Assessment of Hand Washing Facilities, Personal Hygiene and the Bacteriological Quality of Hand Washes in Some Grocery and Dairy Shops in Alexandria, Egypt

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ABSTRACT

Food produced with satisfactory hygienic standards is one of the essential conditions for promoting and preserving health. A total of 15 grocery and dairy shops were randomly selected from Alexandria, Egypt to assess their hand washing facilities and personal hygiene of food handlers using a pre-designed sanitation checklist. Also the bacteriological profile of the handlers’ hand washes was determined. Only 20% of these shops were acceptable concerning their hand washing facilities (≥ 50% score percentages). Observing 29 food handlers revealed that only 3.4% of them were acceptable in their personal hygiene with a mean score percentage of only 31.0 ± 9.2. Although the hand washing method followed by the food handlers significantly decreased both aerobic mesophilic and staphylococci counts, they were still high. Moreover, fecal coliforms increased insignificantly from 5 to 7 MPN/100ml indicating that the hand washing was improperly done due several pitfalls. Most of the handlers who washed their hands for less than 10 seconds (41.4%) had higher counts of aerobic mesophiles and staphylococci than those who washed for more 10 seconds. Most of the handlers (93.1%) did not avoid contamination from the tap after hand washing.
Moreover, their hand washes were contaminated with fecal coliforms (8 MPN/100ml) and with slightly higher staphylococci counts than those who avoid contamination either by rinsing a tap or closing it by elbow. Recommendations: Much effort should be done from the responsible authority to improve the sanitation inside these shops and food handlers should be given in-service training to know how to efficiently wash their hands.

**Key words:** Dairy shops, sanitation checklist, hand washing, personal hygiene, food handlers, hand washing, staphylococci.

**INTRODUCTION**

Food elaborated with satisfactory hygienic standards is one of the essential conditions for promoting and preserving health, and inadequate control is one of the factors responsible for the occurrence of foodborne disease outbreaks.[1] Milk and milk products were the highest incriminated foods in microbial food poisoning outbreaks admitted to Alexandria Poison Center from 1991-1994 (915 cases) and from August 1997 till July 1998 (103 cases).[2,3] The increasing number of food poisoning outbreaks has led to calls for better hygiene and quality practices.[4] A study on 30 supermarkets in Alexandria reported that only 13% of them were acceptable concerning personal hygiene.[5]

Poor personal hygiene by food handlers frequently contributes to outbreaks of foodborne illnesses caused by *Staphylococcus aureus* (*S. aureus*) and gram negative bacilli such as *Salmonella* spp., *Shigella* spp., *Campylobacter jejuni*, Enterotoxigenic *E. coli* as well as viral agents, such as hepatitis A, and Norovirus.[6-8] The importance of hand hygiene in the control of infection cannot be under-emphasized.[9] Although hand-washing may seem trivial to the food staff, failing to do it can have tragic consequences.[10] It is generally accepted that the
hands of food handlers are an important vehicle of food cross-contamination and that improved personal hygiene and scrupulous hand washing would lead to the basic control of feces-to-hand to-mouth spread of potentially pathogenic transient microorganisms.\(^{(11,12)}\)

Microorganisms on the human skin can be divided into two groups: permanent and transitory; and the only pathogenic microorganism in the permanent group of bacteria associated with the human skin is \textit{S. aureus}. It is not possible to fix an acceptable contamination level for \textit{S. aureus} after proper hand washing.\(^{(13)}\) Detection and enumeration of indicator organisms are widely used to assess the efficacy of sanitation programs.\(^{(14)}\) Indicator organisms associated with hygiene practices include, amongst others, total viable counts, total coliforms, \textit{E. coli}, members of the family Enterobacteriaceae and \textit{S. aureus}.\(^{(15)}\)

People in the food production and foodservice industries should be well trained and motivated to follow good personal hygiene practices, to use correct hand washing procedures and to follow these procedures while working in order to prevent the spread of infection.\(^{(16)}\) The aim of the current study was to assess the sanitary condition of the hand washing facilities in some grocery and dairy shops in Alexandria and the level of personal hygiene among their food handlers. Also it was designed to explore the level of hand bacterial contamination of food handlers and evaluate the effectiveness of their commonly used hand-washing method in reducing hand contamination levels.

**MATERIAL AND METHODS**

A total of 15 shops were randomly selected from five zones of Alexandria (El-Montazah, East, Middle, West and El-Gomrouk)
where three shops were selected from each zone. For each shop, the following methods were conducted:

1- Assessment of hand washing facilities and personal hygiene of the food handlers.
2- Determination of the bacteriological profile of the handlers’ hand washes.

1. Assessment of hand washing facilities and personal hygiene of the food handlers

A pre-designed sanitation checklist was used for investigating two main parameters in each shop:

- Hand washing facilities.
- Personal hygiene of the food handlers.

• Hand washing facilities

This parameter was evaluated through inspecting the hand washing sink in each shop for the following items:

- Sink condition and design (sink material, curved corners, cleaning, designed solely for hand washing, its repair status and tap design).
- Water and cleaning agent.
- Hand drying method.
- Availability of posters demonstrating proper hand washing and drying.

• Personal hygiene

This parameter was evaluated through observing 29 food handlers who were in direct contact with the food products for the following items and sub-items:

- Health certificates (presence and validity).
- Uniform (head covering, protective clothing, footwear).
- Hands (clean hands, nails, presence of wounds, jewelry and gloves).
- Effective hand washing where each handler was observed during his usual followed way to wash and dry hands with special attention to the following:
  - Friction of the hands, and whether it covered three important areas namely between fingers, the finger tips and around the wrist.
  - Using a detergent.
  - Period of hand washing (seconds).
- Avoidance of post washing contamination from taps.
- Hand drying.

All questions in the checklist were either yes/no questions or multiple options. Each yes/no question was scored by giving one for the right item and zero for the wrong one. The multiple options questions were scored from 0 to 5 with higher scores for better options. The score of each parameter was calculated by summing the scores of its questions that were transformed into percentages. Shops with ≥ 50% score percentages were considered acceptable while those with <50% were unacceptable.[17]

2. Determination of the bacteriological profile of the handlers’ hand washes

Samples from hands of each of the 29 food handlers were collected by asking each one to thoroughly wash his hands in a sterile polyethylene plastic bag containing 100-ml sterile peptone saline (0.1%) focusing on his finger tips, between fingers and around wrist. Then, he was asked to wash his hands in his usual way then to rewash them in another 100-ml sterile
peptone saline (0.1%). Ten fold serial dilutions from each sample were prepared and subjected to the following bacteriological examinations according to the method described in ISO 6687 (1980):^{18}

- **Aerobic mesophilic plate count.** Standard plate count (SPC) agar was drop plated and incubated at 30°C for 72 hours according to ISO/DIS 4833, 1989.\(^{19}\)

- **Enumeration of fecal coliforms** using the most probable number technique (MPN) according to Harrigan (1998).\(^{20}\) Brilliant Green Bile broth was inoculated and incubated at 30°C for 4 hours then at 44 ± 0.2°C for 20 hours and examined for gas production that denoted the presence of fecal coliforms.

- **Enumeration of Coagulase positive Staphylococci** according to ISO/CD 6888-1 (1995).\(^{21}\) Baird-Parker agar base supplemented with egg tullerite emulsion was surface plated and incubated at 35-37°C for 48 hours. The suspected colonies were transferred into brain heart infusion, incubated for 24 hours at 37°C and subjected to tube coagulase test according to Collee et al., (1989).\(^{22}\)

**Statistical Analysis**

Data was statistically analyzed using SPSS program version 9.0. The cutoff point for statistical significance was P value <0.05 and all tests were two-sided. Kruskal-Wallis test was used for comparing bacterial counts (aerobic mesophiles, staphylococci and fecal coliforms) and score percentages of the two parameters among different zones of Alexandria. Monte Carlo proportion was used for comparing the percentages of acceptable shops and handlers among different zones. Paired samples t test was used
to compare between mean bacterial counts before and after hand washing while McNemar test was used to compare between samples contaminated with fecal coliforms or coagulase positive staphylococci. Spearman test was used to measure the correlation between mean bacterial counts and mean score percentages given to the used detergent, friction during washing, period of washing and avoidance of post washing contamination.\(^{(23)}\)

**RESULTS**

Table (1) shows that only 20% of the visited shops were acceptable concerning the parameter of hand washing facilities with a mean score percentage of 39.2 ± 13.8. Moreover, none of the shops in El-Montazah, West and El-Gomrouk were acceptable. Higher acceptable percentages were found among two of its items, 53.3% in sink condition and design and 40% in the water and cleaning agent with higher mean score percentages (50.9 ± 24.7 and 51.1 ± 28.5 respectively). There were insignificant differences among different zones in the mean score and acceptable percentages of the hand washing facilities. A hand drying method or a poster demonstrating proper hand washing was not available near the sink of any visited shop.

Table (2) demonstrates that only 3.4% of the observed 29 handlers were acceptable in personal hygiene with a mean score percentage of 31.0 ± 9.2. Among its items, avoidance of post washing contamination had the lowest acceptability (3.4%) and none of the observed handlers wore acceptable uniforms with the lowest mean score percentages (4.1 ± 18.8 and 5.6 ± 12.2; respectively). The highest percentages of acceptable personal hygiene of handlers (65.5%) were in the presence of valid health
certificates with the highest mean score percentages (65.5 ± 48.4). There were insignificant differences among different zones except in the mean score of both uniform and hand drying as well as in the percentages of acceptable handlers in hand drying and using a detergent (p<0.05).

Table (3) shows the bacteriological profile of hand washes before and after ordinary hand washing. Ordinary hand washing regimes practiced by the food handlers improved the bacteriological profile of their hand washes except the percentages of coagulase positive staphylococci in East and EL-Gomrouk zones that remained constant after washing (28.6% and 14.3% respectively). The percentage and level of contamination with fecal coliforms in the Middle zone worsened and increased to 40% and 50 MPN/100ml respectively. Also the level of contamination of all samples with fecal coliforms increased insignificantly from 5 to 7 MPN/100ml. There were insignificant differences in either the mean bacterial counts or percentages of samples contaminated with coagulase positive staphylococci and fecal coliforms among different zones except in case of staphylococci count before hand washing.

Table (4) illustrates that most of the food handlers (48.3%) washed their hands using bar soap followed by those who did not use any detergent (34.5%) with approximately similar bacteriological profile of their hand washes. They were contaminated with mean fecal coliform counts of 6 and 14 MPN/100ml respectively. The bacteriological profile of the hand washes of the two handlers (6.9%) practicing friction between fingers, finger tips and around wrist and the five handlers (17.2%) who rubbed two areas was approximately similar and better than those either not practicing rubbing at all (41.4%) or
rubbed only one area (34.5%). Most of the handlers who washed their hands for less than 10 seconds (41.4%) had higher counts of aerobic mesophiles ($4.3 \times 10^6$ CFU/100ml) and staphylococci ($8.5 \times 10^5$ CFU/100ml) than those who washed their hands either for 20 seconds and more ($2.4 \times 10^6$ and $7.1 \times 10^5$ CFU/100ml respectively) or for 10-19 seconds ($1.9 \times 10^6$ and $3.3 \times 10^5$ CFU/100ml). The Majority of the handlers (93.2%) did not avoid contamination during closing the tap and their hand washes were contaminated with fecal coliforms (8 MPN/100ml) and slightly higher staphylococci counts ($6.8 \times 10^5$ CFU/100ml) than those who avoided contamination either by rinsing the tap or closing it by elbow ($6.0 \times 10^5$ and $2.0 \times 10^5$ CFU/100ml respectively). There were insignificant differences among the mean bacterial counts in hand washes collected either after using different types of detergents, friction regimes, periods of washing, or after different ways to avoid post washing contamination. There were negative correlations between mean fecal coliform counts and mean score percentages of all items of effective hand washing, between staphylococci counts and both of the periods of washing and avoidance of post washing contamination as well as between aerobic mesophilic counts and both of the periods of washing and friction during washing.

**DISCUSSION**

Food handlers are an important vehicle for microorganisms and improper handling practices may cause food contamination and consequently foodborne diseases, which pose a potential risk to public health.\(^{(1)}\) The present study revealed that the visited 15 grocery and dairy shops in Alexandria confronted problems in both sanitation of their hand washing facilities and
personal hygiene where only one fifth of these facilities and about three percent of their handlers were acceptable. Also, their followed ways to wash hands were not proper since the microbial contamination level though reduced was still high.

**Hand washing facilities**

Hand washing sinks can be sources of pathogenic bacteria because they usually contain stagnant water that supports the growth of microorganisms, which can be transferred to hands during hand hygiene practices. The present study revealed that only 20% of the visited shops were acceptable concerning their hand washing facilities with a mean score percentage of only 39.2. Moreover, about half of the shops had acceptable sink condition and design with a mean score percentage of 50.9. The majority of sinks were unclean, most were made of pottery with a lot of cracks and none of them was used solely for hand washing. Also, one of the shops was not provided with a hand washing sink and washing hands was through using a hose.

Both bar soaps and liquid soaps may become contaminated with bacteria during use, with bar soaps being associated with heavier contamination compared to liquid soaps. However, other studies have suggested that these bacteria are unlikely to be transferred to hands. A lower acceptability percentage (40%) was found in the item water and hand cleaning agent with a mean score percentage of 51.1 since more than half of the sinks were provided with bar soap and none of them was provided with hot water. The FDA specifies that in order to clean their hands, food employees shall use running warm water during their hand washing.

A sign or poster that notifies food employees to wash their hands shall be provided at all hand washing sinks and shall be
clearly visible, also each sink shall be provided with disposable towels or a heated-air hand drying device.\(^{(27)}\) The unavailability of a hand drying method or a poster demonstrating proper hand washing in any of the visited shops contributed in lowering the acceptability and the mean score percentage of the hand washing facilities parameter. It has been reported that all food handlers in 74.1% of the surveyed schools in Brazil did not practice correct hand hygiene, mainly because most of the sinks (81.5%) did not have antiseptic liquid soap or paper towels but instead they were provided with bar soap and cloth towels that are important vehicles for food contamination.\(^{(1)}\)

**Personal hygiene**

The word hygiene usually refers to cleanliness and especially to any practice which leads to the removal or reduction of harmful infectious agents.\(^{(9)}\) A study in the USA suggested that improper food handling practices in food serving establishments contributed to 97% of foodborne illnesses, thus employees should pay attention to their personal hygiene.\(^{(28)}\) The level of personal hygiene in the visited shops needs rapid intervention from both of the responsible authorities and food handlers to ensure the safety of their food products. The mean score percentage of this parameter was only 31 with a very low percentage of acceptability among shops (3.4%). This can be attributed to several serious defects in the uniform, hand washing, avoidance of post washing contamination and hand drying items.

None of the observed handlers wore acceptable uniforms with a mean score percentage of 5.6 since few handlers wore clean and light colored uniforms. Others reported that only 6.7% of the food handlers were wearing clean light colored uniform.\(^{(5)}\)
Many of the studies conducted have proven that it is imperative to care about personal hygiene, and especially hand cleanliness.\textsuperscript{(29,30)} Hand-washing which is a simple and effective way to cut down on cross-contamination is too often forgotten.\textsuperscript{(31)} It seems that the hand washing method followed in the present study was improper since its mean score percentage was only 39.2, and the practices of less than one third of the handlers (31\%) were acceptable. All observed food handlers washed their hands with tap water, about half of them (48.3\%) used bar soap and friction of the hand areas (between fingers, finger tips, around wrist) was either not practiced at all (41.4\%) or only one area was rubbed (34.5\%). Moreover, only 37.9\% of the observed handlers washed their hands for more than 20 seconds. The US FDA stated that food employees shall clean their hands and exposed portions of their arms for at least 20 seconds while paying attention to removing soil from underneath the fingernails and creating friction on the surfaces of the hands and arms, finger tips, and areas between the fingers.\textsuperscript{(27)}

It is worth mentioning that the majority of the observed handlers failed to avoid contamination of their hands after washing (93.1\%) and the rest used to either closing the tap by elbow or rinsed the tap with water alone that is considered insufficient to remove the microbial contaminants. To avoid recontaminating hands after washing, food employees may use disposable paper towels or similar clean barriers when touching surfaces such as manually operated faucet handles.\textsuperscript{(27)}

Hand drying is an essential component of effective handwashing. Damp hands as a result of ineffective hand drying can lead to skin excoriation which in turn leads to higher numbers of bacteria colonizing the skin and facilitating the
spread of microorganisms. Less than half of the observed handlers (48.3%) had acceptable level concerning their hand drying with a mean score percentage of 33.1 since most of them dried their hands either in papers used for wrapping food products, in a piece of clothes or in a yellow towel where their microbial quality is questionable and requires further studies. Cloth towels are not recommended because of evidence that microorganisms are less effectively removed. There is also the risk of cross contamination. Soft, absorbent paper towels are more acceptable to users and may contribute to compliance with hand hygiene recommendations.

None of the observed handlers wore gloves during handling of food products but instead use bare hands, knives or the wrapping plastic sheaths. A considerably significant amount of bacteria have been found on bare hands compared with the amount of bacteria on gloved hands. In 2003, the investigation of 18 dairy shops in Alexandria showed that all food handlers used ungloved hands during handling of dairy products. So much efforts are required from the responsible food control authority to enforce careful use of gloves.

**Bacteriological profile of the handlers’ hand washes**

Microorganisms are transferred to the hands in the process of handling food and through poor personal hygiene resulting in the hands being heavily contaminated with enteric pathogens. Although the hand washing method followed by the food handlers significantly decreased both aerobic mesophilic and staphylococci counts, they were still high. Moreover, fecal coliforms increased insignificantly from 5 to 7 MPN/100ml indicating that the hand washing was improperly done due to several pitfalls in one or more of the followings; the type of the
used detergent, friction regimes during hand washing, the period of hand washing or avoidance of post hand washing contamination. A study in Iran (2006) reported that correct hand hygiene resulted in a microbial reduction from 72.7% to 32%.

Most of the observed handlers washed their hands either without any detergent at all (34.5%) or used bar soap (48.3%) where washes collected after their hand washing were contaminated with mean fecal coliform counts of 14 and 6 MPN/100ml; respectively.

Regarding friction regimes during hand washing, about three quarters of handlers were either not practicing rubbing between fingers, finger tips and around wrist or rubbed only one area. Their hand washes were contaminated with higher aerobic mesophilic and staphylococci counts than washes collected from those who rubbed three or two areas. Also they were contaminated with mean fecal coliform counts of 20 and 5 MPN/100ml; respectively. Detection of fecal coliforms characterizes a situation of potential risk, owing to the interrelation of these bacteria and the possible occurrence of enteric pathogens.

Concerning the period of hand washing, 41.4% of the handlers washed their hands for less than 10 seconds while 20.7% washed for 10-19 seconds and those who washed for less than 10 seconds were contaminated with higher counts of aerobic mesophilic and *staphylococci* than those who washed their hands either for 20 seconds and more or for 10-19 seconds but without significant variations among them. Washes collected after hand washing for these three periods were unfortunately contaminated with fecal coliforms ranging between 5 and 8 MPN/100ml. This suggests a problem of post hand washing
contamination that was unfortunately observed among 93.1% of the handlers where their hand washes were contaminated with a mean fecal coliform count of 8 MPN/100ml.

Staphylococci are ubiquitously distributed in the environment and strains present in the nose often contaminate the back of hands, fingers and face, and nasal carriers could therefore easily become skin carriers.\(^{(35)}\) Although the hand washing followed in the present study reduced the contamination with coagulase positive Staphylococci, 10.3% of the hand washes were still contaminated. Information from staphylococcal food poisoning outbreaks indicates that strains of *Staphylococcus aureus* isolated from specimens of vomitus and faeces were identical with those from the implicated food and from the hands and often the nose of a food handler.\(^{(36)}\)

Fecal coliforms are among the transient hand flora that can be easily removed by hand washing.\(^{(9)}\) Their presence indicates fecal contamination and food handlers are not taking enough care in hand hygiene.\(^{(13)}\) The hand washing regime followed by the food handlers in the present study failed to free their hands from the fecal coliforms but instead it increased the percentage of contaminated hand washes to reach about 14%. This can be attributed to either inefficient hand washing or post hand washing contamination. Another study reported that *Escherichia coli* was isolated from 7.8% of the hand samples.\(^{(37)}\)

**RECOMMENDATIONS**

Much effort should be done from the responsible authority to improve the sanitation inside the grocery and dairy shops in Alexandria focusing on personal hygiene of their handlers. Food handlers should be given in-service training to know how to efficiently wash their hands.
REFERENCES


