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MICROBIOLOGICAL EVALUATION OF READY-TO-EAT SALADS FROM RESTAURANTS IN ZAGAZIG CITY

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ABSTRACT

The increased consumption of ready-to-eat salads outside homes as a result of a fast paced lifestyle, awareness on their nutritional attributes and enhanced processing technology is well documented. This study was aimed to determine the microbiological quality of two types of ready-to-eat salads (RTE) which were collected from three categories of restaurants *i.e.*, tourist restaurants (TR), local restaurants (LR) and food vehicle (FV) in Zagazig City, Sharkia Governorate, Egypt. Total of 60 samples representing: 24 Coleslaw salad samples (twelve in summer and twelve in winter) were collected from (TR) and (LR), and 36vegetable salad samples (eighteen in summer and eighteen in winter) were collected from (TR), (LR) and (FV). These samples were used for detection and enumeration of *Escherichia coli* 0157 : H7, *Salmonella* spp., *Shigella* spp., Coliforms group, total count of bacteria and total count of yeast and moulds, using standard methods. Homogenized salad samples were incubated in selective enrichment broths to allow the concurrent growth pathogens. The tested microorganisms varied widely between samples for different types of restaurants and seasons. *Salmonella* spp. was found in twelve of eighteen vegetable salad samples in summer and four of eighteen samples in winter. *Shigella* spp. was found in fifteen of eighteen vegetable salad samples in summer and twelve of eighteen samples in winter. *Escherichia coli* 0157 : H7 was found in fourteen of eighteen vegetable salad samples in summer and ten of eighteen samples in winter. *Shigella* spp. was found in five of twelve coleslaw salad samples in summer and three of twelve samples in winter, and *Escherichia coli* 0157:H7 was found in five of twelve coleslaw salad samples in summer and four of twelve samples from twelve in winter. The average microbial counts ($\log_{10}$ cfu/g) of coliforms group in vegetable salads ranged from 5.08 to 6.47 in summer, and from 4.71 to 6.45 in winter. Total count of bacteria ranged from 5.20 to 6.46 in summer, and from 3.98 to 5.84 in winter. Total count of yeast and moulds ranged from 2.95 to 5.24 in summer and from 3.58 to 5.13 in winter season. According to the Egyptian standard specifications for foods, these samples are unacceptable from the standpoint of microbiological safety; therefore, these data indicate that food handlers may contribute to pathogens contamination and that there are some handling practices that require more attention.

Kay words: Vegetable salad, coleslaw salad, microbiological quality, restaurant, season.

INTRODUCTION

Fresh product is an important part of a healthy diet and has been reported to be consumed in larger quantities in all countries. The incidence of human pathogens on fresh product is a serious concern in most industrialized countries. *Escherichia coli*, *Listeria monocytogenes*, and *Salmonella* spp are among the most common pathogens associated with fresh product illness outbreaks (Lapidot *et al*., 2006). Fresh vegetables are rich sources of water-soluble vitamins and other nutrients essentials to improve the nutritional status and decrease the risk of cardiovascular disease (Su and Arab, 2006). However, when they are not carefully prepared, they can be subjected to pathogenic contamination and become hazardous to health particularly when eaten raw (WHO, 2008). Rajkowski and Fan (2008) reported findings of leafy greens sold in the markets contaminated with the pathogens. Their study

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revealed that microbiological quality of fresh product is a concern for both food safety and product shelf-life. It is estimated that 30% of product is lost due to microbial spoilage between the time of harvest and consumption. Few studies on the microbiological quality of leafy vegetables have been documented. Pingulkar *et al.* (2001) examined the microbiological quality of salad in India and found a prevalence of 73% for *Listeria* but did not detect the presence of *Salmonella*. Also, they found higher bacterial counts in salads compared to freshly-washed vegetable ingredients. Furthermore, Johnston *et al.* (2005) reported a mean of 4.5 - 6.6 $\log_{10}$ cfu/g for total aerobic bacteria in leafy vegetables. The Centers for Disease Control and Prevention (CDC) revealed that foodborne illnesses linked to *E. coli* O157:H7 have been estimated at 73,000 in the US each year. One hundred eighty-three outbreaks of foodborne illness associated with *E. coli* O157:H7 have been reported in the US since 1982, of those outbreaks, 21% were linked to produce sources including lettuce, apple juice, salad, coleslaw, melons, sprouts, and grapes (Rangel *et al.*, 2005 and Cooley *et al.*, 2007). In Australia, leafy salad vegetables such as lettuce, rocket and baby spinach are the most common products in the fresh cut vegetable category, contributing towards an estimated national production value of $44 million for the year 1997/98 (Szabo and Coventry, 2001). Controlling and ensuring the safety of street-vended food in many countries is a big challenge considering that this food is often less expensive and is often prepared/sold in the streets by local food vendors (WHO/FAO, 2010). This food constitutes the primary source of food for many low-and middle-income consumers outside their home (FAO, 2009).

Gurler *et al.* (2015) showed that the microbiological safety of ready -to- eat foods is of special concern as they are not exposed to further processing before consumption, therefore there are need of implementing hygienic rules in the production chain of ready -to- eat foods to ensure microbiological safety and to improve shelf life.

Ready-to-eat fruit and vegetables requiring minimal or no further processing prior to consumption have been implicated as vehicles for transmission of infectious microorganisms although the frequency of foodborne outbreaks of gastrointestinal illness associated with fruit and vegetables appears to be low compared to products of animal origin (European Commission, 2002). Enteric pathogens such as *Escherichia coli* and *Salmonella* spp are among the greatest concerns during food-related outbreaks (Buck *et al.*, 2003).

Salads should be cleaned properly, as they are generally eaten raw or partially cooked (Bartz and Wei, 2003). The majority of microorganisms associated with raw vegetables are non-pathogenic and Gram negative organisms tend to dominate the bacterial population including *Enterobacter* spp., and other coliforms group. Vegetables are highly exposed to microbial contamination through contact with soil, dust and water and by handling at harvest or during postharvest processing. They therefore harbor adverse range of microorganisms including plant and human pathogens (Carmo *et al*., 2004). Differences in microbial profiles of various vegetables result largely from unrelated factors such as resident microflora in the soil, application of nonresident microflora *via* animal manures, sewage or irrigation water, transportation and handling by individual retailers (Ray and Bhunia, 2007 ; Ofor *et al.*, 2009). Surveillance data showed that vegetables have been implicated in foodborne disease outbreaks caused by a variety of pathogenic microorganisms (Sivapalasingam *et al.*, 2004). As a result, numerous studies have been performed to determine the occurrence of microorganisms such as *Salmonella* (Giusti *et al.*, 2010; Gorski *et al.*, 2011 ; Sant'Ana *et al.*, 2011) and pathogenic *Escherichia coli* (Bohaychuk *et al.*, 2009 ; Rúgeles *et al.*, 2010) in different types of vegetables.

The microbiological safety of coleslaw, *Escherichia coli* was isolated from cabbage roots but not from the edible portion, when cabbage plants were irrigated with contaminated creek water (Wachtel *et al.*, 2002). Contamination of carrots at harvest occurred when *Salmonella enterica* and *Escherichia coli*-containing manures were applied to soils under conditions simulating warm (daily average maximum temperature of >20°C) summer conditions. In contrast, the pathogens were not present in carrots harvested in soil to which nonsterile manure had been applied and subjected to

repeated freeze-thaw cycles (Natvig *et al.*, 2002). Adding mayonnaise to salads that contain cabbage, carrots, celery, or onions as a major or minor ingredient can influence the fate of pathogens. Mayonnaise, by itself, is not a medium in which pathogens survive. The highest manufacturing target pH for mayonnaise-based dressings and sauces is 4.4, which is below the 4.75 pKa of acetic acid and below the reported inhibitory pH of 4.5 for foodborne pathogens in the presence of acetic acid. Hence, the most important factors in destroying pathogenic bacteria in mayonnaise-based products are pH as adjusted with acetic acid and concentration of acetic acid in the water phase (Smittle, 2000). Acetic acid is a much more effective acidulant than citric acid for inactivation of *S. aureus* and *L. monocytogenes* in mayonnaise-based surimi salads (Bornemeier *et al.*, 2006). In coleslaw salad, *L. monocytogenes* populations decreased during storage, while they increased during storage in ham and seafood salads. This growth response is likely a result of the product pH. Although, acetic acid concentrations decrease in coleslaw and potato salads as a result of absorption of the acid by the vegetable tissue (Brocklehurst and Lund, 1984).

Therefore, this study was conducted to determine the extent to which vegetable and coleslaw salads were contaminated with some pathogenic microorganisms during summer and winter seasons from some restaurants in Zagazig city, Egypt.

MATERIALS AND METHODS

Materials

Ready-to-eat salad samples collection

Ready-to-eat salad samples were specifically collected from tourist restaurants (TR), local restaurants (LR) and food vehicle (FV) in Zagazig City, Sharkia Governorate, Egypt. Sampling was monthly performed in summer season from June to August 2013 and in winter season from November 2013 to January 2014. Salad samples were grouped into two categories:

- Twenty four samples of coleslaw salad (twelve samples in summer and twelve samples in winter) were collected from (TR) and (LR).
- Thirty six samples of vegetable salad (eighteen samples in summer and eighteen samples in winter) were collected from (TR), (LR) and (FV).

Coleslaw salad consists of 75% chopped white cabbage and 10% shredded carrots in addition to 15% mayonnaise and spices, in TR and LR.

Vegetable salad consists of 40% tomato, 40% cucumber, 15%water and 5% garlic and spices in FV, 40% tomato, 30% cucumber, 15% carrots, 10% pepper and 5% water, salt and lemon juice in LR and 40% tomato, 30% cucumber, 10% parsley, 10% pepper, 8% lettuce and 2% salt and lemon juice in TR.

All salad samples were collected aseptically and placed in cool sterile containers, hold at 3±1°C until analysis, and then transferred to Microbiology Laboratory at Food Science Dept., Fac. Agric. Zagazig University, Egypt. All salad samples were examined at the same day of collection.

Preparation and dilutions of salad samples

Ready –to– eat salads were mixed in mixer and then twenty-five g of each sample was rinsed with distilled water to get rid of traces of cleanser, and diluted with buffered peptone water (by adding 1 g peptone and 8.5 g sodium chloride to 1 liter of distilled water) to make the sufficient dilutions for the microbiological analysis. Ten folds dilutions of homogenates were prepared and one tenth ml of each dilution was spread on the surface of the plates of the used selective media, according to the method of FDA (2002). Homogenized salad samples were incubated in specific selective enrichment broth for each bacterial species. After cultures were streaked onto sets of selective agar plates, bacterial colonies with characteristic features were confirmed biochemically and immunologically, according to Kim and Bhumia (2008).

Methods of Analyses

Detection of *Escherichia coli* 0157:H7

Detection of *Escherichia coli* 0157:H7 in salad samples was carried out by spreading 0.1 ml of suitable dilutions onto plates of sorbitol MacConkey agar medium then incubated at 35°C for 24 hrs. The growth of *Escherichia coli* 0157:H7 on MacConkey sorbitol agar shows colourless colonies, and the results were expressed as positive and negative of salad, accordance with the method of FDA (2002).

Detection of *Salmonella* spp. and *Shigella* spp.

Detection each of *Salmonella* spp. and *Shigella* spp. in salad samples was carried out by spreading 0.1 ml of suitable dilutions onto plates of *Salmonella shigella* (*SS)* agar medium, then incubated at 37°C for 24 hrs. The growth of *Salmonella* spp. on plates shows colourless colonies with black centres and growth of *Shigella* spp. shows colourless colonies, and the results were expressed as positive and negative of salad according to the method of FDA (2002).

Enumeration of total count of bacteria

Enumeration of total count of bacteria in salad samples was carried out by spreading 0.1 ml of suitable dilutions onto plates of plate count agar (PCA) plates, then incubated at 30°C for 48 hrs., and the results were expressed as $\log_{10}$ cfu/g salad, accordance with the method of (FDA, 2002).

Enumeration of total count of yeasts and moulds (FDA, 2002)

Enumeration of yeasts and moulds were carried out using the potato dextrose agar medium. Plates were incubated at 25°C for 3 days, colonies of yeasts and moulds were counted and calculated per g of sample, and the results were expressed as $\log_{10}$ cfu/g salad, according to the method of (FDA, 2002).

Determination of moisture and pH value

The moisture content was determined by measuring the mass of a food before and after the water is removed by evaporation, the values measured by drying at 105° C for 3 hrs., until a constant weight was achieved. Moisture content was determined using the method described in AOAC (2005).

The procedure for determining the pH of salad samples was performed by use of a pH meter Model SED-12500V made in China as described according to the method of AOAC (2005).

RESULTS AND DISCUSSION

Microbiological Evaluation of Vegetable Salad Samples During Summer Season

With regard to the *Salmonella* spp., data in Table 1 indicate that the contamination percentage ranged from 33.30% to 100% according to the types of restaurant. Higher contamination percentages were obtained from vegetable samples in LR1, FV1and FV2 while, vegetable samples in TR2 contained the lowest contamination. FV1 and FV2 restaurant samples were contaminated by 100% pathological microbes. FV1 and FV2 restaurants samples contained the highest incidence (100%) of *Salmonella* spp., *Shigella* spp. and *Escherichia coli* 0157 : H7 while, TR2 restaurants samples contained the lowest incidence (0%) of *Salmonella* spp. While, TR1 restaurants samples contained the lowest records of coliforms group and total count of bacteria, while sample of TR2 restaurants samples contained the lowest numbers of *Escherichia coli* 0157:H7, *Salmonella* spp., *Shigella* spp. and total count of yeast and moulds. These results are in agreement with Meldrum *et al.* (2009) who reported that the microbiological guidelines revealed that 4.7% of 1213 salad vegetable samples were of unsatisfactory microbiological quality due to *Escherichia coli* level at $\geq 10^2$ $\log_{10}$ cfu/g. With a high surface/weight ratio and a relatively high pH, salad vegetables host a large microbial population, particularly bacteria, which may contribute to the natural decay of vegetative organs detached from the plant (Nguyen-The and Carlin, 1994 ; Ragaert *et al.*, 2007).

Fig. 1 shows that the average log No. of coliforms group ranged from 5.08 to 6.47, total count of bacteria ranged from 5.20 to 6.46 and No of total count of yeast and moulds ranged from 2.83 to 5.24.

pH values recorded were between the ranges of 3.76 to 4.50 as seen in Table 2, this explains the low number of microbes in the samples as the low value of pH makes the environment acidic so it became not suitable for the growth of many microbes. While, the high moisture content in salad generally considered a good compromise for the growth of microbes. Moisture percentage ranged from 91.20% to 95.54%. These results are in accordance with Miedes and Lorences (2004) who showed that many fruits and vegetables present nearly ideal conditions for the survival and growth of many types of microorganisms. The internal tissues especially vegetables are nutrient rich, and have a pH near neutrality. Their structures are composed mainly of the polysaccharides, cellulose, hemicellulose, and pectin and the principal storage polymer is starch. Spoilage microorganisms exploit the host using extracellular lytic enzymes that degrade these polymers to release water and the plant's other intracellular constituents for use as nutrients for their growth.

Microbiological Evaluation of Vegetable Salad Samples During Winter Season

Fig. 2 illustrates that average log No. of coliforms group ranged from 4.17 to 6.45 $\log_{10}$ cfu/g, total count of bacteria ranged from 3.98 to 5.84 $\log_{10}$ cfu/g and the average log No of total count of yeast and moulds ranged from 3.85 to 5.13 $\log_{10}$ cfu/g. pH value ranged from 4.30 to 4.75 and moisture percentage ranged from 92.48% to 95.98% as seen in Table 2, All these parameters (pH value and moisture percentage) effects the microbial growth in salad as the low pH value reduce the growth of microbes.

In addition, data in Table 3 indicates that the percentage of contaminated samples ranged from 33.30% to 100% according to the type of restaurant. The highest contamination percentage was obtained for FV (1, 2) while, TR (1, 2) contained the lowest contamination.

Samples of FV1 restaurant contained the highest incidence of *Escherichia coli* 0157:H7 while; FV2 restaurants samples contained the highest incidence of *Shigella* spp. TR1, TR2, LR1 and FV1 restaurant samples give negative results when it detects *Salmonella* spp. while, restaurants LR2 and FV2 gave positive results in winter season. These results are in agreement with Capanigro *et al*. (2010) who reported that neither *Salmonella* spp. nor *L. monocytogenes* was found (detection limit: presence in 25 g). *Escherichia coli* was detected in 27% of the lots (detection limit: 5 $\log_{10}$ cfu/g), with probability of occurrence and counts highest in autumn and for lettuce and arugula. Average visual quality was higher and other components of the microbial load were lower in winter and spring compared to summer and autumn (0.6 $\log_{10}$ cfu/g of total aerobic counts, 1.3 $\log_{10}$ cfu/g of coliforms, 0.6 $\log_{10}$ cfu/g of yeasts and moulds). Distribution of leafy greens at 5°C or below can effectively prevent the growth of *Escherichia coli* O157 : H7 (Mc Evoy *et al.*, 2009). However, temperature abuse may occur during transportation and storage (Khalil and Frank, 2010).

Microbiological Evaluation of Coleslaw Salad Samples During Summer Season

It was observed that samples of coleslaw were free from *Salmonella* spp. in all coleslaw salad samples in summer and winter seasons.

Respecting to the *Shigella* spp. and *Escherichia coli* 0157:H7, data in Table 4 indicate that the contamination percentage ranged from 33.30% to 66.60% according to the types of restaurant. High contamination percentage were obtained for coleslaw samples in TR2 while, coleslaw samples in TR1, LR1 and LR2 contained the lowest contamination in summer season. These results are in accordance with Smittle (2000) who reported that adding mayonnaise to salads that contain cabbage, carrots, celery, or onions as a major or minor ingredient can influence the fate of pathogens. Mayonnaise, by itself, is not a medium in which pathogens survive.

Fig. 3 illustrates that the average log No. of coliforms group ranged from 4.48 to 5.71 $\log_{10}$ cfu/g, total count of bacteria ranged from 4.16 to 5.19 $\log_{10}$ cfu/g and total count of yeast and moulds ranged from 3.17 to 3.92 $\log_{10}$ cfu/g.

In addition, data in Table 5 shows that the pH value ranged between 3.75 to 4.25. This may be due to the components involved in the preparation, such as mayonnaise, acetic acid and lemon juice, which interprets pH value low.

Table 1. Incidence of *Salmonella* spp., *Shigella* spp. and *Escherichia coli* O157:H7 in vegetable salad samples in summer season.

Restaurant type	No. of samples	*Salmonella* spp.		*Shigella* spp.		*Escherichia coli* O157:H7	
		Positive samples	Incidence percentage	Positive samples	Incidence percentage	Positive samples	Incidence percentage
TR1	3	1	33.30%	2	66.60%	1	33.30%
TR2	3	0	0%	1	33.30%	2	66.60%
LR1	3	3	100%	3	100%	2	66.60%
LR2	3	2	66.60%	3	100%	3	100%
FV1	3	3	100%	3	100%	3	100%
FV2	3	3	100%	3	100%	3	100%

TR (1, 2) = Tourist restaurant LR (1, 2) = Local restaurant FV (1, 2) = Food vehicle

Table 2. pH value and moisture percentage in vegetable salad samples of the different categories for restaurants in summer and winter seasons

Restaurant type	Vegetable salad			
	Summer		Winter	
	pH value ± SD	Moisture (%) ± SD	pH value ± SD	Moisture (%) ± SD
TR1	4.50 ±0.07	95.28 ± 2.79	4.75 ± 0.24	95.98 ± 1.14
TR2	3.76 ± 0.33	95.52 ± 2.90	4.30 ± 0.13	95.49 ± 0.46
LR1	4.50 ± 0.13	95.54 ± 1.99	4.50 ± 0.09	94.85 ± 0.47
LR2	3.89 ± 0.07	92.50 ± 0.19	4.40 ± 0.13	93.68 ± 0.46
FV1	4.10± 0.04	91.20 ± 4.63	4.60 ± 0.13	92.48 ± 0.30
FV2	4.50 ± 0.16	94.93 ± 0.01	4.30 ± 0.04	92.92 ±0.17

SD = Standard deviation TR (1, 2) = Tourist restaurant LR (1, 2) = Local restaurant FV (1, 2) = Food vehicle

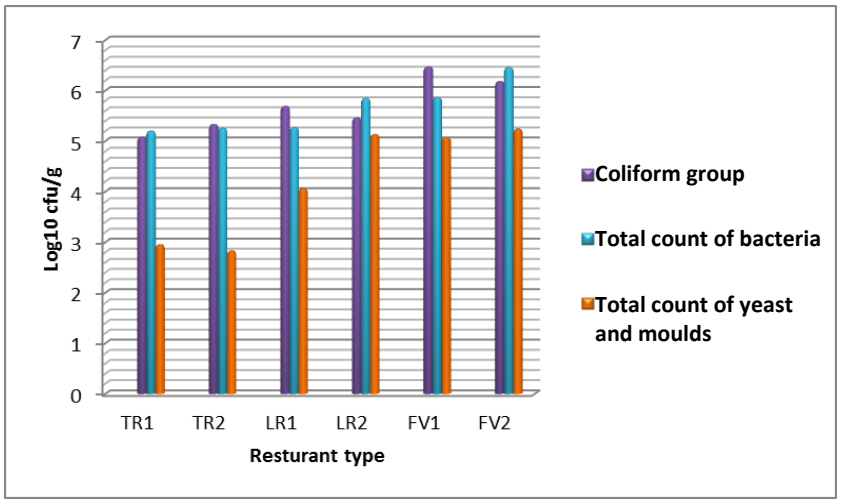

Fig. 1. Microorganisms in vegetable salad samples in summer season

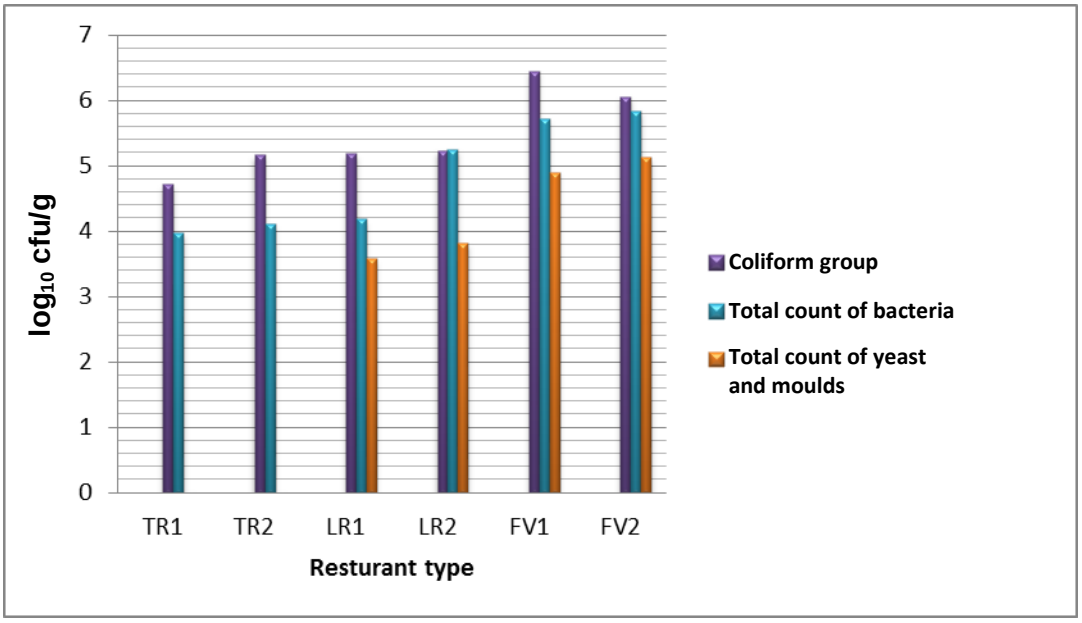

Fig. 2. Microorganisms in vegetable salad samples in winter season

Table 3. Incidence of *Salmonella* spp., *Shigella* spp. and *Escherichia coli* O157:H7 in vegetable salad samples in winter season

Restaurant type	No. of samples	*Salmonella* spp.		*Shigella* spp.		*Escherichia coli* O157:H7	
		Positive samples	Incidence percentage	Positive samples	Incidence percentage	Positive samples	Incidence percentage
TR1	3	0	0%	1	33.30%	1	33.30%
TR2	3	0	0%	1	33.30%	1	33.30%
LR1	3	0	0%	2	66.60%	1	33.30%
LR2	3	1	33.30%	2	66.60%	2	66.60%
FV1	3	1	33.30%	2	66.60%	3	100%
FV2	3	2	66.60%	3	100%	2	66.60%

TR (1, 2) = Tourist restaurant LR (1, 2) = Local restaurant FV (1, 2) = Food vehicle

Table 4. Incidence of *Shigella* spp. and *Escherichia coli* O157:H7 in coleslaw salad samples in summer season

Restaurant type	No. of samples	*Shigella* spp.		*Escherichia coli* O157:H7	
		Positive samples	Incidence percentage	Positive samples	Incidence percentage
TR1	3	1	33.30%	1	33.30%
TR2	3	2	66.60%	2	66.60%
LR1	3	1	33.30%	1	33.30%
LR2	3	1	33.30%	1	33.30%

TR (1, 2) = Tourist restaurant LR (1, 2) = Local restaurant

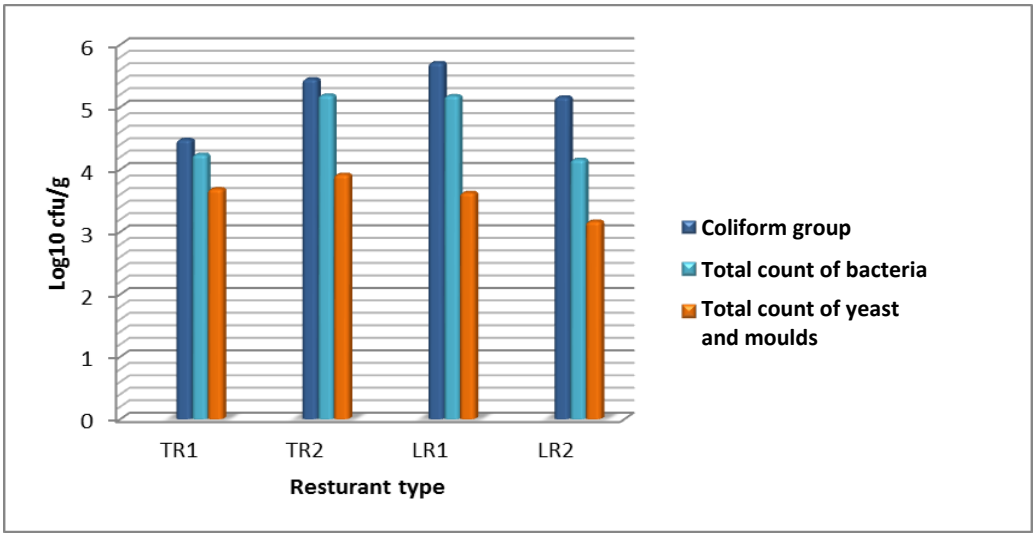

Fig. 3. Microorganisms in coleslaw salad samples in summer season

Moisture ratio ranged between 54.80% to 78.76%. It is low compared with the moisture ratio in vegetable salads. This explains the low numbers of microbes in coleslaw salads. King *et al.* (1976) reported that the pH of the coleslaw was about 4.2. Smittle (2000) found that the highest manufacturing target pH for mayonnaise-based dressings and sauces is 4.4, which is below the 4.75 pK_a of acetic acid and below the reported inhibitory pH of 4.5 for foodborne pathogens in the presence of acetic acid. Hence, the most important factors in destroying pathogenic bacteria in mayonnaise-based products are pH as adjusted with acetic acid and concentration of acetic acid in the water phase. Incorporation of other organic acids reduces the inhibitory or lethal activity of mayonnaise against pathogens, with the order of effectiveness of acids being acetic acid > lactic acid > citric acid (Abdul-Raouf *et al.*, 1993). Similarly, acetic acid is a much more effective acidulant than citric acid for inactivation of *S. aureus* and *L. monocytogenes* in mayonnaise-based surimi salads (Bornemeier *et al.*, 2006). *Escherichia coli* O157:H7 survived longer in salads prepared with real mayonnaise than with reduced-calorie mayonnaise dressings (Hathcox *et al.*, 1995).

Contamination of carrots at harvest occurred when *S. enterica* and *Escherichia coli* containing manures were applied to soils under conditions simulating warm (daily average maximum temperature of > 20°C) summer conditions. In contrast, the pathogens were not present in carrots harvested in soil to which nonsterile manure had been applied and subjected to repeate freeze-thaw cycles (Natvig *et al.*, 2002). The antimicrobial effects of some plant compounds in coleslaw and the competition from the indigenous microbial population were presumed to be the reasons for the inactivation of *Escherichia coli* O157:H7.

Microbiological Evaluation of Coleslaw Salad Samples During Winter Season

With regard to the *Shigella* spp. and *Escherichia coli* 0157:H7, data in Table 6 indicate that the contamination percentages ranged from 0% to 33.30% according to the type of restaurant. All types of restaurant were equal in the number of positive samples except for LR2 which gave negative results for *Shigella* spp. These results are in accordance with King *et al.* (1976) who showed that the microbiology of a common commercial type of coleslaw was investigated with the objective of extending its shelf life at refrigerator temperature by delaying microbiological spoilage. Cabbage, the principal ingredient, had a total bacterial count of about 10^5/g. Microbial growth in cabbage was prevented by storage at 1°C but not at 10°C or above. In coleslaw, the cabbage flora died and was replaced by the flora of the cultured sour cream contained in the dressing , and the researcher

Table 5. pH value and moisture percentage in coleslaw salad samples of the different categories for restaurants in summer and winter seasons

Restaurant type	Coleslaw salad			
	Summer		Winter	
	pH value ± SD	Moisture (%) ± SD	pH value ± SD	Moisture (%) ± SD
TR1	4.20 ± 0.07	78.76 ± 1.68	4.30 ± 0.13	77.95 ± 0.36
TR2	4.23± 0.02	74.77 ± 2.28	4.45 ± 0.04	80.85 ± 0.76
LR1	4.25 ± 0.04	75.82 ± 0.83	4.40 ± 0.09	77.12 ± 0.08
LR2	3.75 ± 0.02	54.80 ± 1.11	4.40 ± 0.07	78.07 ± 0.74

SD = Standard Deviation TR (1, 2) = Tourist restaurant LR (1, 2) = Local restaurant

Table 6. Incidence of *Shigella spp.* and *Escherichia coli* O157:H7 in coleslaw salad samples in winter season

Restaurant types	No. of samples	*Shigella spp.*		*Escherichia coli* O157:H7	
		Positive samples	Incidence percentage	Positive samples	Incidence percentage
TR1	3	1	33.30%	1	33.30%
TR2	3	1	33.30%	1	33.30%
LR1	3	1	33.30%	1	33.30%
LR2	3	0	0%	1	33.30%

TR (1, 2) = Tourist restaurant LR (1, 2) = Local restaurant

found that at 14°C, the total count increased and the coleslaw deteriorated organoleptically. In addition, at 7°C, bacterial growth was suppressed but organoleptic deterioration occurred as rapidly as at 14°C. Thus, the deterioration was caused primarily by the physiological breakdown of plant tissue rather than by microorganisms, as was the original premise.

Fig. 4 illustrates that the average log No of coliform group, total count of bacteria and total count of yeast and moulds were between 3.59 to 4.20 $\log_{10}$ cfu/g; 2.90 to 3.99 $\log_{10}$ cfu/g and 2.94 to 3.62 $\log_{10}$ cfu/g, respectively.

In addition, data in Table 5 shows that the pH values ranged between 4.30 to 4.45 and moisture percentage ranged between 77.12% to 80.85%, which it is low compared with the moisture ratio in vegetable salads.

Also, prior exposure of *Salmonella* to nonlethal acid environments or low temperatures enhances survival of the pathogen in mayonnaise (Lock and Board 1995; Tosun and Gonul 2003) and would likely also occur in mayonnaise-based salads. A previous study (Francis and O'Beirne, 2001) showed that populations of *Escherichia coli* O157:H7 in coleslaw salad increased during the initial days of storage at 8°C, and subsequently declined on extended storage, while on packaged swedes, populations of *Escherichia coli* O157:H7 increased by 1 log during 12- day storage.

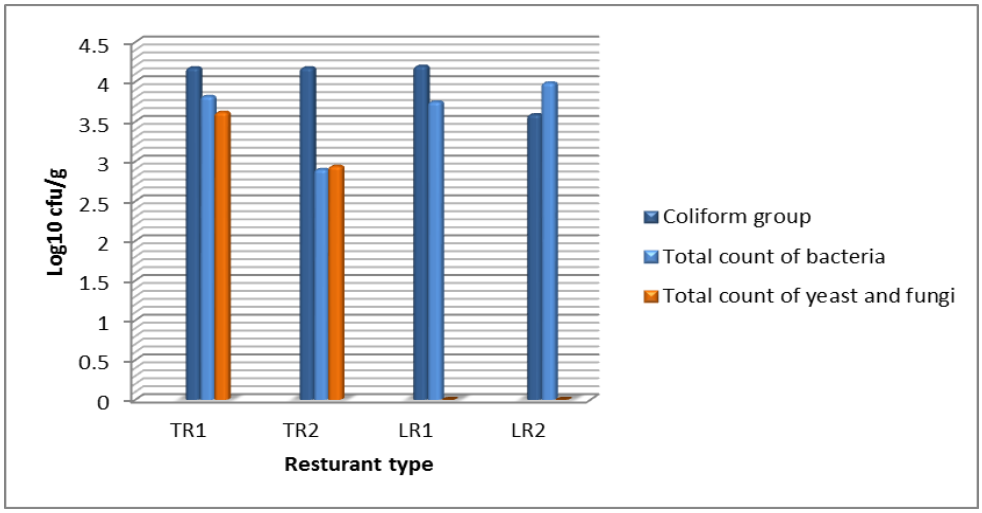

Fig. 4. Average log. No. of the tested microorganisms in coleslaw salad samples in winter season

Conclusion

Increasing numbers of microbes in salad, especially in the summer and in the restaurants of a class (LR) and (FV) is due to the use of poor quality vegetables and disinterest good hand washing vegetables. Therefore it is recommended to select the finest vegetables, and raw materials used in the preparation of salads and the observance of sanitary conditions for workers in restaurants, as well as the tools, and must hold ready-to-eat salad under cooling in refrigerators isolated from the outside air show. Since the high temperature during the summer lead to the provision of a suitable for the growth of microbes on vegetables, as well as low pH value are not suitable for the growth of microbes therefore advised to enter the lemon juice in the preparation of salads. According to the Egyptian standard specifications from food, these samples are unacceptable from the standpoint of microbiological safety, therefore, the presence *Escherichia coli* 0157 : H7, *Salmonella* spp., *Shigella* spp., coliforms group, total count of bacteria and total count of yeast and moulds, in foods constitutes a significant risk and can be used as an indication of cross contamination. Results from this study indicate that the personal hygiene of food handlers, the use of protective utensils during processing (mask, gloves, hairnets, *etc.*) and good manufacturing practices (GMP) should be improved in the kitchen and serving units. Unfortunately, Hazard Analysis Critical Control Point (HACCP) systems have not yet been implemented in these facilities. In light of the results presented in this study, there is a new emphasis on GMPs and on retail HACCP, which should be implemented to enhance food safety in these establishments.

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التقييم الميكروبي للسلطات الجاهزة للأكل من المطاعم في مدينة الزقازيق

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يتزايد الاستهلاك من السلطات الجاهزة للأكل خارج المنزل والذي يرجع لأسلوب الحياة السريع والتوعيه على الصفات الغذائية والعمليات التكنولوجية المحسنة الموثقة بشكل جيد، تهدف هذه الدراسة إلى الكشف عن الجودة الميكروبية لنوعين من السلطات الجاهزة للأكل (RTE) المجمعة من ثلاث فئات من المطاعم والمصنفة كالتالي: مطاعم سياحية (TR)، مطاعم محليه (LR) وعربات الطعام (FV) في مدينه الزقازيق - محافظه الشرقيه - مصر، جمعت ٦٠ عينه من السلطات تمثلت في: ٢٤عينه من سلطة الكولسلو (١٢ عينة في فصل الصيف، ١٢عينة في فصل الشتاء) من (TR) و(LR) على حد سواء، و٣٦ عينه من السلطة الخضراء (١٨ عينة في فصل الصيف، ١٨عينة في فصل الشتاء) من (LR) و (TR) و(FV) بالتساوي، تم الكشف بإستخدام طرق الكشف القياسية عن وجود كل من (*Escherichia coli* 0157:H7, *Salmonella* spp., *Shigella* spp., coliforms group, total count of bacteria and total count of yeast and moulds) حضنت عينات السلطة بعد خلطها جيدا وتجانسها في selective enrichment broths وهي خطوة ضرورية للسماح للميكروبات المرضية بالنمو، وقد تباينت أعداد الميكروبات في عينات السلطات باختلاف فئات المطاعم وفصول السنة، حيث عثر على *Salmonella* spp. في إثنا عشر عينه سلطه خضراء من إجمالي ثمانية عشر عينه في فصل الصيف وفي اربع عينات من إجمالى ثمانية عشر عينه في الشتاء، وعثر على *Shigella* spp. في خمسه عشر عينه سلطه خضراء من اجمالي ثمانيه عشر عينه في الصيف، وفي إحدى عشر عينه من اجمالي ثمانيه عشر عينه في الشتاء، وعثر على *Escherichia coli* 0157:H7 في أربعة عشر عينة سلطه خضراء من اجمالي ثمانيه عشر عينه في الصيف، وفي عشره عينات من إجمال ثمانيه عشر عينه في الشتاء، عثر على *Shigella* spp. في خمسه عينات من سلطه الكولسلو من إجمالى إثنى عشر عينه في الصيف وفي ثلاث عينات في الشتاء، وعثر على *Escherichia coli* 0157:H7 في خمسه عينات من سلطه الكولسلو من اجمالى اثناعشر عينه في الصيف وفي أربعة عينات في الشتاء من اجمالى إثنى عشر عينة، وتراوح العدد الميكروبي (log_{10} cfu/g) coliforms group في السلطه الخضراء ما بين ٥.٠٨ الى ٦.٤٧ في الصيف، و٤.٧١ إلى ٦.٤٥ في الشتاء ، وتراوح العدد الميكروبي (log_{10} cfu/g) للعدد الكلي للبكتريا ما بين ٥.٢٠ الى ٦.٤٦ في الصيف وما بين ٣.٩٨ الى ٥.٨٤ في الشتاء وللخمائر والفطريات ما بين ٢.٩٥ إلى ٥.٢٤ في الصيف ، و٣.٥٨ إلى ٥.١٣ في الشتاء، ووفقاً للمواصفات القياسية المصرية للغذاء فإن هذه العينات غير مقبولة من وجهة نظر السلامة الميكروبيولوجية، وبالتالى فإن هذه البيانات تشير إلى أن متداولي الأغذية يمكنهم أن يسهموا في تلوث الغذاء بمسببات الأمراض وأن هناك بعض الممارسات التي تتطلب المزيد من الاهتمام.

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