

Knowledge and attitudes in food safety and the occurrence of indicator bacteria on hands of food handlers at the point of pastrami sale

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Abstract: The aim this study was to evaluate food safety knowledge and attitudes of food handlers and to determine the presence of indicator bacteria on the hands of food handlers in the pastrami retail points in Kayseri, Turkey. Food handlers were interviewed and the samples were taken from their hands by touching the petri dishes. Food handlers' knowledge and attitudes were evaluated by questionnaires and checklists. Conventional methods were followed for microbiological analyses. The presence of total coliforms, *E. coli*, members of the family Enterobacteriaceae and *S. aureus* on the hands of food handlers were analyzed. Results indicated that coliforms were present in 37.3% of food handlers hands and 32% exceeded the limit when compared to the literature suggesting a target value of <2.5 cfu/cm². *E. coli*, Enterobacteriaceae and *S. aureus* were present in 10.6%, 44.6% and 34% of handler's hands, respectively. Food safety knowledge evaluation received high scores with mean score of 69.06%. Only one handler was below the score of 50%. Despite the high scores on food safety knowledge, high numbers of hand samples were found to be contaminated with pathogens. Data obtained from this study reveal that despite their adequate food safety knowledge, food handlers on pastrami retail points were found insufficient for implementation. Therefore, it is not only sufficient to provide food safety trainings but also the sources of problems, such as lack of hygiene infrastructure, in the practice should be identified and resolved in retail points.

Keywords: Food handler, food safety knowledge, indicator bacteria, pastrami.

Pastrıma satıř noktalarındaki gıda alıřanlarının gıda gvenlięi bilgi ve tutumları ve ellerindeki indikatr bakteri varlıęının belirlenmesi

zet: Bu alıřmanın amacı, Kayseri'de bulunan pastrıma satıř noktalarındaki gıda alıřanlarının gıda gvenlięi bilgi ve tutumlarını deęerlendirmek ve ellerindeki indikatr bakterileri varlıęını tespit etmektir. Gıda alıřanlarıyla grřlmř ve alıřanların ellerinden petrilere dokundurularak rnek alınmıřtır. Gıda alıřanlarının gıda gvenlięi bilgi ve tutumları, anketler ve kontrol listeleri ile deęerlendirilmiřtir. Mikrobiyolojik analizler iin geleneksel yntemler takip edilmiřtir. Gıda alıřanlarının ellerinde total koliform, *E. coli*, Enterobacteriaceae trleri ve *S. aureus* analiz edilmiřtir. Elde edilen sonulara gre gıda alıřanlarının %37,3'nn el rneklerinde koliform bulunmuř ve %32'sinin literatrde koliformlar iin limit deęer olarak belirtilen <2,5 cfu/cm²'yi ařtıęı belirlenmiřtir. *E. coli*, Enterobacteriaceae trleri ve *S. aureus*, gıda alıřanlarına ait el rneklerinin sırasıyla % 10,6, % 44,6 ve % 34'nde bulunmuřtur. Gıda gvenlięi bilgi deęerlendirme anket alıřması, ortalama % 69,06 skoru ve % 50 puanın altında tek gıda alıřanı ile yksek puanlar almıřtır. Gıda gvenlięi bilgisine dair yksek puanlara raęmen, gıda alıřanlarına ait el rneklerinin patojenlerle kontaminasyon dzeyleri olduka yksek bulunmuřtur. Bu alıřmadan elde edilen veriler, Trkiye'de pastrıma satıř noktalarında alıřanların gıda gvenlięi hakkında yeterli bilgiye sahip olmalarına raęmen uygulama noktasında yetersiz kaldıklarını ortaya koymaktadır. Dolayısıyla sadece gıda gvenlięi eęitimi vermek yeterli olmamakta, satıř yerlerindeki hijyen altyapı yetersizlięi gibi uygulamadaki aksaklık nedenlerinin de belirlenerek zlmesi de gerekmektedir.

Anahtar szckler: Gıda alıřanı, gıda gvenlięi bilgisi, indikatr bakteri, pastrıma.

Introduction

Pastrami is a raw, cured, edible paste coated and commonly consumed ready-to-eat (RTE) meat product in Turkey. It is often sliced now of sale by food handlers. RTE products that have been associated with several outbreaks are recognized to be contaminated during slicing (32).

Food borne diseases remain the significant public health problem although improvements in health systems and the increase in food hygiene training programs in developed countries. A report from the USA indicates annually 76 million food borne diseases with 5200 cases of mortality (6).

Food handlers should have the necessary knowledge and skills to enable them to apply hygiene practices that are obligatory in EU (27). According to EU regulation no: 852/2004 on the hygiene of food staff, it is required for food handlers to be trained on food hygiene according to their work activities. Besides, food business operators are required to ensure the hygiene requirements at all stages of food production (34). Hence, great emphasis on managers was underlined to provide food hygiene training program for food handlers and to monitor their performance at work place (19). Previous data on risk factors for food borne disease suggest that, most of the outbreaks occur through undesirable food handling practices of food handlers that cannot be easily overturned, even by the training programs (9,16,37,38).

Presences of indicator organisms are commonly used to evaluate the effectiveness of the sanitation programs (17,30). Some pathogens including *S. aureus* and *E. coli* have shown to survive on hands and surfaces even for days after the contact with the organism (20,22).

The safety of pastrami should be guaranteed in every stage of food chain to protect public health. Lack of knowledge or negligence of food handlers are predisposing factors in increasing prevalence of food borne disease. Assessment of food handler's knowledge and practices are essential to provide required data for further action that are previously studied by some other reporters (4,19,21,27,28,40). There is need to understand all factors contributing to poor hygiene practices at the point of sale. Therefore, this study is designed to evaluate the food handling attitudes and food safety knowledge of pastrami handlers and to highlight the importance of hand hygiene in pastrami contamination in Kayseri, Turkey.

Materials and Methods

This study was designed among pastrami handlers at retail points where pastrami is often sliced at moment of sale in Kayseri, Turkey. Total of 150 retail points located in city center were visited. Samples were collected from 150 food handler's forefingers and thumps during working

hours without previous notification and were transported to laboratory in a cool box.

Rodac plates containing Baird Parker Agar (Merck 1.05406) with Egg-yolk Tellurite emulsion were used to sample forefingers for *S. aureus* enumeration. Agar plates were incubated at 35°C for 24-48 h and black colonies with clear zones around were evaluated after being confirmed with coagulase test (3). *S. aureus* ATCC 25923 was used as positive control.

Rodac plates containing Chromocult Coliform Agar (Merck 1.10426) were used to sample thumbs; to enumerate total coliforms, *E. coli* and members of Enterobacteriaceae family. Plates were incubated at 35-37 °C for 24 h and colonies were differentiated presumptively on the basis of their appearance and color. In this context, colonies salmon to red in color were reported as total coliforms, dark blue to violet as *E. coli* and colorless ones as members of Enterobacteriaceae family (5,11).

A checklist was formed to evaluate food hygiene level in the establishments. Fourteen food construct items were selected including food handlers attitudes (4 items) and retail store conditions (10 items). The checklist was aiming to determine the food safety attitude of food handlers depending on the observations of the interviewer. Additionally, two questionnaires, modified from previous studies, were designed to determine the food safety knowledge and demographic characteristics of food handlers (14,28,40). The emphasis was put on hygiene practices, personal hygiene, food borne disease and temperature control. Handlers with the correct answers lower than 10 for 16 questions ($\geq 62.5\%$ accuracy) were considered to have "insufficient" knowledge and those with scores greater than 10 points were reported to have "Good" knowledge.

The population of the study consisted of 468 active markets and delicatessens operating in the central districts of Kayseri. Previsit observations revealed that almost half of the markets were retailing pastrami (N = 234). In the study, it was calculated that at least 145 retail points should be taken by using stratified sampling method according to districts with 95% confidence interval. The sample size of the study was determined as 150 pastrami retail points throughout Kayseri (41).

Calculation of sample size (n0) is given in the following equation;

$$n_0 = \frac{Nt^2pq}{d^2(N-1) + t^2pq} = \frac{234(1.96)^2 0.5 * 0.5}{0.05^2(234-1) + (1.96)^2 * 0.5 * 0.5} \cong 145$$

Representation power: 150/234=0,64

N = Population size; t-table value for t = 95% confidence interval = 1.96; p, q = The frequency of occurrence of the event of concern, agent being (+) and (-) p = 0.5, q = 0.5; d = Deviation according to the frequency of occurrence.

Table 1. Hand hygiene profiles of food handlers.

| Microorganisms | n | No. of positive samples (%) | No. of positive samples exceeding the target value (cfu/cm ²) |
|-----------------------------|-----|-----------------------------|---|
| <i>Enterobacteriaceae</i> * | | 67 (44.6) | - |
| Coliforms | 150 | 56 (37.3) | 48 (32) ≥ 2.5 |
| <i>E. coli</i> | | 16 (10.6) | 16 (10.6) >1 |
| <i>S. aureus</i> * | | 51 (34.0) | - |

n: Total number of hand samples from different pastrami store.

*: No target value

Results

No target values were found in Turkish Food Codex for bacteriological counts on food handlers hands. Therefore, only coliforms and *E. coli* positive samples were compared to the literature target values of ≥ 2.5 cfu/cm² and ≥ 1 cfu/cm², respectively. Table 1 summarizes the microbial contaminations on hands of pastrami food handlers.

When demographic characteristics of food handlers were considered, all food handlers (100%) analyzed were male. Approximately two third of the participants (65.2%) were aged between 25 and 45 years. Most of them were married (82.6%) and the education level of largest group (47.3%) was primary school. Two third of the participants had the experience more than 10 years on their work. The demographic characteristics of pastrami food handlers were presented in Table 2.

Table 2. Demographic characteristics of pastrami food handlers.

| Characteristics | N | % |
|--------------------|-----|------|
| Gender | | |
| Male | 150 | 100 |
| Age | | |
| 17-25 | 14 | 9.3 |
| 25-35 | 46 | 30.6 |
| 35-45 | 52 | 34.6 |
| 45-55 | 24 | 16 |
| >55 | 14 | 9.3 |
| Marital status | | |
| Married | 124 | 82.6 |
| Education | | |
| Primary school | 71 | 47.3 |
| 12th year | 63 | 42 |
| University | 16 | 10.6 |
| Experience (years) | | |
| 0-10 | 50 | 33.3 |
| 10-25 | 58 | 38.6 |
| >25 | 42 | 28 |
| Position | | |
| Owner | 60 | 40.1 |
| Staff | 90 | 59.9 |

N: Number of retail points.

Table 3. Food safety construct items.

| | n | % |
|-------------------------------------|-----|------|
| Food Handler Attitude | | |
| 1. Glove use | 14 | 9.3 |
| 2. Apron use | 72 | 48 |
| 3. Nail length | | |
| Trimmed short | 134 | 89.3 |
| Long | 16 | 10.6 |
| 4. Wearing jewelry | 22 | 14.6 |
| Retail store conditions | | |
| 1. Type of retail store | | |
| Producer | 4 | 2.6 |
| Market | 20 | 13.3 |
| Franchise | 126 | 84 |
| 2. Retail store age | | |
| ≥ 10 | 56 | 37.3 |
| < 10 | 94 | 62.6 |
| 3. Number of Employees | | |
| > 5 | 12 | 8 |
| 2-5 | 90 | 60 |
| 1 | 48 | 32 |
| 4. Floor material | | |
| Tile | 126 | 84 |
| Other | 24 | 16 |
| 5. Wall material | | |
| Tile | 80 | 53.3 |
| Other | 70 | 46.6 |
| 6. Product variety to be sailed | | |
| Only pastrami | 124 | 82.6 |
| Market (All meat and meat products) | 26 | 17.3 |
| 7. Cutting board material | | |
| Wood | 116 | 77.3 |
| Acrylic | 32 | 21.3 |
| Other | 2 | 1.3 |
| 8. Knife haft material | | |
| Wood | 136 | 90.6 |
| Acrylic | 12 | 8 |
| Other | 2 | 1.3 |
| 9. Cleaning agent | | |
| Detergent | 118 | 78.6 |
| Bleach | 4 | 2.6 |
| Detergent + Bleach | 20 | 13.3 |
| Other | 8 | 5.3 |
| 10. Pastrami storage conditions | | |
| Refrigerator temperature | 96 | 64 |
| Room temperature | 12 | 8 |
| Both | 42 | 28 |

n: Number of retail points.

Table 4. Food safety knowledge of food handlers in pastrami retail points.

| Statement | Correct Answer (%) |
|--|--------------------|
| 1. Hand washing before handling reduces food contamination risk | 100 |
| 2. Food borne infections could be reduced if the food handlers properly wash their hands where necessary | 88 |
| 3. Disposable gloves should be worn before handling pastrami | 96 |
| 4. Proper cleaning and sanitation of utensils reduces the food contamination risk | 96 |
| 5. Food and beverage consumption by handlers in the work place increases the food contamination risk | 44 |
| 6. Previous preparing of food prevents food contamination | 36 |
| 7. Repetitive heating of cooked food can increase contamination risk | 80 |
| 8. Foods must be stored at 5 °C | 80 |
| 9. Periodical check of refrigerator temperatures could reduce the microbial growth in food | 85 |
| 10. Freezing could kill all the bacteria in food | 40 |
| 11. Contaminated food always changes in color, odor and taste | 8 |
| 12. In case of infectious wounds on skin, take a break from work is necessary | 92 |
| 13. Is it possible that your diarrheal infection threatens consumers health | 44 |
| 14. Healthy people could also carry pathogen microorganisms on their skin, nose and mouth | 84 |
| 15. Healthy adults and the people at risk group (children, pregnant woman, elderly) can be considered at equal risk for food borne disease | 64 |
| 16. Food-borne diseases could be the cause of abortion in pregnant woman | 68 |

Mean: 69.06%

The majority of food handlers were recorded to not to use gloves (90.7%) and not to wear (52%) aprons during handling pastrami. In addition, 10.6% of them had long nails and 14.6% wore jewelry. Checklist of food safety construct items (food handler attitude and retail store conditions) and their corresponding scores were summarized in Table 3. Within the scope of the current study, 60% of attendants declared that they received formal food hygiene training (Data not shown).

The average of correct answers for the questionnaire was 11, corresponding to 69.06% of questions answered correctly. The maximum score was 15 (93.75%) and the minimum was 6 (37.5%). Table 4 shows the percentage of correct answers obtained for each question. Except for questions 5, 6, 10, 11 and 13 (given bold in Table 4), all other questions received high percentage of correct answers (above 50%). The highest scores achieved by food handlers in this study focused on general cleaning procedures.

Almost all of the food handlers (92%) in our study believed that contaminated food could be distinguished by sensory properties. Half of them (56%) did not believe that food and beverage consumption in work place and their diarrheal infections threaten consumer's health. The lowest level of knowledge was obtained from the topics closely related to food safety issues especially source of food contamination (questions 5, 13) and sensory properties of contaminated food (question 11).

Questions, emphasizing hand washing before handling had highest percentage of correct answers

followed by questions related to wearing gloves and cleaning of utensils, respectively.

Discussion and Conclusion

RTE food handlers has critical role to ensure food safety and to prevent food borne diseases. As stated by Codex Alimentarius (10), all individuals in contact with food must be qualified and must recognize their role and responsibility in not to contaminate food. Likewise, every food producing point should provide a training program.

S. aureus is the very common pathogen reaching RTE food by food handlers who carry this agent on their nasal cavity or skin (1,33). Nose flora often contaminates fingers and back side of hands (15). Being the permanent flora of human skin, *S. aureus* could not be removed even after proper hand washing practices therefore no fixed acceptable contamination level is available for this agent (2). As shown in Table 1, *S. aureus* were isolated from 34% of the sampled population's hands ranging from 1 to 4.0×10^1 cfu/cm². Higher results were obtained by Lues et al. (24) and Soares et al. (40) who reported 88% and 53.3% of food handler's hands to be contaminated with *S. aureus* and coagulase-positive staphylococci, respectively.

In contrast to *S. aureus*, Enterobacteriaceae numbers could be reduced by proper hand washing. Therefore, its presence points out to the possible presence of *Salmonella*, *Shigella*, *Yersinia*, *Proteus*, *Klebsiella* spp. and others (31). In this study, Enterobacteriaceae was detected from 44.6% of hands ranging from 5 to 20 cfu/cm². Higher results were obtained in a comparable study, reporting

Enterobacteriaceae to be isolated from 56% of food handler's hands in South Africa (24). Enterobacteriaceae presence on hands is reported to not to be a good indicator of personal and toilet hygiene as hands might be contaminated with Enterobacteriaceae irrelevant to toilet use and could be reduced by hand washing (12).

Coliforms are often used to evaluate the efficiency of sanitation programs as their presence indicates the increased risk of pathogen existence. For different kind of surfaces, target value was suggested as <2.5 cfu/cm² (30). In this study, 32% of hands were found to exceed the target value for coliforms, which reveals the improper personal hygiene. Lues et al. (24) and Campos et al. (8) also reported 40% and 55.6% of retail food handler's hands to be contaminated with coliforms which are higher than our results.

Being normally absent on hands, *E. coli* is regarded as the better indicator of the fecal contamination and enteric pathogens compared to all Enterobacteriaceae family members (12). *E. coli* was detected from 16% of the food handler's thumbs in this study. *E. coli* presence on the handler's hands is worthy of consideration as these isolates could involve Enterohaemorrhagic *E. coli* O111 or *E. coli* O157:H7. In the view of the literature, the specified limit for *E. coli* on surfaces is 1 cfu/cm² (23). High prevalence rate of the indicator bacteria in hands and some inappropriate attitudes observed in this study could be sourced from poor working conditions, and lack of periodical training. Most of the retail points were observed to have no hand washing sink to be used where needed.

All of the participants were male in this study. On the contrary Santos et al. (35) and Martins et al. (27) report 85% and 96% of participants to be female in Portugal, respectively. In the present study, about two third of the participants (65.2%) were aged between 25 and 45 years. Most of them were married (82.6%) and the education level of largest group (47.3%) was primary school. Two third of the participants had the experience more than 10 years on their work. Similarly, Marais et al. (25) reported more than 60% of managers to have >5 years of experience in food industry. Hand hygiene profiles of experienced food handlers were reported to be more satisfactory than the hands of inexperienced staff (23). It is indicated that experienced staff are less likely to participate training activities (43).

Most of the food handlers were observed to not to use gloves (90.7%) and more than half of the participants were not wearing aprons during handling pastrami. Although food handlers knew when gloves needed to be worn, in practice this remains a problem, as they state that wearing gloves during pastrami slicing does not allow to slice thinner as preferred by consumers. In this regard hand hygiene and proper glove and apron use by food handlers need to be emphasized within the frame of the

training program. On the contrary, Eren et al. (13) indicated that most of the food handlers had proper attitudes during food preparation including wearing aprons and gloves, using different cutting boards and knives for raw meat and salads.

In this study, 10.6% of them had long nails and 14.6% wore jewelry. These results on long nails are lower than that reported by Miranda et al. (29) and Campos et al. (8) reporting 41.7% and 81.5% of long nailed food handlers respectively.

In this study, 60% of attendants declared that they received formal food hygiene training (Data not shown). Such training was done as once-off activity without refreshing training. Similarly, Baş et al. (4) reported that almost 52% of participants received food safety training in Turkey and the food safety knowledge score was 43.4. Campos et al. (8) in Brazil and Silva et al. (39) in Spain stated that only 35.9% and 43.3% of food handlers received periodical training, respectively. In this study, 79.3% (119/150) of the participants had the score above 62.5% and were reported to have "good knowledge" on food safety. Only one food handler had the score below 50% (Data not shown).

Food handlers who participated in the study answered 69.06% of questions correctly. This is higher than that obtained by Gomes-Neves et al. (14) and Martins et al. (27) who reported 62% and 56.5% of handlers had correct answers in Portugal respectively. Similarly, Marais et al. (25) obtained 46% of correct answers from their food hygiene knowledge study on food handlers in South Africa which is similar to Baş et al. (4) with the mean score of 43.4% in Turkey. On the other hand, Yardımcı et al. (44) reported that food staff achieved 76.5% of the total score from personal hygiene, 73.3% of food hygiene, and 76.6% of kitchen and equipment hygiene knowledge tests.

In this study the lowest level of knowledge was obtained from the topics closely related to food safety issues especially source of food contamination (questions 5, 13) and sensory properties of contaminated food (question 11) which is different from those obtained by Jevsnik et al. (19), Santos et al. (35), Marais et al. (25) and Martins et al. (27) reporting that food handlers have significantly lower level of knowledge on the role of temperature in maintaining food safety. These results suggest significantly lower level of knowledge and understanding probably due to lack of appropriate hygiene training on these topics. Low level of knowledge may result in decreased level of concern during food handling and promote wrong practices (27).

In our study, 92% of attendants believe that contaminated food could be distinguished by visual, olfactory or taste properties. These results are in same line with Gomes-Neves et al. (14), Walker et al. (42) and

Jevsnik et al. (19) with 55.7%, 57% and 52.5% of incorrect results for the similar questions respectively.

In this study, 56% of food handlers did not believe that food and beverage consumption in work place and their diarrheal infections threaten consumer's health which implies that they do not have perceptions on the sources of food contaminations. According to Codex Alimentarius (10), food handlers should not eat, handle money or engage in any act that could contaminate the food during performance of their activities. Lack of knowledge on contamination sources might increase improper implementations in work place which in turn could promote microbial hazards and food borne diseases.

Other topics having low scores from food handlers were; freezing and in advance preparing of food. More than half of respondents (60%) believed that freezing process could kill all the bacteria in the food. Baş et al. (4) also reported deficit knowledge on the critical temperature of food preservation among food handlers.

In our study, questions emphasizing hand washing had highest score followed by questions related to wearing gloves and cleaning of utensils, respectively. Our results are compatible to the works of Martins et al. (27) and Marais et al. (25) reporting the best results from the issues of cleaning and sanitation. Although 96% of participants had the correct answers on glove use, their glove use practice does not reach this score. Seaman and Eves (36) underline that training could only be effective if the knowledge leads to required changes in behavior during food handling.

In this study, food handler's awareness on not handling food in case of infectious wounds on their skin was evident (92%). Most of food handlers (64-68%) gave correct answers to the questions referring to high risk population group.

Result of this study revealed that although the food handlers have the satisfactory knowledge on food safety, hand hygiene profiles do not seem to be parallel to their questionnaire results. A possible explanation for these findings may be related to low educational level of food handlers. This finding corroborates with the results of Baş et al. (4) who indicate that training may cause an increase in knowledge on food safety however may not always give rise to a positive change in behavior. Similarly, no significant relation was reported between the hygiene training of food handlers and hygiene standards of retail points (42). It is a great concern in food industry to encourage food handlers implement the principles they learnt on food safety (26). However, Cakiroglu and Ucar (7) reported inadequate knowledge of hygiene perception among food handlers and they underlined the immediate need for training on the subject.

The reality of the retail points exhibited that despite the fact of high level of food safety knowledge, food handler's hand hygiene profiles were not reflecting the same results. The main problems identified within the frame of this study were poor working conditions, lack of hand washing infrastructure in the retail points and lack of specific, periodic and formal training among food handlers although it is legal requirement in Turkey. Evaluation of the effectiveness of training is an important part of food safety, as stated by ISO 22000:2005 (18).

Data obtained from this study reveal that despite their adequate food safety knowledge, food handlers on pastrami retail points were lack of food safety practices. Therefore, it is not only sufficient to provide food safety trainings, but also the sources of failures in the practice should be identified and resolved.

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Conflict of Interest

All authors declare that they have no conflicts of interest.

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