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Original Article

Evaluation of the Bacteriological quality of two types of salad prepared at the Libyan Airlines Catering Center in Tripoli, Libya

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Abstract

The aim of this study was to evaluate the bacteriological quality of two types of salads prepared at Libyan airlines catering center near Tripoli International Airport /Tripoli, Libya. The study lasted for 10 months starting from January until October, 2010. During this period 221 salad samples (132 for the economy class and 89 samples for business and flight crew class) were collected. All samples were subjected to periodical bacteriological analysis which included determination of Total Plate Count (TPC), Total Coliforms (TCF) count, in addition to detection and enumeration of some pathogenic bacteria: *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* spp., *Vibrio parahaemolyticus*, *Bacillus cereus* and *Listeria* spp. using two methods of detection: conventional method vs. compact dry method. The results of the study have shown that the mean of initial TPC for the first type of salad were 11.38 $x10^3$ cfu/g using the conventional method of enumeration and 54.17$x10^2$ cfu/g using the compact dry method, while the means of TCF count were 54.07$x10^2$ and 14.90 $x10^2$ cfu/g using the first and the second method respectively. On the other hand the initial TPC means for the second type of salad were 64.00$x10^2$ cfu/g using the first method and 81.30 $x10^2$ cfu/g using the second method. The TCF count means were 15.40 $x10^3$ and 78.60 $x10^2$ cfu/g using both methods respectively. Even though, there was no significant difference between the two types of salads in respect of TPC and TCF counts, data indicated that the conventional method appears to have a relatively better support for total microbial growth vs. the compact method. A gradual decline in TPC and TCF counts were observed throughout the period of the study and reached minimum values at the end of the last month. The reduction percentages of TPC in the economy class salad were 14.24% and 61.69% at the 2nd and 3rd

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months vs. 90.77% vs 99.02% reduction at the end of the last month of the study using the conventional method of enumeration. Relatively similar pattern was observed for business and flight crew class salad. The results have shown that the presence of pathogenic bacteria was different depending on the type of salad and the detection method applied. *S. aureus* was the most predominant in the economy class salad representing 17.4% of the samples using the conventional method and 14.4% using the compact dry method. As for *E. coli* it was detected in 7.6% and 9.8% of the samples using the conventional method and the compact dry method respectively. *Salmonella spp.* was present in 3.4% and 3.8% of the samples using both methods of detection respectively. On the other hand, the presence of these pathogens was reversed in the business and flight crew class salad, since *E. coli* recorded the highest percentage (14.6% and 16.9 %) followed by *S. aureus* (13.5% and 11.2%), and then *Salmonella spp.* (6.7% and 6.70%) using the conventional method and the compact dry method respectively. *V. parahaemolyticus* which was detected using the compact dry method only recorded the least percentage (4.9%). As for *B. cereus* and *Listeria spp.* they were not detected in either type of salad. Finally, the data indicated that the significance decrease in bacteriological counts at the end of the sixth and the seventh months of the study, was coincided with the application of the (HACCP) system for the first time at the catering center.

Key words: Air lines catering centers, salads, Shrimp, RTEF, Total Plate Count, Total Coliforms, Pathogenic Bacteria.

Introduction

Worldwide air travel is in a steady increase and the number of passengers reaches several millions/ year, more than 4% of such number is young children, in addition to elderly people and other most sensitive groups (Crockett and Keystone, 2006). Most national and international air lines usually serve a variety of food items on board which means the possibility for some food borne diseases (FBD) and outbreaks to exist. Optimistic opponents argue that FBD incidences on board of modern air flights are quite rare and food safety is in its highest beak due to the new advances and innovations in food technology during processing, distribution, storage and serving, in addition to the application of the Hazard Analysis and Critical control Points (HACCP) system and other strict measures and regulations related to food safety during air travel.

Literature cited however, indicated that this positive view was not completely true since several outbreaks did happen in the 1960's – 90's of the last century and even during the first decade of the new century (Ivana *et al.,* 2008). For instance, an outbreak on board of a flight from London to South Asia was reported by Preston (1968) in which the crew personnel were the victims and the causative agent was *Escherichia coli*. Similarly, Peffers (1976) cited several outbreaks during international air travel with an emphasis on *Vibrio*

parahaemolyticus. Numerous outbreaks were also reported by the Center for Disease Control (CDC) during the years 1981 and 1986.

In one of such out breaks, 19 passengers became sick including the crew personnel; the agent was reported to be *Staphylococcus aureus* (CDC, 1981a). In another incidence reported by the same center, 24 passengers were infected due to turkey meat contaminated with *Clostridium perfringence* (CDC, 1986). In addition, McMillan *et al.*, (2007) reviewed literature on FBD incidences during air travel for the past 3 to 4 decades and reported occasional outbreaks throughout that period. Moreover, several workers reported scattered incidences and out breaks on board of many large and famous international air lines during the years extending from 1990 to 2008 (Lambiri *et al.,* 1995; Eberhart, 1996; Hataka, 1998; Crockett and Keystone, 2006; Wiley, 2007; Ivana *et al.,* 2008). Even though, there is a significant decline in the rate of such out breaks during the last 5 to 10 years, it does not mean that air travel is immune of such possibility or that food safety is 100% guaranteed.

Many epidemiologists state that the reason for the lack of data concerning FBD incidences on board of present time national and international flights could be attributed to difficulties in tracing back the exact source and time of a FBD incidence due to the short duration of most flights (few hours) vs. the relatively long incubation period of food borne illnesses which could take several hours or days.

The other reason could be attributed to the fact that most cases are not being reported at the hospitals. Also, even in those few hospitalized cases medical authorities can only identify the causative agent (chemical or microbial) and cannot know for certain the source of the illness and often recorded as unknown due to the lack of the main evidence which is the suspected food itself. Besides that, in most cases air travel involves multiple flights which also make it more difficult to trace the incidence to a particular flight. Finally, some may argue that an illness could originate from foods being eaten at home or in a fast food establishment at or near the airport several hours prior to getting on board. For those reasons and others, only few FBD incidences are being reported during air travel which might convince some researchers to believe the optimistic view stated earlier.

Despite the above contradicting views, several studies indicate that ready to eat foods (RTEF) served on board, especially cold salads could be considered the main threatening source of FBD incidences during air travel. This is because of the unique criteria of leafy and root vegetables often used for preparation of these salads. Vegetables are heavily contaminated with natural flora of soil and water origin, they are subject to human source of contamination during preparation, and no heat treatment is applied and are usually served cold (Maritinez-Tmomè *et al.*, 2000). Moreover, some pathogenic bacteria that could be present in vegetables and other RTEF have the ability to resist freezing and cold chock storage, a process that is strictly depended upon in catering centers and air lines for preserving their food stocks (Abdul-Raouf

et al., 1993; Bollman *et al.*, 2001). Among the leading pathogens that are often carried out by salads and RTEF are: *Salmonella* and *Staph. Aureus* followed by *Shigella, E. coli, E. coli* O157:H7, *Bacillus cereus Clostridia* and many others, in addition to *V. parahaemolyticus* when marine products are served or added to salads (Maritinez-Tmomè *et al.*, 2000 and Little and Gillespie, 2008). This reflects the importance of continuing monitoring of the safety of foods served during air travel especially in developing countries where safety and regulatory measures are still not fully met due to technological, financial and other burdens. Literatures cited on the national level revealed that there was almost no information related to potential hazards associated with RTEF - especially salads prepared at catering centers in Libya. Thus, this study was the first of its kind to deal with such important and sensitive safety issue.

In designing this study two main objectives were set forward. The first objective was to evaluate the microbiological quality of two types of vegetable salads prepared at the catering center in Tripoli, while the second objective was to compare the efficiency of two techniques for detection and enumeration of microorganisms in vegetable salads. These methods are the conventional methods and the compact dry method.

Materials and Methods

The study was conducted during the year 2010, and extended for 10 months in The Micro-Lab. located at the catering center affiliated with the Libyan Airlines.

This center prepares meals for national and international Airlines that use the main Airports in Libya. Two hundred Twenty one (221) samples were analyzed in the study: 132 for type 1 salad (Economy class) plus 89 for type 2 salad (First class). The main difference between the two types lies in the addition of a marine product item (usually shrimp) to the first class salad. Other components of both types of salads were the same and usually consist of lettuce, tomatoes, cucumbers and sometimes pickled olives.

All samples were randomly selected and periodically analyzed for Total Plate Count (TPC) and Total coliforms (TCF) counts, in addition to detection and/or enumeration of some pathogenic bacteria mainly: *E. coli*, *S. aureus, Salmonella spp.*, *B. cereus, Listeria spp.* and *V. parahaemolyticus*. Three replications/ sample were taken and the analysis was conducted in duplicates.

Two methods of analysis were used for the detection and/or enumeration of those pathogens which included: Conventional and Compact Dry Methods. The compact dry method differs from the conventional methods in applying ready to use prepared mini-plates containing selected and differential solid media. This method was conducted according to the procedure described in the official manual provided by the manufacturing company (HyServe GmbH, Germany).

On the other hand, the conventional methods were conducted according to the procedures outlined in the official microbiological manual set by APHA (2001).

Results and Discussion

Table (1) summarizes the results of total microbial counts of both types of salads using the two methods of enumeration, the overall means for both types of salads during the first 3 months of the study were in the range of 10^2 to 10^3 cfu/g., then declined by approximately one log cycle by the end of the 4th and 5th month, and reached less than 10^2/g. at the end of the 10th month. Data also revealed that there was no significant difference in TPC of the two types of salads, but the difference between the two methods of enumeration is relatively significant. The conventional method appeared to have a relatively better support for microbial growth compared to the compact dry method: 53.7 x 10^2 and 19.39 x 10^2 cfu/g for conventional vs. 26.19 x 10^2 and 12.62 x 10^2 cfu/g for compact dry method of enumeration in type1 and type 2 salads respectively. Such decrease in total counts is clearly represented by reduction in percentages given in the same table. The reduction percentage started from 14.24% and 61.69% at the 2nd and 3rd months and reached over 90% at the end of the last month of the experiment. However, such pattern of decline in counts was much faster in type 2 salad compared with type 1, especially when using compact dry method of enumeration instead of conventional method.

Results of total coliform (TCF) counts of both types of salads using the two methods of enumeration are shown in Table (2). The overall means of counts for both types of salads were in the vicinity of 10^2 cfu/g. during the first 2 - 3 months, then declined by approximately one log cycle at the end of the 4th and 5th month, and reached 10 cfu /g. or less at the end of the 10th month.

Data also revealed that there was no significant difference in TCF counts of the two types of salads, but the difference between the methods of enumeration is relatively significant. Similarly, the conventional method appeared to have a better support for coliforms than compact dry method (26.20 x 10 and 22.20 x 10^2 cfu/g.) for conventional method vs. (28.0 x 10 and 96.10 x 10 cfu/g) for compact dry method in type1 and type 2 salads respectively. Such decrease in total coliform counts is similarly represented by the reduction in percentages data given in the same table. The reduction percentages started from 28.70% and 68.14% at the 2nd and 3rd months and reached over 99% at the end of the last month.

However, such pattern of decline in coliform counts was much faster in type 2 salads compared with type 1 (60.39%) and (96.39%) at the 2nd and 3rd months using conventional method. Again the percentage of reduction in counts was much faster when compact dry method was used (84.99% and 93.40%) at the 2nd and 3rd months respectively.

Data presented in table (3) show the numbers and percentages of pathogenic bacteria isolated from the two types of salads, using the two methods of detection. *S. aureus* scored the highest percentage (17.6 and 14.4%) among the other four pathogens in type 1 salad, followed by *E. coli* and *Salmonella* spp., using the conventional and compact dry methods respectively.

Table 1. Over all means and percentages reduction in Total Plate Counts (TPC) of the two types of salad samples during the entire period of the study (Jan. – Oct.).

Period (Months)	Type 1 Salad (Economy class)				Type 2 Salad (First class)			
	Conventional		Compact Dry		Conventional		Compact Dry	
	Means (cfu/g)	Reduction (%)	Means (cfu/g)	Reduction (%)	Means (cfu/g)	Reduction (%)	Means (cfu/g)	Reduction (%)
Jan.	11.38 x10^2	-	54.17 x10^2	-	64.00 x10^2	-	81.30 x10^2	-
Feb.	09.76 x10^2	14.24	81.30 x10^2	+50.08	97.43 x10^2	+52.23	10.80 x10^2	86.72
Mar.	13.33 x10	61.69	80.70 x10^2	+48.97	13.30 x10^2	79.22	12.00 x10^2	85.24
Apr.	13.33 x10	88.29	31.20 x10^2	42.40	79.00 x10	87.66	10.84x10^2	86.67
May	84.9 x10	25.40	77.80 x10^2	+38.08	46.30 x10	92.72	44.20 x10^2	45.63
June	76.3 x10	32.95	37.80 x10	30.22	35.60 x10	94.44	38.30 x10	95.29
July	15.8 x10	86.12	11.5 x10	97.88	9.30 x10^2	85.47	06.00 x10	99.76
Aug.	10.4 x10	90.86	06.0 x10	98.89	10.00 x10	98.43	10.10 x10	99.05
Sep.	70.9 x10	37.70	06.9 x10	98.73	06.80 x10	98.94	07.10 x10	99.91
Oct.	10.5 x10	90.77	05.3 x10	99.02	07.10 x10	98.89	07.40 x10	99.09
Over all Means	53.70 x10^2	-	26.19 x10^2	-	19.39 x10^2	-	12.62 x10^2	-

Table 2. Over all means and percentages reduction in Total Coliform (TCF) Counts of the two types of salad samples during the entire period of The study (Jan. – Oct.)

Period (Months)	Type 1 Salad (Economy class)				Type 2 Salad (First class)			
	Conventional		Compact Dry		Conventional		Compact Dry	
	Means (cfu/g)	Reduction (%)	Means (cfu/g)	Reduction (%)	Means (cfu/g)	Reduction (%)	Means (cfu/g)	Reduction (%)
Jan.	54.7 x10^2	-	14.9 x10^2	-	15.4 x10^3	-	78.6 x10^2	-
Feb.	39 x10^2	28.70	11 x10^2	26.17	61 x10^2	60.39	11.8 x10^2	84.99
Mar.	75.8 x10	68.14	14.3 x10	90.40	57.4 x10	96.27	51.9 x10	93.40
Apr.	2.8 x10	99.49	‹10	99.93	5.5 x10	99.64	1.5x 10	99.81
May	3.4 x10	99.38	0.4 x10	99.73	7.8 x10	99.49	2.4 x10	99.69
June	13.4 x10	97.55	5.2 x10	96.51	1.3 x10	99.92	1.3 x10	99.83
July	‹10	99.99	0.8 x10	99.46	0.4 x10	99.97	‹10	99.97
Aug.	0.4 x10	99.99	0.4 x10	99.73	‹10	99.99	‹10	99.99
Sep.	‹10	99.99	0.3 x10	99.80	‹10	99.99	‹10	99.99
Oct.	0.5 x10	99.99	‹10	99.99	‹10	99.99	‹10	99.99
Over all Means	68.2 x10	-	28 x10	-	22.2 x10^2	-	96.1 x10^2	-

Table 3. Number and Percent (%) of Type 1 and Type 2 salad samples containing the four types of pathogenic bacteria that were detected using the conventional and the compact dry methods.

Type of Pathogen	Type 1 salads (Economy class)				Type 2 salads (First class)			
	Conventional		Compact Dry		Conventional		Compact Dry	
	Positive Samples		positive Samples		Positive Samples		positive Samples	
	No.	%	No.	%	No.	%	No.	%
E. coli	10.0	07.6	13.0	09.8	13.0	**14.6**	15.0	**16.9**
Staph. aureus	23.0	**17.4**	19.0	**14.4**	12.0	13.5	10.0	11.2
Salmonella spp.	04.0	03.4	05.0	03.8	06.0	06.7	06.0	06.7
V. parahaemolyticus	Nd.	Nd.	Nd.	Nd.	Nd.	Nd.	04.0	04.9

Bold data indicating the highest percentage. Nd.: Not detected.

Table 4. Over all means and percentage (%) reductions of Total coliform (TFC) counts of the two types of salad samples during the entire period of study (Jan–Oct).

Period (Months)	Type 1 Salad (Economy class)				Type 2 Salad (First class)			
	Conventional		Compact Dry		Conventional		Compact Dry	
	Means (cfu/g)	Reduction (%)	Means (cfu/g)	Reduction (%)	Means (cfu/g)	Reduction (%)	Means (cfu/g)	Reduction (%)
Jan-Apr ($1^{st} - 4^{th}$)	$56.50x10^2$	-	$13.40x10^2$	-	$73.58x10^2$	--	$47.43 x10^2$	$56.50x10^2$
May-Jul ($5^{th} - 7^{th}$)	65.3x10	88.44	1.90x10	98.58	4.87x10	93.38	1.73 x10	65.3x10
Aug-Oct ($8^{th} - 10^{th}$)	0.28x10	**99.95**	0.40x10	**99.70**	‹10	**99.99**	‹10	0.28x10

Bold data indicate highest % Reduction.

In contrast, *E. coli* scored the highest percentage (14.6 and 16.9%), followed by *S. aureus* and *Salmonella* spp. in type 2 salad, using the conventional and compact dry methods respectively.

V. parahaemolyticus was only detected in the first class salad samples, since it contained pieces of a marine product (shrimp) using the compact dry method. This pathogenic bacteria was only recorded in 4 (4.9%) samples. However, the international guidelines recommend that TCF counts should not exceed 10^2 cfu/g and that *E. coli* and other pathogenic bacteria especially *S. aureus* and *Salmonella* spp. should be absent from RTEF including salads (Gilbert *et al.*, 2000, CFS, 2007 and AEA, 2010).

According to such guidelines, results of the present study indicate that the bacteriological quality of both types of salads were not satisfactory especially during the first 6 months of the study

period. Results of this study were in agreement with the findings of Abdul-Raouf *et al.*, (1993), Hatakka (1998), Bollman *et al.,* (2001) and Wiley (2007) and several workers in such area. All of them proved the potential presence of several spoilage and pathogens in RTEF especially salads and agree that such presence is an alarming issue for the safety of world Airline travel which should be properly tackled. The pattern of change in the number of isolated pathogens along the entire period of the study is shown in (table 4). Data related to type 1 salad indicated that *S. aureus* ranked 1st (4 times/month) for the first 3 months in a raw and 2 time/month for another 3 months, followed by *E. coli* which appeared 3 times/month for 3 months in a raw, then 1 – 2 times during the 5th and 6th month. Such ranking of these two pathogens was reversed in type 2 salad since *E. coli* was the most frequent during the 1st 3 months (3 times/month) vs. *S. aureus* (2 times/ month). The third rank was *Salmonella* which was detected more frequent in type 1 salad. The least was *V. parahaemolytius* which was detected 2 times only in type 2 salads during the entire period. With few exceptions, the presence of these pathogens was not recorded after the 6th month of the study in both types of salads. In other words, regardless of the method of detection, it could be seen that there was some fluctuation in the numbers of isolates. The frequency of occurrence was relatively higher during the 1st three months, and then declined after 3 – 4 months and almost disappeared after 6 th and 7th months of the study. This improvement was coincided with the application of the HACCP system at the 6th month of the study. Concerning the type of food contributed most as a source of each type of the pathogenic bacteria isolated from both types of salads, a complementing study was performed in which each food component was separately analyzed. Results of such investigation are shown in table (5), data indicated that both types of food items contributed for the presence of either one of the four isolates but in a relatively different proportion. The fresh vegetables were the main source of *E. coli,* and *Salmonella* spp., but *E. coli* gave the highest share vs. relatively lower proportion for the other pathogen (*Salmonella*). On the other hand, the presence of *V. parahaemolyticus* was not detected in fresh vegetables and the marine product was the main source in this case. Such findings were in agreement with the work of Maritinez-Tmomè *et al.*, (2000) and Little *et al.*, (2008).

Table 5. Number of vegetable and marine product (shrimp) samples.

Marine Product (Shrimp)	Green Vegetables	Type of Pathogens	
6	9	*E. coli*	1
6	4	*S. aureus*	2
2	4	*Salmonella spp.*	3
4	0	*Vibrio parahaemolyticus*	4

Contaminated With the isolated pathogens (1,2,3,4).

The isolation of *E. coli* and *S. aureus* from both types of salads gave an indication that there was a sanitation and personnel hygienic problems at the center. Yet, the significant decline in TPC and TCF counts, besides the absence of most of the

pathogenic bacteria during the last 3 - 4 months gave a positive indication that some improvement have been achieved and the application of the HACCP system was relatively effective. A follow up evaluations few months later (unpublished data) had confirmed the above stated optimistic view and assured that the situation was finally became under control.

Conclusion

In the light of the previous discussion, it could be concluded that the bacteriological quality of both types of salads prepared at the designated catering center was not satisfactory due to relatively high TPC and TCF counts in addition to the presence of *E. coli* and other pathogens especially during the first 4 - 6 months of the study. With few exceptions, the results revealed that the conventional method was relatively better in supporting the bacterial growth as compared with compact dry method, yet the latter was relatively better for the detection and enumeration of most of those pathogens.

Even though, there was some improvement in the bacteriological quality of the investigated salads near the end of the study, the fluctuation in the total counts along the period of the study accompanied with the detection of some pathogens is a matter of concern. This simply implies that urgent correction measures including more focus on good hygienic practices and the effective application of the HACCP system have to be taken, besides a periodical re-evaluation of the situation by an independent agency.

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تقييم الجودة البكتريولوجية لنوعين من السلطة المجهزة بالمركز الليبي لتموين الرحلات الجوية الواقع بمدينة طرابلس، ليبيا

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المستخلص

استهدفت هذه الدراسة تقييم الجودة البكتريولوجية لنوعين من السلطة المجهزة بمركز تموين الرحلات الجوية المجاور لمطار طرابلس العالمي بليبيا. استغرقت الدراسة عشرة أشهر ابتداء من شهر يناير وحتى شهر أكتوبر لسنة 2010، تم خلالها جمع 221 عينة سلاطة (132 للدرجة السياحية و 89 لدرجة رجال الأعمال والطاقم الجوي). أخضعت جميع العينات للتحاليل الميكروبيولوجية بشكل دوري وتضمنت تقدير العدد الميكروبي الكلي وأعداد مجموعة بكتيريا القولون، بالإضافة إلى الكشف عن وجود بعض البكتيريا الممرضة:

Escherichia coli, Staph. aureus, Salmonella spp., *Vibrio parahaemolyticus, Bacillus cereus* and *Listeria* spp.

بينت نتائج الدراسة أن متوسطات العدد الكلي المبدئية للنوع الأول من السلطة كانت 11.38 χ 10^3 وحدة مكونة للمستعمرات/ جرام (و. م. م/ جم) باستعمال طريقة العد التقليدية، و 54.17 χ 10^3 و. م. م/ جم باستعمال طريقة الأوساط المضغوطة الجافة، بينما كانت متوسطات أعداد مجموعة بكتيريا القولون 54.07 χ 10^2 و 14.90 χ 10^2 و. م. م/ جم باستعمال الطريقة الأولى والثانية على التوالي. ومن جهة أخرى فقد كانت متوسطات العدد الكلي المبدئية للنوع الثاني من السلطة 64.00 χ 10^2 و. م. م/ جم باستعمال طريقة العد التقليدية، و 81.30 χ 10^2 و. م. م/ جم باستعمال طريقة العد الثانية، وكانت متوسطات أعداد مجموعة بكتيريا القولون 15.40 χ 10^3 و 78.60 χ 10^2 و. م. م/ جم باستعمال الطريقتين على التوالي. وعلى الرغم من عدم تسجيل فروق معنوية بين نوعي السلطة من حيث العدد الكلي وأعداد مجموعة بكتيريا القولون، إلا أن النتائج تشير إلى كون الطريقة التقليدية كانت أفضل نسبياً فيما يتعلق بدعم النمو الميكروبي.

لوحظ انخفاضاً تدريجياً في الأعداد الكلية وأعداد مجموعة بكتيريا القولون طيلة مدة الدراسة، ووصلت أدنى قيم في نهاية الشهر الأخير من الدراسة. وكانت نسبة انخفاض العدد الكلي 14.24% و 61.69% في سلطة الدرجة السياحية عند الشهر الثاني والثالث مقارنة بنسبة 90.77% في نهاية الشهر الأخير من الدراسة باستعمال طريقة العد التقليدية. ولقد سجل انخفاضاً مشابهاً نسبياً في سلطة درجة رجال الأعمال والطاقم الجوي.

أوضحت النتائج اختلافاً في نسب وجود البكتيريا الممرضة، وذلك حسب نوع السلطة وطريقة الكشف المتبعة. فقد كانت بكتيريا *S. aureus* الأكثر تواجداً في سلطة الدرجة السياحية بنسبة 17.40% باستعمال الطريقة التقليدية، و 14.40% من إجمالي العينات باستعمال طريقة الأوساط المضغوطة الجافة. وسجل وجود بكتيريا *E. coli* في 7.6% و 9.8% من إجمالي العينات باستعمال طريقتي العد الأولى والثانية على التوالي. وسجل وجود بكتيريا .*Salmonella* spp بنسبة 3.00% و 3.80%

فقط من إجمالي العينات باستعمال طريقتي العد الأولى والثانية على التوالي. ومن جهة أخرى كانت نسبة تواجد البكتيريا الممرضة في سلطة درجة رجال الأعمال والطاقم الجوي عكس ذلك، حيث سجلت بكتيريا *E. coli* أعلى نسبة (14.60% و 16.90%) تواجد، ويليها *S. aureus* بنسبة 13.5% و 11.2%، ثم بكتيريا *Salmonella pp.* بنسبة 6.74% و 6.70% باستعمال طريقتي العد الأولى والثانية على التوالي. أما البكتيريا الأقل تواجداً فكانت *V. parahaemolyticus* التي عزلت من سلطة درجة رجال الأعمال والطاقم الجوي بطريقة الأوساط المضغوطة الجافة فقط. ولم يسجل وجود بكتيريا *B. cereus* أو *Listeria spp.* بأي نوع من السلطة. تجدر الإشارة إلى أن المباشرة في تطبيق نظام تحليل المخاطر والسيطرة على النقاط الحرجة للمرة الأولى بمركز تموين الرحلات الجوية قيد الدراسة، قد تزامن مع تسجيل انخفاض ملحوظ في الأعداد الميكروبية بشكل عام بعد الشهر السادس والسابع من بداية الدراسة.

الكلمات الدالة: مراكز تموين الخطوط الجوية، سلطة، الأغذية الجاهزة, جمبري، العدد الكلي، أعداد بكتيريا القولون والبكتيريا الممرضة.

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