



Contributor factors for the occurrence of salmonellosis during preparation, storage and consumption of homemade mayonnaise salad



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ARTICLE INFO

Article history:

Received 7 August 2015

Received in revised form 21 September 2015

Accepted 23 September 2015

Available online 30 September 2015

Keywords:

Food safety

Eating habits

Food preparation

Consumer choices

Good hygienic practices

Hygiene

ABSTRACT

This study aimed to analyze the impact of practices adopted for preparation, storage and consumption of homemade mayonnaise salad (HMS) as contributor factors for the occurrence of salmonellosis. A total of 493 individuals answered a questionnaire composed of demographic and socioeconomic questions and, preparing, storage and consumption practices of HMS. The level of good hygiene practices (GHP) of respondents was calculated using Good Practice and Outbreak Prevention Indexes. The consumer behavior and the correlation between practices were performed using Multiple Correspondence Analysis (MCA). 75% of respondents consume HMS, being 43% of interviewees doing this at least once per month. HMS was prepared from 30 min to 1 h before being served by 46% of individuals, it remaining for 30 min to 1 h at room temperature during the meal by 63% of people. Furthermore, 51% of respondents left the HMS container open or improperly closed, which may lead to cross-contamination. Most respondents (66%) stated reuse the HMS for less than one day (44%), at once (76%). 77% of participants declared that they prepare HMS, being only 7% preparing HMS without eggs. The majority (51%) used a cooked and a raw egg yolk. In addition, 75% of the cases showed raw eggs in recipe. The Weighted Good Practice Index, Weighted Outbreak Prevention Index and Weighted Harmonic Outbreak Prevention Index were 63%, 62% and 27% of participants, respectively. The MCA gathered the participants into two groups one commits various errors and other commits few errors on GHP. Thus, a consumer would probably perform multiple either good or bad practices simultaneously.

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1. Introduction

Salmonellosis is a foodborne illness with a great incidence worldwide (Scallan et al., 2011). This disease usually causes a self-limiting gastroenteritis, however severe infections such as bacteremia, meningitis, peritonitis and myocarditis have also been reported (Asseva, Petrov, Ivanova, & Kantardjiev, 2012; Matheson et al., 2010; Papamichalis et al., 2011). Several foods have been involved with salmonellosis outbreaks, however, egg and egg products stand out as most frequent foods involved with this illness (Scallan et al., 2011; Anonymous, 2014). Among egg products, homemade mayonnaise salad (HMS) prepared with raw eggs (Guerra & Miguel, 2010) has been identified as a major food involved in salmonellosis outbreaks (Anonymous, 2014; Fica et al., 2012; Norton et al., 2012; Di Pinto, Novello, Montemurro,

Bonerba, & Tantillo, 2010). Homemade mayonnaise (HM) is commonly used to prepare HMS, which is the mixture of HM with cooked potato, and sparsely other vegetables such as carrots and green beans. As such, the resulting HMS can support *Salmonella* growth, if the pathogen is present.

Although eggs can be contaminated by *Salmonella* through the infection of reproductive organs or through egg shell and membrane penetration (Gantois et al., 2009), the pathogen will only reach high levels, frequently associated with illness cases, if HMS is stored under inappropriate conditions (Smittle, 2000; Zhu, Li, & Chen, 2012; Leuschner & Zamparini, 2002). The storage at abusive temperature and inappropriate time periods, failure in hygienic practices and cross-contamination/recontamination appear as the major risk factors for occurrence of foodborne disease outbreaks (Hedberg et al., 2006; Todd, Greig, Bartleson, & Michaels, 2007). The chances of outbreaks to occur are even greater, when high risk ingredients, such as raw eggs, are used to prepare a specific meal or food product (Howard, O'Bryan, Crandall, & Ricke, 2012). Although improper storage seems to be an important risk factor for the occurrence of salmonellosis outbreaks linked to

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HMS, it should be highlighted that low cell concentrations of *Salmonella* can still cause infection (Gog et al., 2012). Therefore, consumer choice to prepare HMS using raw eggs, can also be considered a risky-practice. Given these aspects, it becomes clear that consumer behavior regarding the preparation, storage and consumption of HMS can contribute for the occurrence of salmonellosis outbreaks. Then, it must be borne in mind that food handlers hold responsibility for the safe handling and storage of foods (Oliveira & Thébaud-Mony, 1997). Thus, the knowledge of consumer's practices comprises valuable information needed to be taken into account for the design of strategies targeting protect public health. The knowledge and use of GHP can be considered the basic requirement to be applied to ensure the sanitary quality of foods.

The main issues addressed by GHP are how to avoid the contamination and how to preserve a food in the other to inhibit the growth of pathogenic microorganisms (Bruhn & Schutz, 1999; Raspor, 2008). In this sense, proper temperature cooking, proper storage (time and temperature), and personal and kitchen hygiene can be regarded as the main measures to be applied to deliver safe foods (Tondo & Bartz, 2014). Thus, the current study was performed to understand the food handler/consumer practices involving the preparation, storage and consumption of HMS given its high association with salmonellosis outbreaks.

2. Materials and methods

2.1. Questionnaire

This study was conducted in Rio Grande do Sul (RS), the southernmost state of Brazil, where HMS is highly consumed as a side dish with *churrasco* (a type of barbecue very consumed at Southern Brazil). The sample was composed by 493 RS inhabitants proportionally distributed in all regions of this state. The survey was carried out in 2013 and the respondents gave informed consent.

A draft of the survey questionnaire was developed using literature reviews (Bruhn & Schutz, 1999; Hedberg et al., 2006; Raspor, 2008; Pouillot, Lubran, Cates, & Dennis, 2010) on eating habits and eating behaviors of RS inhabitants and then reviewed by nutrition and food safety experts. After the draft revision, the questionnaire was pilot-tested with 10 RS inhabitants conveniently chosen, in order to check understanding and the wording of sentences. After the adjustments, the final questionnaire was sent by internet to participants (see Supplementary material).

The questionnaire was composed by four different parts. The first part enquired information on demographic and socioeconomic data. The second part concerned the preparing practice of HMS. The third was planned to investigate the storage practices and the fourth to analyze the HMS consumption practices by handlers or consumers (see Supplementary file).

Socioeconomic and demographic questions (age, race, gender, marital status, education, employment status, type of housing, and family income) were used to verify the sample heterogeneity of population interviewed. The HMS preparation questions asked which were the ingredients used and the amounts of the HMS generally prepared, emphasizing the use or not of raw or cooked eggs. Also the use of GHP procedures, for example, cleaning hands and using different utensils for raw and cooked food when the HMS was prepared was also questioned.

About consumption habits, respondents were asked to indicate the frequency and the amount of HMS consumed per meal. In order to obtain information about storage practices, the preparation time was questioned before serving the HMS and the temperature it remained packed until the time of consumption. It was also asked about how long the HMS was kept at room temperature during the meal. In addition, it was questioned about the destiny of HMS leftovers and its reuse. Finally, it was inquired what would be the main criterion used before consuming a stored food.

2.2. Data analysis

2.2.1. Good hygienic practices (GHP)

The questionnaire responses were analyzed in Microsoft Excel 2010. There were no missing data, because the questionnaire was answered online. Thus, it only could be completed and sent after all responses have been answered adequately. First, Eq. (1) was used in order to verify what was the most used HMS recipe by the interviewees.

$$E\{\text{ingredient}|\text{Recipe}\} = \frac{\sum\{\text{ingredient}|\text{Recipe}\}}{\#\text{Recipe}} \quad (1)$$

where:

Recipe = ingredient occurrence in isolation in a particular recipe.

In order to analyze the level of GHP employed by respondents, it was calculated the Weighted Good Practice Index (WGPI), adapted from Leal, Sturion, and Alves (2011). This index considered different weights to each alternative answer to the questions in Table 1. Thus, each response was classified in conformed (value 4), partly conformed (value 2) or not conformed (value 0) and the WGPI was obtained using Eq. (2).

$$\text{WGPI} = \frac{\sum_{i=1}^N R_i}{4 \times N} \quad (2)$$

Table 1

Conformity level of responses to the questions used in the weighted Good Practices index.

Feature	Practice	Conformity	
Cleaning hands before, during and after food preparation	Do	C	
	Not do	NC	
	Do only before	PC	
	Do only during	PC	
	Do only after	NC	
Utensil separation	No mixture of utensils of raw and cooked foods	C	
	Uses the same utensils independent of the type of food	NC	
Main criterion to consume a stored food	Smell	NC	
	Taste	NC	
	Appearance	NC	
	Storage time	C	
	The 4 factors together	NC	
What is the aspect of egg yolk after being cooked	Yolk still soft or partially soft	NC	
	Hard yolk (fully cooked)	C	
	Eggs used in the preparation of HMS	Whole raw egg	NC
		Whole boiled egg	C
		Only the cooked yolk	C
Closing the container that stores the HMS	Only the raw yolk	NC	
	Cooked and raw yolk	NC	
	Not use egg	C	
	The closed all the time, removing the lid only to serve	C	
	Closed only when it is stored in the refrigerator, freezer or room temperature	PC	
	Not closed	NC	
	HMS time at room temperature during the meal	Less than 30 min	C
30 min to 1 h		PC	
More than 1 h and less than 2 h		NC	
2 h to 6 h		NC	
Where is the HMS before to serve it (Temperature)	Refrigerator	C	
	Freezer	C	
	Room temperature	NC	
	How long the HMS reused is consumed	Less than 1 day	C
1 day		C	
2 days		C	
3 days		NC	
Where is the reused HMS	Freezer	C	
	Refrigerator	C	
	Room temperature	NC	

C: conformed; PC: partly conformed; NC: not conformed.

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