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Research Article

An Evaluation of Conventional Culture and VIDAS® System as Detection Tools for *Salmonella* in Different Food Sources

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Abstract

The presence of *Salmonella* spp. in food may result from accidental contamination at any step in the food-production chain. This study was carried out in order to determine the prevalence of *Salmonella* in different food sources with the "Vitek immunodiagnostic assay system (VIDAS®) and compared to the culture method followed by serological test. Altogether, 400 samples were tested, and the overall results clearly indicate that from the 400 food samples analyzed, 73 samples (18.25%) showed positive results, and displayed that (10) 40% of the examined frozen meat, (9) 36% of minced meat, (16) 64% of frozen chicken, (5) 20% of hamburger, (6) 24% of fresh kebab, (4) 16% of salad and ice cream, (3) 12% of each *basturma*, fruit Cocktail, orange juice and raisin juice, (2) 8% of mayonnaise and *tabbouleh* were contaminated with *Salmonella* spp. Pomegranate juice and watermelon were not contaminated. The traditional method for the detection of *Salmonella* reveals *Salmonella* and bacteria-like *Salmonella*; a Serological detection was used to distinguish the *Salmonella* only. The results indicate 61 samples (83.56%) out of the 73 were *Salmonella* spp., and 13 (30.14%) samples out of 61 were *Salmonella typhimurium.* The results of VIDAS® method indicated that 61 samples (15.25%) out of the 400 were positive. The results displayed that 32% of the examined frozen meat, 52% of frozen chicken, 24% of minced meat and fresh kebab, 16% of hamburger and salad, 12% of each basturma, Chickpea, fruit cocktail and raisin juice 8% of each Mayonnaise, Tabbouleh, orange juice and ice cream were contaminated with *Salmonella* Spp., whilst pomegranate juice and watermelon not contaminated. This method detects *Salmonella* spp., further identification of *Salmonella typhimurium* was achieved by using the serological test. In conclusion was that the traditional method is laborious, time consuming and less accurate because it detects Salmonella and bacteria-like Salmonella. Whilst VIDAS® method was accurate and rapid screening of large numbers of samples for the presence of *Salmonella*.

Keywords: *Salmonella*, *Salmonella typhimurium*, Food, Beverages, Culture/ method, Immunoassay/methods

Introduction

Salmonella is a food-borne pathogen that is typically acquired through consumption of contaminated food and water [1] Salmonellosis continues to be a major public health problem worldwide. It also contributes to negative economic impacts due to the cost of surveillance investigation, treatment and prevention of illness [2]. The presence of *Salmonella* in food sources, is of major concern to both developed and developing countries, because *Salmonella* causes food-borne disease in humans [3,4]. Food poisoning is usually caused by the consumption of contaminated food or water containing various bacteria, viruses, parasites or toxins of biochemical or chemical nature. As *Salmonella* are ubiquitous in the environment, they are common causative agents of food poisoning [5]. The global burden of human gastroenteritis due to *Salmonella* has been estimated 93.8 million cases, resulting in 155,000 deaths each year [6]. The possible solution is more attention in every point of the food chain (from farm to fork) [7]. To control these risks efficiently and in due time, it is urgent to develop rapid, sensitive and accurate methods that allow the screening of a large number of *Salmonella*-suspected samples [8]. Conventional pathogen detection methods, such as microbiological and biochemical identification are time-consuming and laborious, while immunological or nucleic acid-based techniques require extensive sample preparation and are not amenable to miniaturization for on-site detection [9]. Culture methods are also not convenient for routine monitoring of a large number of samples [10].

The Vitek Immunodiagnostic Assay System (VIDAS®; Biomerieux, Marcy L'Etoile,

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France), an automated enzyme-linked fluorescent assay-based system, has been used as an alternative method for the rapid detection of *Salmonell* in food samples. Vitek immunodiagnostic assay (VIDAS®; Biomerieux, Marcy L'Etoile, France), an automated enzymelinked fluorescent assay-based system that allows for the accurate and rapid screening of large numbers of samples for the presence of *Salmonella* by the Vitek immunodiagnostic assay system *Salmonella* (VIDAS®) method [11,12]. The VIDAS® method is particularly useful for detecting *Salmonella* from food matrices heavily contaminated with competitive background flora [13]. Although several studies in the current literature report the successful use of VIDAS® for detecting *Salmonella* in poultry meat [14-16], in poultry meat products [17,18], broiler chickens [19], and red meat [7,20-22]. Jasson, et al. [23] reported the successful use of VIDAS® in a study where they used the method to detect low numbers of healthy and sub lethally injured *Salmonella enterica* in chocolate. The VIDAS® *Salmonella* assay utilized the somatic and flagellar antibodies for Salmonella to detect motile and nonmotile *Salmonella*. Evaluation of the VIDAS® kit indicated that sensitivity of the assay could be reduced by the presence of competing microflora such as Citrobacter in the food matrices [24]. Problems with detection of some *Salmonella* spp. serotypes were observed during detection by the immune-enzymatic method. This may be caused by weak binding of antibodies, which is confirmed by results obtained by other authors, Temelli, et al. [25] mentioned that the VIDAS® did not seem to be a suitable method for detecting *Salmonella* in poultry meat products.

Poor sanitation of school's street foods (that are obtained from street vendors outside schools), exposed foods that are sold on the sidewalks, and in popular restaurants which is commonly found in Iraq, may lead to the disease that could risk thousands of humans health. Therefore, *Salmonella typhimurium* is an important food hygiene indicator to access the quality of street foods. Common sources for transmitting foodborne pathogens are raw meat including beef, buffalo, and poultry products. Other food products such as milk, cheese, eggs, vegetables, fruits and ready-to-eat food also could be contaminated with these pathogens. Consumption of food contaminated by this pathogen has not only caused numerous infections but also resulted in numerous foodborne outbreaks. The World Health Organization estimates that some 2.2 million deaths occur annually due to food and water-borne illnesses, and 1.9 million among them are children [9]. Therefore, the aim of this study was to determine the capability of culture method and VIDAS® system to detect *Salmonella* in a total of 400 samples from different food sources.

Materials and Methods

Collection of samples

Through the period extending from December 2013 till June 2014, A total of 400 different food and beverage samples were collected, 25 sample of each (Frozen meat, Minced meat, Frozen Chicken, Hamburger, Basturma, Fresh Kebab, Salad, Chickpea, Mayonnaise, Tabbouleh, Fruit Cocktail, Pomegranate juice, Melon juice, Orange juice, Raisin juice, and ice Cream) from street vendors, exposed foods that are sold on the sidewalks, and in popular restaurants, Baghdad, Iraq. Samples were collected using sterile bags and transported to the Central Public Health Laboratory (CPHL) in Baghdad for detection of pathogenic bacteria (*Salmonella ser. Typhimurium*).

Cultur method

Allot of 400 food and beverage samples were collected from street vendors, exposed foods that are sold on the sidewalks, and in popular restaurants, Baghdad, Iraq. Samples were selected for the possibility of contamination of *Salmonella* during the handling, processing and storage of raw material of the foods and beverages. Each food product was scheduled for analysis in a different week. The sampled material was transported in a cold chain and delivered to the laboratory. The pre-enrichment of samples was performed according to (ISO, 2002). Briefly, twenty five g of cheese sample was placed in 225 ml of nutrient Broth for the enrichment, incubated for 24 hours at 37°C.

Transfer one ml from the mix into *Tetrathionate* broth and Selenite Sistein broth, incubated for 24 hours at 37°C. Loop full of the enrichment broth was cultured on selective media Xylose Lysine Deoxycholate (XLD), incubated for 24 hours at 37°C. The pre-enrichment culture was used to confirm the presence of *Salmonella* by standard cultural method, and followed by biochemical and serological confirmatory tests.

VIDAS® method

The enrichment protocol used in this study was as recommended by the manufacturer at the time the study was performed. The samples were inoculated into lactose broth and incubated for 18 h at 37°C (non-selective pre-enrichment). Subsequently, 0.1 ml of this medium is inoculated into Rappaport–Vassiliadis broth and 1 ml into tetrathionate broth, and then incubated for 8 h at 42°C and 8 h at 37°C, respectively. Then, 1 ml of each broth is inoculated separately into 10 ml of M-broth and incubated at 42°C for 18 h. Finally, 1 ml of each broth is placed in a tube, which is heated for 15 min at 100^0C. Following preenrichment, immuno-concentration, and post enrichment of test portions, an aliquot of the boiled test suspension is placed into the reagent strip and is cycled in and out of the SPR for a specific length of time. The intensity of fluorescence is measured by the optical scanner in VIDAS®. The fluorescence intensity is measured twice at 450 nm.

Statistical Analysis

The Statistical Analysis System- SAS [26] was used for the evaluation of the effect of different factors in study parameters. Chi-square test was used to compare between the percentages in this study, *P*-values less than 0.05 were considered statistically significant.

Results and Discussion

Results

Detection by traditional method: The results indicate that 73 samples (18.25%) out of the 400 were positive results (Table 1). All kinds of food, beverage and ice cream were contaminated with *Salmonella* in varying degrees with the exception of pomegranate juice and watermelon, which were not contaminated. Frozen chicken, frozen meat, and minced meat were most polluted with *Salmonella* and differ significantly ($p < 0.01$) from plant products. In general, meat products were the more contaminated than plant products (Table 1).

The microbiological procedure used for the detection of studied bacteria in food, beverage and ice cream were performed

N. of sample / Type of food	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total	Percentage (%)
Frozen meat	-	+	+	+	+	-	-	+	+	+	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	**10**	40
Minced meat	-	+	-	+	+	+	-	+	-	+	-	+	-	+	-	-	-	-	-	-	+	-	-	-	-	**9**	36
Frozen Chicken	+	+	-	+	-	+	+	+	+	+	+	-	-	-	-	+	-	+	+	+	-	-	+	+	+	**16**	64
hamburger	-	+	-	-	+	-	-	-	+	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	**5**	20
Basturma	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	**3**	12
Fresh Kebab	-	+	-	-	+	+	-	-	-	+	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	**6**	24
Salad	-	-	-	-	-	+	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**4**	16
Chickpea	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	**3**	12
Mayonnaise	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2**	8
Tabbouleh	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	**2**	8
Fruit Cocktail	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	**3**	12
Pomegranate juice	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**	0
Melon juice	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**	0
Orange juice	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	**3**	12
Raisin juice	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	**3**	12
Ice Cream	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	**4**	16
Total	**73**																									**73**	**18.25**
**** (P<0.01).**	**---**												**-------**														**13.26****

Table 1: *Salmonella* spp isolated from food samples by using the traditional method

according to protocols of *Salmonella* organism. The results of culture method displayed that 64% of the examined frozen chicken, 40% of frozen meat, 36% of minced meat, 20% of hamburger, 24% of fresh kebab, 16% of salad and ice cream, 12% of each basturma, fruit Cocktail, orange juice and raisin juice, 8% of mayonnaise and tabbouleh were contaminated with *Salmonella* Spp., whilst pomegranate juice and watermelon not contaminated (Figure 1).

Depending on morphology, round pale colony with black center on XLD agar, and the outcome of biochemical test clarified that the 3 isolates of *Salmonella* Spp., fermented glucose not lactose, appeared as red surface and yellow bottom of KIA with gas and H_2O formation. The traditional method for the detection of *Salmonella* reveals *Salmonella* and bacteria-like *Salmonella*. A Serological detection was used to distinguish the *Salmonella* only. Serological identification of *Salmonella* spp. established the presence of *Salmonella* spp. in food, beverage and ice cream samples. The results indicate sixty one samples (83.56%) out of the 73 were *Salmonella* spp., and 13 samples out of 61 were *Salmonella typhimurium* (Table 2). Serological examination showed that the highest contamination of food with bacteria was by *salmonella typhimurium* (30.14%) followed by *salmonella anatum* (20.55%) (Table 2).

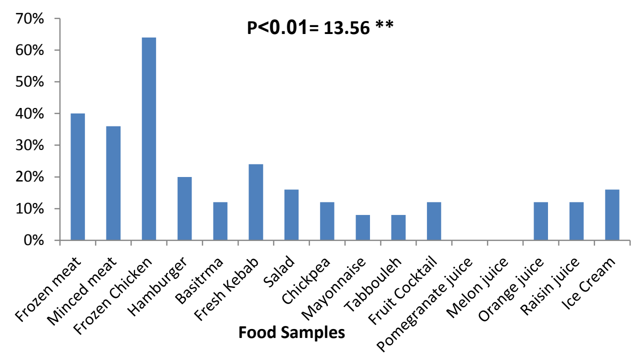

Figure 1: Percentage of *Salmonella* spp isolated from food samples by using the traditional method

Detection by VIDAS® method: The results indicate sixty one samples (15.25%) out of the 400 were positive a result is shown in Table 3. All kinds of food and beverage were contaminated with *Salmonella* in varying degrees with the exception of pomegranate juice and watermelon, which were not contaminated. Frozen chicken, frozen meat, minced meat and fresh kebab were most polluted with *Salmonella* and differ significantly ($p < 0.01$) from plant products. In general, meat products were the more contaminated from plant products (Table 3).

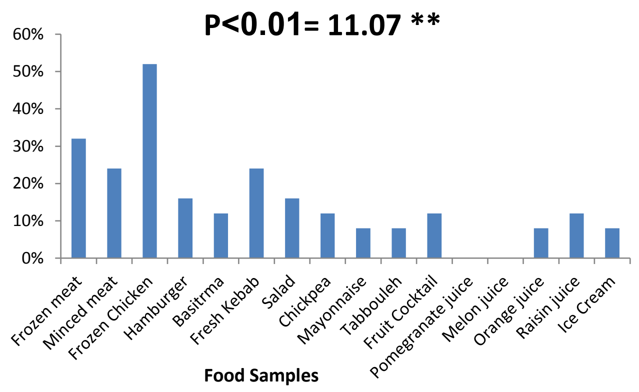

Figure 2: Percentage of *Salmonella* spp. isolated from food samples by using VIDAS® metho

The results of displayed that 32% of the examined frozen meat, 52% of frozen chicken, 24% of minced meat and fresh kebab, 16% of hamburger and salad, 12% of each basturma, Chickpea, fruit cocktail and raisin juice 8% of each Mayonnaise, Tabbouleh, orange juice and ice cream were contaminated with *Salmonella* Spp., whilst pomegranate juice and watermelon not contaminated (Figure 2). Further identification of *Salmonella typhimurium* was achieved by using the serological test.

No.	Species	No.	Species
1	*Salmonella enteritidis*	45	*Salmonella typhimurium*
2	*Salmonella anatum*	46	*Salmonella typhimurium*
3	*Salmonella enteritidis*	47	*Salmonella typhimurium*
4	*Salmonella dublin*	48	*Salmonella typhimurium*
5	*Salmonella dublin*	49	*Salmonella typhimurium*
6	*Salmonella anatum*	50	*salmonella Typhimurium*
7	*Salmonella anatum*	51	*Salmonella typhimurium*
8	*Salmonella anatum*	52	*Salmonella typhimurium*
9	*Salmonella anatum*	53	*Citrobacter spp*
10	*Salmonella anatum*	54	*Proteus spp*
11	*Proteu sspp*	55	*Citrobacter spp*
12	*Citrobacter spp*	56	*Citrobacter spp*
13	*Salmonella typhimurium*	57	*Citrobacter spp*
14	*Salmonella typhimurium*	58	*Citrobacter spp*
15	*Salmonella typhimurium*	59	*Salmonella ohio*
16	*Salmonella typhimurium*	60	*Salomnella enteritidis*
17	*Salmonella typhimurium*	61	*Salmonella anatum*
18	*Salmonella dublin*	62	*Salmonella anatum*
19	*Salmonella typhimurium*	63	*Salmonella typhimurium*
20	*Salmonella typhimurium*	64	*Salmonella ohio*
21	*Salmonella typhimurium*	65	*Salmonella braenderup*
22	*Salmonella typhimurium*	66	*Salmonella braenderup*
23	*Salmonella newport*	67	*Salmonella braenderup*
24	*Salmonella newport*	68	*Salmonella braenderup*
25	*Salmonella enteritidis*	69	*Salmonella braenderup*
26	*Salmonella enteritidis*	70	*Salmonella braenderup*
27	*Salmonella hato*	71	*Salmonella anatum*
28	*Salmonella hato*	72	*Salmonella anatum*
29	*Salmonella typhimurium*	73	*Salmonella braenderup*
30	*Salmonella typhimurium*		
31	*Proteusspp*		
32	*Proteusspp*		
33	*Salmonella typhimurium*		
34	*Salmonella typhimurium*		
35	*Salmonella hato*		
36	*Salmonella hato*		
37	*Proteusspp*		
38	*Proteusspp*		
39	*Salomnella ohio*		
40	*Salmonella anatum*		
41	*Salmonella anatum*		
42	*Salmonella anatum*		
43	*Salmonella anatum*		
44	*Salmonella anatum*		

Table 2: Serological identification of Salmonella serotype.

Discussion

Four hundred of food sources were collected street-vended, and in popular restaurants, including 25 sample of each Frozen meat, Minced meat, Frozen Chicken, Hamburger, Basturma, Fresh Kebab, Salad, Chickpea, Mayonnaise, Tabbouleh, Fruit Cocktail, Pomegranate juice, Melon juice, Orange juice, Raisin juice, and ice Cream were investigated for their presence of *Salmonella* using two different microbiological examination methods including classic selective media and VIDAS® method. Results of Conventional method indicate 73 samples (18.25%) out of the 400 showed positive results for more than one type as shown in table 1. All kinds of food, beverages and ice cream were contaminated with Salmonella in varying degrees with the exception of pomegranate juice and watermelon, which were not contaminated. The presence of *Salmonella* in foods and beverages could be due to several reasons such as contamination of raw material, poor hygienic conditions, contamination of water sources and unsanitary processes of foods and beverages. Frozen chicken, frozen meat, and minced meat were most polluted with *Salmonella* (Figure 1). The results indicated that meat products were the more contaminated than plant products. Compared to foods of animal origin, which are usually consumed once cooked, fruit and vegetables are mostly eaten raw and therefore a significant part of foodborne outbreaks due to the consumption of raw vegetables has been attributed to *Salmonella* [27].

In the current study, *S. typhimurium* was detected in 64% of examined frozen chicken samples. This result is higher than that reported by Abdellah, et al. [28] who reported *Salmonella* contamination in chicken meat and giblets, 4 different serotypes were identified of which *S. typhimurium* (40.35%) was the most frequent, and Abd El-Aziz, et al. [29] who detected *S. typhimurium* at rate of 44%, 40% and 48% in chicken meat, liver and heart, respectively, but not in gizzard. *Salmonella* spp. was analyzed in beef and chicken and in beef hamburgers, of the 80 hamburger samples analyzed, 22 (27.5%) were positive for *Salmonella* spp., 10 (12.5%) beef and 12 (15%) chicken and beef hamburgers [30]. In a similar study Almeida Filho, et al. [31] analyzed 30 samples, of which 15 (30%) were contaminated with *Salmonella* spp. On the other hands other studies conducted to analyze *Salmonella* spp. in hamburgers did not reveal the presence of the pathogen in this food [32]. The traditional method for the detection of *Salmonella* reveal *Salmonella* and bacteria-like *Salmonella*, so that need further serological detection to distinguish the *Salmonella* spp. Traditional *Salmonella* detection methods are based on cultures using selective media and characterization of suspicious colonies by biochemical and serological tests [33]. Traditional culture-based methods for detecting Salmonella are reliable but labor-intensive and time-consuming, demanding several days for a definitive result [34,35]. Traditional approaches for analysis of *Salmonella* has relied on cultural techniques and several selective differential media have used for differentiation. However, biochemical analysis for an analysis of *Salmonella* has relied on cultural techniques and several selective differential media have used for differentiation. However, biochemical analysis for an enzyme associated with the particular pathogenic trait could be cross reactive with other enteric bacteria. The results of serological test indicate that 61 samples (83.56%) out of the 73 were *Salmonella* spp. ,and 13 samples out of 61 were *Salmonella typhimurium* (Table 2). Serological examination showed that the highest contamination of food with bacteria was by *salmonella typhimurium* (30.14%) followed by *salmonella anatum* (20.55%) (Table 2). Different methods have been developed to reduce the time required for the detection of this pathogen, because standard culture methods, such as the International Organization for Standardization Method 6579 [36] and the United States Food and Drug Administration's Bacteriological Analytical Manual Chapter 5: *Salmonella* [37], require up to 5 days (including biochemical and serological confirmations) and are not efficient in the routine monitoring of large numbers of samples. In this context, rapid, accurate, and economical methods, which require less technical expertise in the detection of *Salmonella* in these types of foods,

N. of sample / Type of food	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total	Percentage (%)
Frozen meat	-	-	+	+	-	-	-	+	+	+	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	**8**	32
Minced meat	-	+	-	+	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	**6**	24
Frozen Chicken	+	+	-	-	-	-	+	+	+	+	-	-	-	-	-	+	-	+	+	+	-	-	+	+	+	**13**	52
Hamburger	-	+	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	**4**	16
Basturma	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	**3**	12
Fresh Kebab	-	+	-	-	+	+	-	-	-	+	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	**6**	24
Salad	-	-	-	-	-	+	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**4**	16
Chickpea	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	**3**	12
Mayonnaise	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2**	8
Tabbouleh	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	**2**	8
Fruit Cocktail	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	**3**	12
Pomegranate juice	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**	0
Melon juice	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**	0
Orange juice	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2**	8
Raisin juice	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	**3**	12
Ice Cream	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	**2**	8
Total													**61**													**61**	15.25
**** (P<0.01).**												**---**													**-------**	**---**	11.07 **

Table 3: *Salmonella* spp. isolated from food samples by using VIDAS® method

are crucial both for the industry and for laboratories reporting results to governmental authorities for taking legal actions. One alternative to these culture methods is the use of VIDAS® method that allows for the accurate and rapid screening of large numbers of samples for the presence of *Salmonella* [12].

Results of VIDAS®method did not distinguish *Salmonellla typhimurium* from other *Salmonellla* spices (Table 3). VIDAS® method is currently used in Department of the Central Public Health Laboratory (CPHL)/Baghdad. In our study, the VIDAS® method performed comparably to the culture method, in another study VIDAS® gave better results for cattle samples than the compared culture method [38]. Eriksson and Aspan [12] used different *salmonella* detection methods (culture method, VIDAS® and PCR) and concluded that the sensitivity of the different methods depended to a great extent on the origin of the fecal matrices and the *salmonella* strains used to "spike" the samples. Several previous studies compared VIDAS® and various culture methods for the detection of *Salmonella,* McMahon, et al. [14] indicated that VIDAS® SLM performed equally well as the FDA method. Uyttendaele, et al. [39] found a 95% agreement between VIDAS® SLM and DIASALM. Whilst Reiter et al. [15] found an even higher percentage of *Salmonella* positive samples by VIDAS® SLM versus the FDA method. Moreover Patrick, et al. [22] observed significant difference between the VIDAS® SPT method and the reference method for the low inoculums level where the VIDAS® SPT method recovered a higher number of positive results than the reference method. On the other hands, Temelli, et al. [25] found that the VIDAS® ESLM did not seem to be a suitable method for detecting *Salmonella* in poultry meat products.

The results of our study are generally in agreement with recent reports by Bucher, et al. [40] and Eglezos, et al. [41]. The VIDAS® *Salmonella* assay VIDAS® is an automated, qualitative enzyme-linked fluorescent immunoassay system that can generate presumptive positive or negative results in 2 days. The VIDAS® *Salmonella* assay utilized the somatic and flagellar antibodies for *Salmonella* to detect motile and nonmotile *Salmonella* matrices [24]. A recent report on the use of VIDAS® for screening raw meat and by-products from pork and beef showed that the number of positive samples detected was two-fold higher than that by culture method [21]. Based on the comparative studies with the standard plate method, it can be concluded that the VIDAS® system can be used to get fast results; however, because these results can be false positive then they have to be confirmed by culture method [11,42]. There may be many factors affecting the differences in the detection rates of *Salmonella* between our study and the results reported in other studies; these differences are mainly related to a) samples and sampling (type, source/location, initial bacterial load), b) environmental and seasonal factors, c) the strictness of hygiene and biosecurity policies used at the various sampling locations, and d) the detection methodology used.

The results of displayed that 32% of the examined frozen meat, 52% of frozen chicken was contaminated with *Salmonella* spp. (Figure 2). Chicken products are widely acknowledged to be a significant reservoir for *Salmonella*. They have frequently been incriminated as a source of *Salmonella* contamination and consequently thought to be major sources of the pathogen in humans [43]. Furthermore, one of the commonest causes of *Salmonella* infection reported in humans has been through the handling of raw poultry carcasses and products, together with the consumption of undercooked poultry meat [44]. Also, poultry meat was extensively contaminated with *Salmonella* (40%) [45].

The results of VIDAS® method showed that meat and meat products were more contaminated with *Salmonella* spp. than plant products, beverage and ice cream (Table 3 and Figure 2). The presence of *Salmonella* in foods and beverages could be due to several reasons such as contamination of raw material, poor hygienic conditions, contamination of water sources and unsanitary processes of foods and beverages [34].

Conclusions

The results obtained in this study on the prevalence of *Salmonella* spp. confirm that these food can be an important source of *Salmonella* and represent a definite risk for the consumers when eaten raw or under-cooked. We determined that VIDAS® system have the potential as alternative of culture method, that allows for the accurate and rapid screening of large numbers of samples for the presence of *Salmonella*.

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