countries also export chicks within the region. It has been reported that imported day-old chicks can be responsible for the introduction of *Salmonella* into other countries[23]. The need to institute an effective surveillance programme for *Salmonella* detection at the ports of entry in the Caribbean countries cannot be over-emphasized. It is also important that the veterinary public health units or similar units should be mandated to monitor the eggs and egg products being imported into the region.

It is relevant to mention that all the 11 countries studied have layer farms and eight (72.7%) of these countries have hatcheries for either broilers and/or layers. According to the survey, most of the countries had small to medium farms. This reduces the risk of *Salmonella* infection since large farms are associated with increased risk of infection[24]. This is a critical control point for the reduction of *Salmonella* in table eggs hence less foodborne illnesses. This can be accomplished by increased hygiene, biosecurity measures and monitoring at hatcheries and layer farms[18].

The data obtained will be useful for implementing a foodborne disease surveillance and food safety programme. Also, the diagnostic capacity for *Salmonella* in the Caribbean region must be improved. Critical monitoring points include ports of entry, layer farms and hatcheries, point of sale and eating establishments. However, it is important to note that only approximately 41% of the countries completed the study questionnaire which is considered a limitation of the study. The lack of response could be attributed to the lack of proper documentation or data availability or accessibility to the data requested by the questionnaire in the countries that failed to respond despite repeated follow-up.

CONCLUSION

It is concluded that based on the data on foodborne/egg-borne cases or outbreaks and the causative agents generated from the questionnaire survey, table eggs produced by the layer farms in the Caribbean countries that responded, did not appear to pose a high risk for salmonellosis to egg consumers. The lack of laboratories to identify *Salmonella* spp. and other pathogens in eggs in 7 (63.6%) of the 11 countries surveyed indicate a potential under-reporting of *Salmonella* spp. in table eggs in these countries. There is a need to introduce a routine surveillance system for *Salmonella* spp. in the poultry industry in the region to detect outbreaks and investigate risk factors for infection so that control measures can be implemented.

SIGNIFICANCE STATEMENT

The study revealed the number of foodborne illnesses, the causative agents of the foodborne illnesses, the importation of eggs and the lack of laboratory support to diagnose foodborne pathogens in the English-speaking Caribbean. This study will help the Chief Veterinary officers in the region to appreciate the need to implement a food safety programme and a routine surveillance system for foodborne diseases in each country. The implementation of such programmes will lead to a decreased the possibility of foodborne outbreaks.

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