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Microbiological quality of some ready-to-eat foods distributed in the local market of Damanhour (El-Behaira Governorate), Egypt.

By

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ABSTRACT

The focus of this study was to evaluate the microbial quality of 20 different ready-to-eat street vended food items at the point of sale located at Damanhour, El-Behaira Governorate, Egypt. Also, surface swab and water samples were collected and examined in order to assess the potential cross-contamination between foods and the environments that vendors operate.

Microbial count ranges of tested foods were found to be wide indicating considerable variabilities between foods from different vendors. Mean ACC count ranged between $5.87x10^2$ cfu/g for tehina salad and $48.16x10^6$ cfu/g for vegetable salad. Mold and Yeast incidence was noted in 15 of 20 food items. where balady bread had the highest load ($69.5x10^3$ cfu/g). Most tested food samples were contaminated by one or more of food borne pathogenic bacteria. *Coliforms* loads varied between $0.55x10^2$ to $94.687x10^3$ cfu/g for battered fried meat and vegetable salad respectively. Tehina salad showed its freedom of contamination with *Staphylococcus aureus*, while other food items were harboured by such organism at different incidence % and levels. As for *Salmonella spp.* Contamination, 84.51% of tested samples exerted positive occurrence of this pathogen, while all collected samples of three food items (tehina salad, balady bread and tomato sauce) were free of Salmonella contamination.

Results of surface swab samples indicates that all surfaces were loaded with ACC mean counts of $3.83x10^2$ to $28.35x10^8$ cfu/cm^2 where hands and cloths of workers were the highest contaminated surfaces. All surfaces (except interior walls and tables) were free of mold and yeast contamination. *Salmonella spp.* contamination was detected at varied levels in most studied surfaces. Contamination with pathogenic bacteria was found at different loads in most surfaces. Hands and cloths of workers were contaminated with one or more potentially pathogenic bacteria. The high levels of microbial contamination of working surfaces highlights the need for improved personal hygiene as a major step in ensuring the safety of street foods.

Microbiological analysis of water declares that stored water was highly contaminated with aerobic bacteria compared to running water. Coliforms and *S.aureus* were detected at slight counts; while mold and yeast and Salmonella were not detected in both types of water.

It could be concluded that microbial contamination of ready-to-eat foods occurred due to several reasons and by different sources and ways. Cross-contamination usually occur during vending and selling operations.

INTRODUCTION

Fast, street and /or ready-to-eat foods were defined by **Dawson and Canet (1991)** as those foods prepared and sold in the streets for immediate consumption or for consumption at a later time without further processing or preparation. Street-vended foods were defined by **Martins and Anelich (2000)** as those foods prepared on the street, ready to eat, or prepared at home and consumed on the street without further preparation. Also, **Wei *et .al.* (2006)** cited that ready to eat foods are prepared and sold in public markets, and they provide consumer for immediately consumption with simple processing or preparation.

The growth of the fast foods industry has been nothing less than astonishing. This enormous growth has had a proportionate impact on economic, political, social and cultural aspects of American life **(De Maria, 2003)**. Street- food vendors provide a source of inexpensive and nutritious meals to a large number of constructions and office workers as well as people in transit **(Dawson and Canet, 1991 and Mosupye and von Holly, 1999)**. Street vendors usually congregate in overcrowded areas where there are high numbers of potential consumers **(Bryan *et. al.*, 1988 and Kubheka *et. al.*, 2001)**. People referred to factors such as working long hours, eating alone and exhausting, and being unable to prepare meals as increasing factors for fast-food consumption **(Dunn *et. al.*, 2008)**.

Fast food consumers belongs to many age stages such as adolescence and adulthood of both sexes (meals and females) **(Larson et.al., 2008)**, childhood **(Guthrie *et. al.*, 2002)**. The wide spread of fast foods seemed to have been driven by massive advertising and marketing campaigns **(Nestle, 2002)**.

Food safety-as a fundemental concern in food service- poses a significant importance due to the apparent difficulty implementing programs to guarantee and control quality such good practices (**Saccol *et. al.*, 2013**). **Sivasankar (2002)** defined quality of food and food products as the degree of excellence of the various characteristics that influence consumer acceptance as well as consumer safety. Consumer safety requires the evaluation of food quality with respect to nutritional quality, hygienic condition and keeping quality. Training and education are essential to ensure food handlers have adequate awareness and knowledge to comply with food hygiene requirements (**Seaman, 2010**). Also, training of food handlers is an essential part of the HACCP concept (**European Council, 2004**).

The microbial risks associated with the consumption of street-vended foods have been widely studied (**Abdussalam and Kaferstem, 1993, Freese *et. al.*, 1988 and Umoh Odoba, 1999**).
Most reported food borne outbreaks occur from food prepared and consumed outside the home (**Li - Cohen and Bruhn, 2002**). The main risks incurred in the preparation of ready-to-eat cooked meals involve their contamination from raw ingredients, the hands of catering staff, direct contact with contaminated work surfaces as well as from the growth of bacteria caused by rises in temperature during the course of their preparation and storage (**Christensen, 1989**). Gastrointestinal infections can be a major concern if customers became ill as a result of consuming food prepared and sold in catering or food service establishments (**Dawson and Canet, 1991**). The top five causes of food poisoning- as cited by **Jeng and Fang (2003)**-were: (1) cross-contamination between raw materials and cooked foods, (2) insufficient cooking treatment, (3) contamination by infected food handlers, (4) keeping foods too long at room temperature and (5) insufficient equipment cleaning.

Food safety experts have identified the most common
food handling problems by consumers: obtaining food from unsafe sources, inadequate cooking or heat processing, improper cooling, intervals of 12 h or more between preparation and eating, poor hygiene or colonized person handling implicated food (**Bryan *et.al.*,1988**). Mishandling associated with specific pathogens included the same contributing factors (**Bean and Griffin, 1990**).

There are several microorganisms capable of causing human illness and have been isolated from vegetables and meat such as *Listeria monocytogenes, Salmonella spp., Escherichia coli and Staphylococcus aureus* (**Soriano *et. al.*, 2001**); fresh vegetables and fruits (**Harvey and Gilmour, 1993 and Lin *et. al.*, 1996**) beef, chicken and shellfish(**Bean and Griffin, 1990**); and tomatoes with *Salmonella spp.* (**Hedberg *et.al.*, 1994**). Moreover, fresh vegetables in open markets are reported by **Monge and Chinchilla (1996)** to be seriously contaminated by bacteria of the coliform group, especially *E.coli* as an indication of contamination of vegetables with feces.

The contaminated food is the usual source of human infection, and poultry products are considered the major infection route by *Salmonella spp.* (**Mead, 1993**). Meat products coming from slaughtering facilities of unsatisfactory hygienic issues are often deteriorated and are contaminated with food poisoning and /or pathogenic bacteria (**Hassanaln Nawal, 2008 and Joushi *et.al.*, 2003**). Many workers emphasized high bacterial counts and high incidence of food borne pathogens in street-vended meat products; **Bryan *et.al.* (1992a)** in ground meat, **Ekanem (1998)** in meat products, **Hussien (1996)** in meat balls, **Harakeh *et.al.* (2004)** in meat-based fast food such as shawerma and **Ismail (2006)** in Hawawshy loaf. Such meat products were found to be contaminated with *Staphylococcus aureus*. Salmonella and coliforms at different loads.

One consequence of the increase in the consumption of large quantities of fast foods is a dramatic upsurge in obesity all around the world (**Bryant and Dundes, 2008**). The world wide obesity epidemic is expected to worsen both rates of morbidity and mortality around the globe. Obesity has accompanied the proliferation of fast food restaurants (**Calapinto *et. al.*, 2007 and Young and Nestle, 2007**).
Many workers correlates between the widespread of fast food establishments and prevalence of obesity (**Bryant and Dundes, 2008** in Australia; **Schlosser, 2001** in Great Britain, China and Japan; **Schroder *et. al.*, 2007** in Spain and **Aioia *et.al.*, 2013** in India and developing countries). Consumption of fast food has been frequently implicated as an important cause of childhood obesity (**French *et. al.*, 2000**).

The present study was accomplished to through some light about the microbiological quality of 20 different commercially available ready-to-eat foods at the point of sale in Damanhour City, El Behaira Governorate, Egypt. Also, water used in food preparation as well as swab samples of working surfaces (hands and cloths of employees, tables, cutting boards, utensils and cutlery .....etc.) were microbiologically assessed to evaluate the hygienic state of surfaces in contact with food during all steps of preparing, cooking and vending (from preparation to consumption).

MATERIALS AND METHODS

I. Materials:

a- Food samples

Ready-to-eat popular foods /meals (355 samples) were collected from twelve different food establishments (premises, restaurants, vending chops and outlets) for preparing, cooking, serving and vending such food items. These establishments are placed at different inner popula/ted and crowded areas on Damanhour City (Capital of El- Behaira Governorate, Egypt), including the public park of bus terminal, railway station, big markets and chopping centers.

Collected samples represented several different popular food courses frequently consumed, classified into five categories according to their main constituents (namely; beans, cereals, beef meat, chicken meat and vegetables). Tested foods, their ingredient and number of collected samples are listed in Table (1).

Table (1) Ready-to-eat foods/meals samples

Food category & item	No. of samples	Ingredients
- Beans:	87	
1-Medamis meal (MM)	18	Stewed broad bean, cumin powder, vegetable oil, salt, lemon juice, tehina.
2-Medamis sandwich (MS)	18	Medamis meal, vegetable salad and balady Bread.
3-Fried tamia patties(FT)	18	Broad bean, parsley herb, salt, spices, onions, garlic and vegetable frying oil.
4-Tamia sandwich (TS)	18	Fried tamia patties, tehina salad, vegetable salad and balady bread.
5-Tehina salad (Te)	15	Tehina(sesame paste), garlic, spices, salt, lemon juice, vinegar and water.
-Cereals:	72	
1-Kushary meal (KM)	18	Rice, macaroni, lentil, onions, chick pea, garlic, spices, salt and tomato sauce.
2-Cooked rice (Ri)	18	Rice, milk, spices, salt, butter and water.
3-Cooked macaroni(Ma)	18	Macaroni, spices, salt, vegetable oil or butter and tomato sauce.
4-Balady bread (BB)		Wheat flour, yeast, salt and water.
-Beef meat:	93	
1-Grilled kofta meal (GK)	15	Minced beef meat, animal Fat, onions, spices and salt.
2-Kofta sandwich (KS)	18	Grilled kofta, tehina salad and balady bread.
3-Battered beef meat meal(BM)	15	Beef meat, onion juice, spices, salt, egg , bread crumb powder, wheat flour, lemon juice, vegetable frying oil.
4-Grilled beef meat meal(GM)	15	Beef meat, onion juice, spices, salt and lemon juice.
5-Shawermasandwich(SS)	15	Beef meat, onions, tomato, parsley herb, spices, salt, animal fat, tehina salad, vinegar and pan bread.
6-Hawawshy loaf (HL)	30	Minced beef meat, animal fat, onions, salt, spices, green pepper and pita bread.
-Chicken meat:	15	
1-Battered chicken meat meal (BC)		Skinless and boneless chicken breasts, onion juice, spices, salt, egg, bread crumb powder, wheat flour, lemon juice and vegetable frying oil.
2-Grilled chicken meal(GC)	15	Chicken parts, onion juice, spices, salt and lemon juice.
-Vegetables:	73	
1-Cooked mixed vegetables (CV)	15	Peas, potato, carrot, onions, salt, spices, tomato juice and vegetable oil or butter.
2-Tomato sauce (ST)	18	Fresh tomato juice, salt, cut herbs, spices, vinegar and oil.
3-Vegetable salad (VS)	40	Fresh vegetables (tomatoes, cucumber, lettuce, onions and carrot), spices, salt, vinegar and vegetable oil.

b- Water and swab samples

Using alcohol sterilized plastic bottles (250ml capacity), approximately 200ml of water used in the tested premises were collected. Eighteen tap (running) and nine stored water samples were obtained. Collected samples were withdrawn at different times of day.

Appropriate area of working surfaces; namely tables; cutting boards; pans and trays; plates and dishes; cutlery(spoons, knives and forks); grill surface and interior wall surface as well as worker's clothings and hands were swabbed using sterile swabs moistened with quarter strength Ringer's solution **(Oxoid)** prior to swabbing.

II. Methods:

1. Collection of food and swab samples

For each food item, five to eight samples were collected at the point of sale from the same establishment at varying times of a day. Appropriate quantity of each sample was obtained using the vendor's own utensils. Samples were packaged individually in sterilized labeled plastic bags. At the point of collection, the temperature of each sample was measured using a portable thermometer. The sample was immediately cooled, if its temperature exceeded 50°c, by putting into insulated ice box. All collected food and water samples as well as surface swabs were kept and transported to laboratory under chilling temperature (8-10 °c) using alcohol sterilized ice box. Microbiological analyses were performed on the same day of collection.

2. Microbiological analyses

Serial dilutions of different food and water samples were obtained after homogenization in sterile 1% peptone water using a stomacher for 2min. swabs were individually shaken in 10ml quarter strength of Ringer's solution for 30 seconds, then serial dilutions were prepared.

According to the methods described in the US Bacteriological Analytical Manual **(Peeler and Maturin, 1992)**, aerobic colony count (ACC) or total plate count (TPC) of all tested samples was carried out. Dilutions were plated in duplicate using plate count agar **(Oxoid, 1990)**, incubated at 35°c for 24-48h.under aerobic conditions.

Potato dextrose agar medium (PDA) **(Oxoid, 1990)** was used to enumerate yeast and mold count. One ml of each dilution was poured in duplicate in (PDA) medium, incubated at 25°c for 72-120 h.

For coliform count, Aliquots of dilutions were inoculated in triplicate tubes of Lauryl Tryptose broth (LTB) **(Oxoid, 1990)**. Inoculated tubes were incubated for 24h at 35°c. loopfulls of samples from inoculated LTB, which were positive for turbidity and gas formation, were streaked onto dry plates of solid Eosin Methylene Blue agar (EMB) to confirm the presence of coliforms. Streaked- plates were incubated at 35°c for 24h. Flat, dark-centered colonies with or without metallic sheen were considered as coliforms.

The procedure described by **Eyles (1989)** was followed for *Staphylococcus aureus* counting. Peptone dilutions were used to inoculate in triplicate tubes of Trypicase Soya broth (TSB). Inoculated TSB tubes were incubated for 48h at 35°c. loopfuls were streaked onto dry plates of solid Baird-Parker (BP)agar base enriched with egg yolk-tellurite solution. Streak-plated plates were incubated at 35°c for 48h. Typical staphylococci colonies, which were round, black colonies with clear opaque zones were detected and counted.

Presumptive test for the detection of *Salmonella spp.* was done based on the method of **Jay and Davey (1989)**. Sample dilution of 10^{-1}in peptone water was incubated for 16-20h at 37°c to resuscitate sub-lethally damaged organisms (pre-enrichment step). One ml resuscinted culture was inoculated to Terathionate Broth medium (TTB) in duplicate and the inoculated tubes were incubated for 18-24hr at 42°c (selective enrichment step). Loopfuls of culture suspension from incubated TTB broth tubes were streaked onto dry solid Bismuth Sulfite (BS) agar plates (selective plating) and incubated at 37°c for 24-48h. Typical *Salmonella spp.*; which appeared brown, gray or black with or without metallic sheen were detected and counts.

The obtained results of all microbiological analyses were expressed as colony forming units (cfu/g) of food sample, per milliliter of water and per $cm^2$of surface.

RESULTS AND DISCUSSION

It cannot be denied that street, fast, ready-to-eat food mentality has permeated virtually every aspect of daily life around the world. In Egypt, those foods are commonly prepared, cooked, served and

sold by street vendors at public areas such as public transport centers as well as populated and crowded areas.

As the presence of microorganisms in food is a natural and unavoidable occurrence, data in Table (2) show the mean counts (c.f.u./g) of different microorganisms in certain ready-to-eat foods widely distributed in the local market of Damanhour City. It is evident that vegetable salad (VS) was heavily loaded with ACC ($48.16x10^6$ cfu/g) followed by cooked macaroni meal (Ma) ($12.66x10^6$ c.f.u/g). For other samples, values ranged from $5.87x10^2$ c.f.u/g for tehina salad (Te) to $38.97x10^5$ c.f.u/g for tamia sandwich (TS). Microbiological count ranges were found to be wide indicating considerable variabilities between foods from different vendors (**Kubheka *et.al.*, 2001**). Microbiological studies carried out on street-food vending in several developing countries have repoted high bacterial counts in foods (**Bryan *et.al.*, 1988; 1992a, b, c, 1997; Umoh and Odoba, 1999 and Kubheka *et.al.*, 2001**). It is worth to mention that aerobic colony count (ACC) of ready-to-eat foods reflects the microbial content of the raw ingredients, effectiveness of processing, and sanitary conditions during handling, preparation and serving.

During food preparation, vendors invariably left raw materials uncovered on tables which resulted in exposure to dust possibly containing bacterial cells and spores (**ICMSF, 1996and 1998**).

Sandwiches were heavily loaded with aerobic bacteria, this possibly may be due to using contaminated dishes, spoons and knives as well as hands of workers during filling in bread to make the sandwich (**Salem, Zainab, 2004**). Also, the presence of salmonella is though to be a result of contamination from workers (skin, cloths) or equipment. Handling and touching foods when filling sandwiches at ambient temperatures was the most serious hazard (**Ali and Spencer, 1996**).

Medamis and tamia patties have shown a higher level contamination when served as sandwiches rather than unsandwiched possibly due to mixing with highly contaminated salad ingredients in addition to application of improper hygienic practices (**Abd El Baki *et.al.*, 1991**).

Molds and yeasts were not detected in 5 different food items of the 20 tested items (namely; FT, Te, BM, BC and ST), while they were occurred in only 7 of 15 samples of grilled beef meat (GM) (46.7% incidence). Moreover, balady bread (BB) exerted the highest count ($69.5x10^3$ c.f.u/g) followed by VS samples ($25.4x10^3$ c.f.u/g) (Table 2).

As food safety is an important concern on a daily basis, many high risk pathogens that cause diseases in humans are transmitted through various food items (**Todd, 1989**). In general, food borne illness are widespread global problems (**Notermans *et.al.*, 1994**). Outbreaks of disease caused by food borne pathogens such as Salmonella, E.coli, Staphylococcus and others have an enormous impact on public health (**Hagens and Loessner, 2007**). The presence of food born pathogens in cooked foodstuffs may be a result of either under processing or cross-contamination between raw and cooked products (**Moore *et.al.*, 2002**). Also, **Dawson and Canet (1991)** declared that fast foods may be exposed to contamination as they constitutes as rich habitat for microorganisms due to both raw materials used and during cooking, handling practices and unclean utensils.

Results in Table (2) reveals that all tested samples were contaminated with coliforms except the 18 samples of fried tamia patties (FT). The highest mean count was exerted by vegetable salad (VS) ($94.6x10^3$ c.f.u/g) followed by kushary meal (KM) ($21.87x10^3$ c.f.u/g), while battered meat (BM) and chicken (BC)meals were loaded by the least comparative counts ($0.55x10^2$ and $0.6x10^2$ c.f.u/g) respectively.

It is reported by **Kaneko *et.al.* (1999)** that fresh products might be contaminated directly with *E.coli* by feces of employees rather than by vegetables. The presence of *coliforms* in the ready-to-eat food samples indicates poor handling practices of food handlers and cross-contamination in the kitchen or serving sites (**Aljuhni, 2009**).

The battered fried chicken samples were found to have mean ACC and coliform counts of $5.42x10^3$ and $0.6x10^2$ c.f.u/g respectively. The findings of **Ma *et.al.* (2004)** agreed with the present results and these counts were almost within the reported guidelines values for ready-to-eat meals reported by **NAS (1985)**. Stewed bean, kushari and tamia sandwiches were contaminated with coliforms (**El-Bahay, Atiat *et.al.*, 2002**). More than 2/3 kushari samples were contaminated with coliform (more than 10^2 cfu/g) while the total bacterial count was of all samples was ranged between 10^2 to 10^7cell/g.

Table (2) Mean microbiological counts of ready-to-eat foods (cfu/g).

Food item	No. of samples	Microbiological analyses				
		ACC[1]	M&Y[2]	Coliforms	*S. aureus*	*Salmonella spp.*
Beans						
Medamis meal (MM)	18	$8.70x10^4$	$0.42 x10^2$	$48.25 x10^2$	$0.42 x10^2$	$3.15 x10^2$
Medamis sandwich(MS)	18	$36.15 x10^5$	$1.40 x10^2$	$7.35 x10^3$	$5.90 x10^2$	$10.87 x10^2$
Fried tamia patties (FT)	18	$17.75 x10^3$	Nil	Nil	$0.30 x10^2$	$2.30 x10^2$
Tammia sandwich (TS)	18	$38.97 x10^5$	$1.20 x10^2$	$3.00 x10^2$	$3.62 x10^3$	$6.07 x10^2$
Tehina salad (Te)	15	$5.87 x10^2$	Nil	$1.05 x10^2$	Nil	Nil
Cereals						
Kushary meal (KM)	18	$14.00 x10^4$	$1.87 x10^2$	$21.87 x10^3$	$2.65 x10^2$	$8.37 x10^2$
Cooked rice (Ri)	18	$14.92 x10^5$	$3.22 x10^2$	$16.07 x10^3$	$42.75 x10^2$	$0.85 x10^2$
Cooked macaroni (Ma)	18	$12.66 x10^6$	$2.77 x10^2$	$41.80 x10^3$	$11.20 x10^3$	$9.55 x10^2$
Balady bread (BB)	18	$11.11 x10^5$	$69.50 x10^3$	$44.15 x10^2$	$10.70 x10^2$	Nil
Beef meat						
Grilled kofta meal (GK)	15	$85.55 x10^2$	$18.47 x10^2$	$1.03 x10^2$	$2.37 x10^2$	$1.27 x10^2$
Kofta sandwich (KS)	18	$12.25 x10^4$	$37.75 x10^2$	$2.60 x10^2$	$3.98 x10^2$	$3.20 x10^2$
Battered beef meat (BM)	15	$27.05 x10^3$	Nil	$0.55 x10^2$	$0.12 x10^2$	$0.70 x10^2$
Grilled beef meat (GM)	15	$61.50 x10^2$	$4.12 x10^2$	$11.00 x10^3$	$9.25 x10^2$	$0.72 x10^2$
Shawerma sandwich (SS)	15	$10.48 x10^5$	$12.02 x10^2$	$8.20 x10^2$	$16.00 x10^2$	$4.95 x10^2$
Hawawshy loaf (HL)	15	$99.50 x10^4$	$19.85 x10^2$	$5.90 x10^2$	$2.97 x10^2$	$0.72 x10^2$
Chicken meat						
Battered chicken meat (BC)	15	$5.42 x10^3$	Nil	$0.60 x10^2$	$0.28 x10^2$	$75.00 x10^2$
Grilled chicken (GC)	15	$89.75 x10^4$	$2.00 x10^2$	$22.25 x10^2$	$11.50 x10^2$	$9.05 x10^3$
Vegetables						
Cooked mixed vegetables (CV)	15	$40.00 x10^4$	$0.37 x10^2$	$16.67 x10^2$	$6.00 x10^2$	$26.30 x10^2$
Tomato sauce (ST)	18	$2.05 x10^3$	Nil	$22.50 x10^2$	$20.75 x10^2$	Nil
Vegetable salad (VS)	40	$48.16 x10^6$	$25.47 x10^3$	$94.60 x10^3$	$18.00 x10^2$	$61.50 x10^2$

(1) ACC: Aerobic colony count (2) M&Y: Mold and yeast

Salem, Zainab (2004) and **El-Fouly (1989)** recorded 10^4 cell/g of *E.coli* in kushary, addition of sauce to kushari raised its level of contamination with *E.coli*. The presence of *S. aureus* in food constitutes a significant risk of contamination by food handlers and it can be also used as an indicator of cross-contamination **(Mossel and Netten, 1991)**.

Tehina salad (Te) (15 samples) showed their freedom of contamination with *Staphylcoccus aureus* (Table 2). In the same time, such microorganism was detected in only 5 of 18, 6 of 18 and 4 of 18 samples of tested Medamis meal (MM), fried tamia patties (FT) and tomato sauce (ST) respectively with incidence rate of 27.8, 33.3 and 22.2% of the tested samples respectively. Other tested foodstuffs were contaminated by *S.aureus* at different loads ranged between $11.20x10^3$ c.f.u/g for Macaroni (Ma) followed by $42.75x10^2$ c.f.u/g for cooked rice (Ri) and $0.12x10^2$ c.f.u/g for battered beef meat (BM). With agreement with **(Abd el- Baki *et.al.*, 1991)** incidence of *S. aureus* in medamis and tamia and their sandwiches was observed with counts of 10^2-10^4 cell/g.

For *Salmonella spp.*, results in Table (2) declares that all collected samples of three foods (namely; Te, BB and ST) were free of contamination as Salmonella was not detected in any of the tested samples. Also, four of 18 (22.2%) tested samples of Rice (Ri) exerted their freedom of contamination. This means that the total incidence % of *Salmonella* in all tested samples was reached to 84.51% (300 of 355 samples), the other 16 tested food items were found contaminated with *salmonella spp.* at different mean loads ranged between $0.7 x10^2$ c.f.u/g for BM samples to $9.05 x10^3$ c.f.u/g for grilled chicken (GC).

Salmonella cross-contamination occurs frequently through the use of contaminated vegetables that are not correctly cleaned and disinfected **(Mosupye and Van Holy, 1999)**. Manure and other animal wastes widely used as fertilizer raises the concern about possible contamination with microbial pathogens **(I.F.S.T., 1999)**.

Kushary in Cairo and Assiut cities, Egypt was contaminated with total bacteria, *E.coli*, yeast and *S. aureus* at varied levels (**Abd El- Raouf, 1997**).

The results of **Salem, Zainab(2004)** coincided with the results in Table (2) as she noted that tamia (fried product at relatively high temperature) had lower aerobic bacterial counts than medamis, which is subjected to lower temperature during cooking. The same notice was also found for mold and yeast, *coliforms, S. aureus and Salmonella spp.* contaminations indicating the desirable effect of high temperature treatments on reducing the microbiological contamination of fast foods.

Salad ingredients added to the microbial contamination of medamis and tamia sandwiches (**Abd el-Baki *et.al.*, 1991 and Salem, Zainab, 2004**).

It is demonstrated by **Olszewka and Paluszak (2002)** that the presence of bacteria on the equipment used for production of cured meats (used in kofta processing) was conductive to its bacteriological contamination. The microbial loads detected for kofta sandwich (KS) in Table (2) were found in general agreement with the findings of **Salem, Zainab (2004).**

The tomato sauce contained freshly cut herbs and spices that may dictate the microbial quality of the product. The addition of unprocessed spices to prepared sauces has been reported by **Longree and Armbruster (1996)** to cause significant microbial re-contamination. Also, contamination with food contact surfaces was viewed inevitable. In addition, sauce was typically contained in open glasses or bottles or wide –mouth jar, which were usually placed on top of the vending cart together with contaminated foods and surfaces and held at ambient conditions for long periods during vending operations.

Shared environments in contact over time with ready-to-eat, street-purchased foods are of appreciable importance and impact on the safety of such foods. It was achieved by **Kim and Frank (1995)** that pathogenic bacteria can attach to and grow on various surfaces commonly found in food processing plants. As the various cooking /preparation stages of fast /street foods were considered points of microbial controls, means of different microbial counts of surface swab samples collected to assess potential cross-contamination of foods are shown in Table (3). It is evident that cloths and hands of workers are highly loaded with aerobic bacteria as their loads reached to $28.3x10^8$ and $71.50 x10^7$ cfu/cm^2 respectively. Other surfaces were contaminated at less counts ranged between $3.83 x10^2$ and $88.90 x10^6$ cfu/cm^2 of pans and trays and tables surfaces respectively. Only two of the surfaces; namely interior wall and tables surfaces were loaded by $14.48 x10^2$ and $81.75 x10^2$ cfu/cm^2 of mold and yeast, while the other seven tested surfaces showed their freedom of mold and yeast contamination. The surfaces of interior wall and plates and dishes were found lightly contaminated with coliforms as their loads were les than 10 cfu/cm^2 (Table 3), while other tested surfaces were contaminated by different loads ranged between 0.47 $x10^2$ and $7.46 x10^4$ cfu/cm^2 for pans and trays and cloths of workers respectively. For *S. aureus* contamination, six surfaces (interior walls, tables, cutting boards, pans and trays, plates and dishes and cutlery) were loaded by light counts (less than 10 cfu/cm^2), while the other three surfaces (hands and cloths of workers and grill surface) were contaminated by s. aureus with counts in the range 10^2- 10^3 cfu/cm^2. The same results points out that interior wall surfaces were free of contamination with *Salmonella spp.*, while working surfaces (tables, cutting boards and grill) were loaded by Salmonella with counts of 10^2- 10^3 cfu/cm^2. Other surfaces (cloths and hands of workers, pans and trays, plates and dishes and cutlery were highly contaminated (less than 10 cfu/cm^2) with Salmonella (Table 3).

Additional bacterial contamination may have occupied at vending sites during cutting (meat and poultry) and chopping (vegetables) using the same knife without in-between cleaning resulting in cross-contamination between the different food types (**Bryan, 1988**). Moreover, the utensil would be left on the table and used again

later either for mixing or dishing out food without first being cleaned which would have resulted in the re-introduction of bacteria into cooked foods (**Mosuoye and van Holy, 2000**). The high bacterial load observed for swabs of cutting boards, plates and dishes and cutlery may be attributed to that these surfaces had been washed several times in the day using the same stored water. Also, the frequent use of the same cloth for wiping down food preparation surfaces may result in contamination (**Cogan *et.al.*, 1999**).

Table (3) Mean microbiological counts of surfaces in contact with ready to eat foods (c.f.u /cm^2)

surface	No. of samples	ACC[1]	M&Y[2]	Coliforms	*S. aureur*	*Salmonella spp.*
Workers	49					
Hands of workers	24	$71.50x10^7$	Nil	$5.00x10^2$	$0.18x10^2$	$<10^1$
Cloths of workers	25	$28.33x10^8$	Nil	$7.46x10^4$	$0.53x10^2$	$0.50x10^2$
Interior walls Surface	12	$15.87x10^4$	$14.48x10^2$	$<10^1$	10^1	Nil
Working surfaces	68					
Tables	26	$88.90x10^6$	$81.75x10^2$	$4.50x10^2$	$<10^1$	$0.11x10^2$
Cutting boards	30					
Grill surface	12	$17.82x10^5$	Nil	$33.55x10^2$	$<10^1$	$0.14x10^2$
		$5.87x10^2$	Nil	$2.25x10^2$	$2.55x10^2$	$3.07x10^2$
Containers	62					
Pans & trays	32	$3.83x10^2$	Nil	$0.47x10^2$	$<10^1$	$<10^1$
Plates & dishes	30	$24.00x10^4$	Nil	$<10^1$	$<10^1$	$<10^1$
Cutlery (spoons, Knives and forks)	20	$21.30x10^6$	Nil	$6.85x10^2$	$<10^1$	$<10^1$

(1) ACC: Aerobic colony count (2) M&Y: Mold and yeast

Shojaei *et.al.* (2006) stated that if food handlers are trained to monitor strict hand-washing program (especially after toilet), the removal of transient pathogenic microorganisms from hands and fingertips is assured. They added that hand washing may seen trivial to the food staff. Also, cloths of workers were found heavily contaminated as 48 and 52% of swab samples respectively were loaded by aerobic bacteria at high counts (10^7 -10^8 and more and 10^8 cfu/cm^2 respectively. **Jacobs- Reitsma (1997)** emphasized that defective personal hygiene could facilitate the transmission of pathogens via food to humans.

The results of microbiological analysis of water used in the different preparation, cooking and other activities in street food establishments (18 samples of running water and 9 samples of stored water) were presented in table (4). It could be noticed that stored water was highly contaminated with aerobic bacteria (ACC)(mean count, $22.36x10^5$ cfu/ml) compared to running water ($17.74x10^2$ cfu/ml). Coliforms and *S.aureus* contaminations were found at slight counts (less than 10 cfu/ml) in both running and stored water. Moreover, mold and yeast and *Salmonella spp.* contamination were not detected in all examined samples. (Table 4).

In conclusion, it could be said that microbial contamination of ready-to-eat foods may be expected for several reasons. These foods are mostly handled without packaging and were prepared, cooked and served manually. Sources of contamination are varied and differential such as polluted raw materials; equipments; water; air; worker's hands, cloths and hair; beside the sick, dirty and wounded or postulated workers. In addition, cross-contamination will occur during vending and solding processes (post-cooking or preparation contaminations).

Table (4) Mean microbiological counts of water used in ready-to-eat premises (c.f.u /ml) .

Water source	No. of samples	ACC[1]	M&Y[2]	Coliforms	*S. aureur*	*Salmonella Spp.*
Running (tap) water	18	$17.74x10^2$	Nil	$<10^1$	$<10^1$	Nil
Stored water	9	$22.36x10^5$	Nil	$<10^1$	$<10^1$	Nil

(1) ACC: Aerobic colony count (2) M&Y: Mold and yeast

Appropriate control measures during processing, adequate hygiene standards, and sufficient cooking during final preparation should ensure that the end products are free (as possible) from viable microorganisms and that the foods are therefore of good microbial quality. In this respect, the use of HACCP system improved the microbiological safety and quality of ready-to-eat foods during processing and serving.

Finally, much efforts must ongoing to improve the microbiological quality and safety of street, fast, ready-to-eat foods prepared and /or cooked, vended in such establishments.

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الملخص العربي

الجودة الميكروبية لبعض أطعمة الشارع بالسوق المحلى بمدينة دمنهور – محافظة البحيرة – جمهورية مصر العربية

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تهدف الدراسة الى تقييم الحالة الميكروبية لعشرين صنف من أطعمة الشارع الجاهزة للاستهلاك والمنتشرة بمدينة دمنهور ـ محافظة البحيرة. اشتملت الدراسة على تقييم لمدى التلوث العارض المحتمل لتلك الأطعمة والذي يصيبها خلال عمليات اعدادها وتداولها مثل الاسطح الملامسة والمياه المستخدمة في جميع خطوات العمل.

تشير النتائج الى تلوث الأطعمة الأطعمة المختبرة بأعداد متباينة من البكتريا وفطريات العفن والخمائر. ويتراوح متوسط عدد البكتريا الهوائية بين ٥.٧٨ × ١٠ ٢ الى ٤٨.١٦× ١٠ ٦ خلية / جرام (في سلطة الطحينة والسلطة الخضراء على التوالي)، كما لوحظ تلوث ١٥ صنف من الأطعمة المختبرة بالخمائر والفطريات حيث كان الخبز البلدي أعلاها تلوثاً (٦٩.٥×١٠ ٣ خلية /جرام). بالإضافة لذلك ... فقد توصلت النتائج الى تلوث معظم العينات بواحد أو أكثر من البكتريا المرضية حيث تراوحت أعداد البكتريا القولون الملوثة بين ٠.٥٥× ١٠ ٢ خلية جرام في وجبة اللحم المحمر والسلطة الخضراء على التوالي. أظهرت سلطة الطحينة خلوها من التلوث البكتريا المرضية S.aureas، بينما تلوثت جميع الأطعمة المختبرة الأخرى بتلك البكتريا بأعداد ونسب تواجد متباينة، كما وصلت نسبة العينات الملوثة ببكتريا السالمونيلا الى ٨٤.٥% بينما خلت جميع العينات المختبرة من سلطة الطحينة، الخبز البلدي، صلصة الطماطم من التلوث بتلك البكتريا المرضية.

توضح النتائج تلوث جميع الاسطح الملامسة للغذاء بالبكتريا الهوائية بأعداد متناهية تتراوح بين٣.٣٨×١٠ ٢ الى ٢٨.٣٥ × ١٠ ٨ خلية /جرام للأيدي العاملة وملابسهم على التوالي، كما تلوثت معظم الاسطح الملامسة للغذاء بالبكتريا المرضية (بكتريا القولون، S.aureasوالسالمونيلا). تحتوي أيدي وملابس العمال على واحد أو أكثر من البكتريا المرضية. يلقى المعدل العالمي لتلوث الاسطح الملامسة الضوء على الحاجة الى اتباع برنامج مطور للنواحي الصحية الشخصية كخطوة هامة لتأمين سلامة الغذاء.

تشير النتائج الخاصة بالحالة الميكروبية للمياه المستخدمة الى ارتفاع مدى تلوث الماء المخزن (مقارنة بالماء الجاري) بالبكتريا الهوائية. تتواجد بكتريا القولون والسالمونيلا بأعداد بسيطة في كلا النوعين من المياه، بينما خلا النوعين من التلوث بفطريات العفن والخمائر وبكتريا السالمونيلا

يلخص البحث الى ان للتلوث الميكروبي للأطعمة الشارع الجاهزة أسباب وطرق ومصادر متعددة ومتباينة، كما يمكن ان تتلوث تلك الأطعمة عارضة اثناء عمليات الاعداد والتقديم والبيع .