

Prevalence of *Salmonella* spp. contamination in hen egg and relationship among sociodemographic knowledge and behavior of the egg consumer in Bangkok, Thailand

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Abstract

Purpose - *Salmonella* spp. is the one of most common foodborne pathogen. Hen eggs play a crucial role as a main source of Salmonellosis. The aim of this study was to investigate the contamination rate of *Salmonella* spp. in eggs and determine the knowledge and behavior level of egg consumption in egg consumers of Sukhumvit area Bangkok, Thailand.

Design/methodology/approach - A cross-sectional survey was performed by randomly selected 196 eggs pooled samples from *Salmonella* free, chemical free and ordinary group. The ISO 6579:2002 method and Kauffman and White classification scheme were used to detect the *Salmonella* spp. and identify their serovars. Cochran Q test was used to compare the contamination rate among each egg group. The parallel cross-sectional survey of 404 egg consumers was conducted by using questionnaire, to determine the level of egg consumption hygiene knowledge and behavior. The scores were described by using descriptive statistic and Fisher's exact test. Spearman's correlation was performed to find significant associations between knowledge and behavior score.

Findings - The 5.05% of all egg samples were found *Salmonella* spp. The contamination rate was not significantly different among each egg groups ($p=0.082$). The 72.7% of respondents were indicated as poor knowledge egg consumption. The 48.0% of respondents were indicated as poor egg consumption behavior. The knowledge score was associated with age, education, income, egg buying place and consumption rate ($p<0.05$) while behavior was not, and this study showed no correlation between knowledge and behavior score ($p=0.443$).

Originality/value - The contamination rates of *Salmonella* among each egg group were not different. Age, education level and income were the socio-demographic factors associated with level of egg consumption hygiene knowledge and consumption behavior. However, it could not guarantee the high knowledge, could cause the better behavior of egg consumption.

Keywords *Salmonella*, Egg, Consumption behavior, Consumption hygiene, Thailand

Paper type Research paper

Introduction

Salmonella enteritica is the pathogen caused human gastrointestinal illness [1]. The clinical sign was mainly based on gastrointestinal system signs such as vomiting and diarrhea; however systemic signs such as fever and collapse can occur [2]. The illness estimated 1 million cases in the United States every year [3]. In 2003, Thailand had 1,115,244 reported cases as diarrheal disease indicated *Salmonella* as a major pathogen [4]. According to the Thailand Ministry of Public Health's report in 2008, the number of food poisoning patient's stools was showed 95.06% positive result from non Typhoidal *Salmonella* [5]. Risk of infection is associated with the consumption of contaminated eggs [6]. The global prevalence of *Salmonella* in egg is uncertainly caused by multiple. Due to the limited studies, it was indicated *Salmonella* contamination prevalence between Ordinary egg, Premium chemical free (Organic egg) and *Salmonella* free brand combined with measurement of egg consumer knowledge and egg consumption behavior previously. The aim of study was investigated the contamination rate of *Salmonella* spp. in eggs and determine

the knowledge and behavior level of egg consumption in egg consumers of Sukhumvit area Bangkok, Thailand.

Materials and methods

Study area and study population

A cross-sectional study was conducted during January –March 2017. This study consisted of 198 eggs samples contained with 10 eggs for each sample and use them to find Salmonella contamination rate and the 404 egg consumers were interviewed to find the association between socio-demography on knowledge and behavior of egg consumption. This study area was mainly focused on Sukhumvit area of Bangkok Thailand.

Data collection

Groups of branded eggs were classified into three groups such as ordinary, Salmonella free and chemical free: were classified by two criterions with 66 samples each group. The first criterion was the price of those brands compared with the market base price announced by the department of internal trading of Thailand. Any brand with its price more than 25% with an official baseline, it moved to the second criteria used the “Salmonella-free” wording if the word described on their label brands indicated as Salmonella free premium grade. If the word was not existed but the other premium declaration wording on their own labels such as antibiotic-free, organic and etc., the brand was counted as a premium chemical free criterion. Each egg group were randomly selected 10 eggs without crack and expired as a pool sample with 11 samples from 6 random brands. The isolation of the Salmonella was used by ISO6579:2002Amd1:2007 method to detect the Salmonella in each sample [7]. The positive samples were used Kauffman and White classification scheme to indicate the serovar group [8].

To study about egg consumption hygiene knowledge and consumption behavior, the convenience sampling for this study consisted of 404 respondents in super market and fresh market in Sukhumvit area. The respondents were interviewed by using the questionnaires which was reviewed by the public health and food safety experts. The questionnaire was divided into three parts, the first part composed of 9 questions about the general demographic information, and the second and third part composed of 13 questions concerning basic knowledge of egg consumption hygiene and behavior. For basic food hygiene and food poisoning knowledge, the respondents were asked to choose between two options true or false for questions. A right answer considered as ‘correct knowledge’ and wrong answer as ‘no knowledge’. Total scores were calculated and converted into a percentage according to Bloom’s classification [9] with 13 points of score in total for 13 questions about egg consumption hygiene. The score below 60% percentage of food hygiene and food poisoning knowledge questionnaire was accounted as poor knowledge, between 60-80% was accounted as moderate knowledge and higher than 80% was accounted as high knowledge [10]. The scale is used three choices among “Never”, “Sometime” and “Always” To measure about egg consumption behavior score. Each question has their individual score as 2,1,0 for risk increasing questions type and 0,1,2 for risk reducing question type. Total score point is 26 for egg consumption behavior part and interpreted at the same way as knowledge score.

Statistical analysis

Cochran’s Q test was used to compare the prevalence of Salmonella among the ordinary, Salmonella free and chemical free egg group. Descriptive statistic was applied to describe about the characteristic and frequency of Salmonella serovar group. Fisher’s exact test was applied to reveal the association between each

demographic factor and score. Spearman's correlation was used to find the correlation between egg consumption hygiene score and egg consumption behavior score. All data were analyzed by computer program SPSS Version 22 (licensed by Chulalongkorn University).

Ethical consideration

This study was approved by the Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University (the approval code no. 020.1/60).

Results

This study was not found positive samples of premium chemical free eggs samples and found the same contamination rate at 7.6% for both Salmonella free and ordinary eggs with 5 positive samples from 66 samples. However, the contamination rate was not significantly different among each egg groups at p -value=0.082. 80 % of positive samples indicated as group C (S.Lomita, S.Djugu, S.Hadar, S.Newport) then follow with the rest 20% were indicated as group B (S.Hadar, S. Bredeney).

Regarding to the general demographic of all respondents (Table 1), Female respondents are slightly more than male at 215(53.2%) compare with 189(46.8%). Majority of the age was adult between 20-29 years of 142(35%) followed by 30-39 years of 90(22.3%), 40-49 years of 74(18.3%). Regarding education level, there were 182(45%) of respondents who had bachelor degree as a majority followed by senior high school and vocational certificate level at 77(19.1%) and 62(15.3%), respectively. Nearly half of respondents 197(48.8%) were shown the income level at between 10,000-30,000 Baht per month, followed by nearly equal proportion between 30,000 – 50,000 Baht and lower than 10,000 per month with amount respondents as 84(20.8%) and 77(19.1%). For the egg buying place, the majority of respondents buy egg from supermarket of 173(42.8%) and fresh market of 149(36.9%). Regarding for egg consumption rate, this study was undercover the result with more than two-thirds of respondents were eaten 1-2 eggs per day of 273(67.6%), the second and third rank of consumption rate were lower than 1 and 3-4 eggs per day at 97(24.0%) and 24(5.9%) respectively. This study was also found 7(1.7%) of respondents indicated themselves as a not egg eater but still eat other product from eggs such as salad dressing.

Table 1. Association among Socio-demographic, egg consumption and hygiene knowledge level (n=404)

Factors	n	Good	Hygiene knowledge (%) Moderate	Poor	p-value
<i>Socio-demographic factors</i>					
Gender					.516
Male	189	4(2.1)	49(25.9)	136(72.0)	
Female	215	1(0.5)	56(26.0)	158(73.5)	
Age (years)					.003*
<20	55	0(0.0)	5(9.1)	50(90.9)	
20-29	142	3(2.1)	48(33.8)	91(64.1)	
30-39	90	1(1.1)	21(23.3)	68(75.6)	
40-49	74	1(1.4)	22(29.7)	51(68.9)	
50-59	27	0(0.0)	8(29.6)	19(70.4)	
>59	16	0(0.0)	1(6.3)	15(93.7)	
Education					.000*
Lower than high school	14	0(0.0)	2(14.3)	12(85.7)	
Junior high school	27	0(0.0)	4(14.8)	23(85.2)	
Senior high school	77	0(0.0)	9(11.7)	68(88.3)	
Vocational certificate	62	0(0.0)	11(17.7)	51(82.3)	

(continued)

Table 1. (continued)

Factors	n	Good	Hygiene knowledge (%) Moderate	Poor	p-value
Bachelor degree	182	3(1.6)	62(34.1)	117(64.3)	.000*
Higher than bachelor degree	42	2(4.8)	17(40.5)	23(54.7)	
Household income / month (34 THB = 1 USD)					
<10,000	77	0(0.0)	11(14.3)	66(85.7)	
10,000 – 30,000	197	3(1.5)	45(22.8)	149(75.7)	
30,001 – 50,000	84	0(0.0)	27(32.1)	57(67.9)	
50,001 – 70,000	27	1(3.7)	16(59.2)	10(37.1)	
70,001 – 90,000	10	1(10.0)	4(40.0)	5(50.0)	
>90,000	9	0(0.0)	2(22.2)	7(77.8)	
Egg consumption behavior					
Egg buying place					.024*
Supermarket	173	3(1.7)	57(32.9)	113(65.4)	
Fresh market	149	0(0.0)	35(23.5)	114(76.5)	
Convenience store	55	2(3.6)	8(14.5)	45(81.9)	
Other (grocery, direct from farm etc.)	27	0(0.0)	5(18.5)	22(81.5)	
Egg consumption / day					.039*
0 egg/day	7	0(0.0)	4(57.1)	3(42.9)	
Less than 1 egg	97	0(0.0)	17(17.5)	80(82.5)	
1-2 eggs	273	5(1.8)	75(27.5)	193(70.7)	
More than 2 eggs	27	0(0.0)	9(33.3)	18(66.7)	

Note: *Statistic significant within group at p-value < 0.05

Table 2. Frequency and percentage of respondents who answered true and false to each question about knowledge towards egg consumption hygiene and level of egg consumption hygiene knowledge (n=404)

Basic egg hygiene knowledge question	Correct n(%)	Wrong n(%)
General food hygiene questions were modified from Five keys to safer food [11] and making food safer to consume [12].		
1. Kept egg with long time storage can cause the diarrhea	321(79.5%)	83(20.5%)
2. Some food was contained with raw egg such as salad dressing, ice cream and mayonnaise	309(76.5%)	95(23.5%)
3. Wash hands carefully. Before and after touching raw egg or the food that contained with raw egg	293(72.5%)	111(27.5%)
4. Cooked egg and Raw egg must keep in separate container	287(71.0%)	117(29.0%)
5. Should separate the chopping block between raw and cooked egg	272(67.3%)	132(32.7%)
6. Eggs with cracked, leaked or dirty are still safe to eat*	166(41.1%)	238(58.9%)
Egg hygiene specific questions were modified from Egg-Grading Manual Agricultural Marketing [12] and risk assessments of Salmonella in eggs and broiler chickens interpretative summary [1]		
1. Cooked egg with firm albumin is safe enough to eat. Although the egg yolk still liquid*	257(63.6%)	147(36.4%)
2. Should buy an egg from shelf that not more than 4 celcius degree temperature	114(28.2)	290(71.8%)
3. Cooked egg must not keep at room temperature more than 1 hour. Before eaten	111(27.5%)	293(72.5%)
4. Broiled egg with or without shell can keep in fridge for 2 weeks. And still safe to eat	111(27.5%)	293(72.5%)
5. The watery albumin is the sign of egg with high freshness*	294(72.8%)	110(27.2%)
6. Temperature at 65 degree celcius was enough to guarantee the safety of eating egg*	308(76.2%)	96(23.8%)
7. Should eat egg within 3 weeks after manufactured date*	322(79.7%)	82(20.3%)

Note: *Negative statement: wrong choice equal to correct answer

Table 3. Frequency and percentage of egg consumption behavior and level of egg consumption behavior (n=404)

Egg consumption behavior	Never n (%)	Some n (%)	Always n (%)
Buying decision			
1. You buy the egg without crack ,leak or dirty on the egg shell	43(10.6)	151(37.4)	210(52.0)
2. You buy the egg from verified producer with clear label	44(10.9)	211(52.2)	148(36.6)
3. You use the egg with more than 2 week in storage to make the food*	113(28.0)	269(66.6)	22(5.4)
4. You use the pooled cracked in plastic bag to make the food*	304(75.2)	88(21.8)	12(3.0)
Acceptance for half cooked eggs			
1. You eat the sunny sided up fried egg*	54(13.4)	199(49.3)	151(37.4)
2. You eat the bakery or dessert that contained with half cooked egg. such as Tart, Tiramisu, Custard or egg yolk fudge balls cooked in syrup*	39(9.7)	246(60.9)	116(29.5)
3. Eat food was contained with raw egg such as Salad dressing, Ice cream and Mayonnaise*	57(14.1)	242(59.9)	105(26.0)
4. You eat scrambled egg with moisture inside*	108(26.7)	209(51.7)	87(21.5)
5. You eat the fried or scrambled egg in buffet set*	70(17.3)	251(62.1)	83(20.5)
6. You eat the soft boiled egg or onsen egg*	97(24.0)	250(61.9)	57(14.1)
7. You dip the grilled meat in raw egg before eat*	210(52.0)	157(38.9)	37(9.2)
8. You eat the raw egg with other type of hot food such as steamed rice*	254(62.9)	122(30.2)	28(6.9)
9. You eat the raw egg or raw egg contained product such as albumin drink*	293(73.8)	87(21.5)	19(4.7)

Note: *Negative statement indicated as risky behavior

Table 2, in order to show the egg consumption knowledge level of the respondents, it showed about 1.4% of respondents in the good knowledge level and 25.9% of respondents in moderate level. Almost all of the respondents (72.7%) indicated as poor knowledge level. The egg consumption behavior level of the respondents, it showed about 7.7% of respondents in the good behavior level and 44.3% of respondents in moderate level. Almost of respondents, 48.0% indicated as poor behavior level.

The association between the egg consumption behavior with the gender (p -value = 0.468), age (p -value = 0.072), education level (p -value = 0.118), household income (p -value = 0.418), egg buying place (p -value = 0.111), egg consumption per day (p -value = 0.990), household egg storage condition (p -value = 0.196), buying volume (p -value = 0.273) and food poisoning from egg at last 3 month (p -value = 0.172).

The respondents were aged between 20 -29 years which indicated as early adult working age and has the highest proportion of poor behavior at 54.3% then followed with 30-39 year at 52.3%. The teenage age showed 47.3% of poor behavior respondents and elder age has the lowest proportion of poor behavior as 6.2% Regarding education level, the respondents were shown the highest proportions of poor behavior at 59.3%, 52.8% and 50.0% on junior high school, bachelor degree and higher than bachelor degree respectively. The spearman correlation was found the weak negative relation between egg consumption hygiene and egg consumption behavior but not significant (p -value = 0.443).

According to the Table 3, for buying decision question number 1 and 2 were only two questions indicated as positive statements. All the rest questions were indicated as negative statements. Almost all of the respondents, 66.6% and 52.0% sometimes use eggs with more than 2 weeks in storage to make the food and always buy only clean egg without dirty on their shells. 52.2% of respondents buy them from verified producer with complete label on their packaging at sometimes, and 36.6% of respondents always buy it from verified producer. Almost respondents were accepting to ate soft boiled egg, sunny sided up fried egg and moisture scrambled

egg at sometimes, at 61.9%, 49.3% and 51.7% respectively. Almost respondents were never used the raw egg as dipping for grilled meat and eat it with other type of hot food, at 52.0% and 62.9%. Those results were shown the same direction of question number 9 and 12. Almost of respondents at 76.2% and 73.8% said never respectively, 59.9%, 62.1% and 60.9% were accepted to eat the food contained with raw egg such as salad dressing, eat fried egg station in buffet set and eat half cooked egg in bakery product sometimes.

Discussion

The contamination rate of *Salmonella* spp. was found between premium salmonella free eggs and ordinary egg at a same rate at 7.6%. This can be described by the cause of contamination along eggs supply chain [1]. At laying hen due to the mechanism of salmonella after infected in hen's body. The pathogen was colonized in gastrointestinal tract, and sometime once eggs were laid, those eggs shell were contaminated with feces that had salmonella inside. The condition *Salmonella* spp. could be found on eggs shell as a majority source [13].

The lower correct questions set were modified from Egg-Grading Manual. Agricultural Marketing [14] and Risk assessments of *Salmonella* in eggs and broiler chickens Interpretative summary [1]. Almost questions base on specific basic knowledge about egg handling and cooking. The overall result of egg consumption hygiene, nearly half of respondents have knowledge ranged at moderate and good knowledge and another half was poor knowledge level especially in specific knowledge about egg hygiene and handling. For example, the question number 2 from Egg specific hygiene category in table 1 the statement was said, "Should buy an egg from shelf that not more than 4 celcius degree temperature" according with study from WHO and FAO in 2002, The study was shown the salmonella have replicated themselves rapidly in eggs higher than 7 celcius degree storage condition. If the storage shelf in egg selling place has temperature control, it can inhibit the multiplication of salmonella and reduce more than 70% chance of salmonellosis per serving. Regarding to question number 7 in egg specific hygiene question group "Should eat egg within 3 weeks after manufactured date," due to the normal storage condition shelf duration of egg has relation with initial dose of bacteria including with salmonella in egg. It was revealed the average shelf life of egg is 2 week [1]. However, there are some points of knowledge about the egg product specification the producer should be provided enough information to consumers. Additional example, the question number 5 statement was "The watery albumin is the sign of egg with high freshness" In the fact, the watery albumin is not the sign of high freshness but it was a sign of some avian disease such as Infectious bronchitis [15]. The public misunderstanding may be caused by lack of information in public relation. This study also revealed the higher score of egg hygiene knowledge not significant correlated with of egg consumption behavior score as like as the result from United State in 2000 [16] and from Canada in 2004 [17]. Both of studies were shown the same result. Knowledge of food safety or hygiene were not always positive correlation with consumption behavior due to the personal preference.

Regarding to the egg consumption behavior score, this study revealed the three major points. The first one refer to question number 1 and 2 for buying decision questions in table 3 Most of respondents make a buying decision of eggs using the completeness and clean of eggshell as a key decision factors. These points were the good manner especially to choose the egg without any dirty things on eggshell being reduced the chance Salmonellosis [13]. The second point also represent by the questions set. Questions numbers 1, 4-8 were determine the risk of acceptance the half cook egg. It was showed the normal egg cooking condition not enough to

completely eradicate the *Salmonella* Enteritis and *Salmonella* Heidelberg [18]. Therefore, the consumer who chooses to eat half cook egg dish has a chance to get the *Salmonella*. The questions number 2 and 3 were represented of the consumer acceptance for half cook egg processed product. It was more than 80% of respondents accepted to eat half cook products such as mayonnaise or ice-crème has the chance of contaminated by *Salmonella*.

Conclusion

This study showed the contamination rate of *Salmonella* spp. in Sukhumvit Bangkok. All samples were classified as a three group Premium *Salmonella*-free, Premium chemical free (Organic) and Ordinary egg. The result revealed the *Salmonella* contamination rate among each group not significantly different by 7.6%. The data about socio-demographic, egg consumption hygiene knowledge and egg consumption behavior the 72.7% of respondents were shown the poor knowledge on egg consumption hygiene. The egg consumption behavior scores showed 48.0% of respondents indicated as poor behavior egg consumers. Majorities of respondents would like to avoid eating the raw eggs and buy eggs with clean shell as a main factor of high scores. The egg hygiene knowledge score results showed age, education and income significantly association with of egg consumption hygiene score. Eating behavior score results were not shown the relationship with socio-demographic factor however the correlation between egg consumption hygiene knowledge and egg consumption behavior was not significant. Due to the study result, the knowledge did not change into consumer behavior. The government sector should begin to create foods safety policy on the supply chain of foods, begin at producers to consumers and *Salmonella* issue is the one the major topic as major foodborne pathogen. It will be the alternate way to reduce the risk of *Salmonellosis* in Thailand.

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