MICROBIOLOGICAL STATUS OF KITCHEN SURFACES IN HOUSEHOLDS

Jelena Janjić1*, Nina Dimovska2, Jelena Ivanović1, Marija Bošković1, Vesna Đorđević3, Tatjana Baltić3, Milan Baltić1

1Department of Food Hygiene and Technology, Faculty of Veterinary Medicine, Bulevar Oslobodenja 18, 11000, Belgrade, Serbia
2Food and Veterinary Agency, Treta makedonska udarna brigade 20, 1000 Skopje, Macedonia
3Institute of Meat Hygiene and Technology, Kacanskg 13, 11000 Belgrade, Serbia

*e-mail: jeckonbg@gmail.com

Abstract
Although food poisoning often happens in house condition, consumer’s knowledge of about food household practices during food handling and storage are deemed insufficient.

Therefore, the aim of our study was to investigate the microbiological status (total number of mesophilic bacteria, Enterobacteriaceae and Coagulase-positive staphylococcus spp.) of kitchen surfaces in households (work surface, wooden board, plastic board, floor, and refrigerator). All microbiological examination were conducted according to ISO methods. This study included 100 households from the Belgrade area.

Results were interpreted according to the instruction from the Guidelines for application of microbiological criteria for food. There were significantly differences between the number of satisfactory and unsatisfactory total mesophilic bacteria. The unsatisfactory number of Enterobacteriaceae were significantly lower than satisfactory number of Enterobacteriaceae of examined samples in households. Coagulase-positive staphylococcus spp. were presented in 25% of examined households.

This survey has confirmed the effect of basic food hygiene knowledge on hygienic practice and identifies specific areas for emphasis in the development and delivery of effective food safety risk communication messages to consumers.

Key words: Kitchen surfaces, Mesophilic bacteria, Enterobacteriaceae, Coagulase-positive staphylococcus spp.

1. Introduction
Foodborne disease caused by microbiological hazards is a large and growing public health problem in Europe and worldwide. However, under-reporting of cases has made it impossible to establish the exact number of foodborne disease cases occurring. The proportion of cases arising from food preparation practices in the home may be especially under-represented in outbreak statistics, due to their disparate and sporadic nature. Consumer knowledge and awareness of the need for good hygiene practices including proper hand washing and food handling practices are paramount in the reduction and prevention of the spread of infectious disease in the home. However, perhaps the greatest problem in achieving improvements in home hygiene is educating the public and promoting behavioral changes. Improper handling, preparation, cooking time and storage of food at home can act as breeding grounds for pathogenic microorganisms [1], [2].

It has long been known that foodborne infections can be caused by contamination of kitchen surfaces or hands when preparing food [3]. Microorganisms may be introduced into the kitchen by the food itself. The authors stated that bacteria could also be carried by the packaging of these products and survive in the kitchen environment. Gram positive bacteria are able to survive on dry surfaces, but wet places in the kitchen are those where bacteria are the most likely to survive or grow and the hands are the most effective vehicle for contamination transfer [4], [5]. Microorganisms can also be transmitted from wet or damp sponges used to clean surfaces where they are able to survive and then are transferred from these surfaces to food [6]. A review of the literature on bacterial transfer to food highlighted that high levels of moisture, contact time and pressure could result in high transfer between surfaces [7]. Simple rinsing of hands only slightly reduced the transfer rate while rinsing cutting boards with hot water at 68 °C for 10 sec. reduced it significantly [8]. Knowing that more conventional washing with cooler water
was not effective [9], these authors concluded that to reduce the risk, cutting boards should be dedicated to one type of food (one board for raw food, another one for ready-to-eat food, etc.).

Microorganisms are capable of adhering to surfaces. Surface conditions which promote bacterial growth, including the presence of water (even intermittently), nutrients and a favorable temperature - bacteria can multiply and may form a biofilm, a microbial community of attached bacteria adhering to each other in a matrix of extracellular polymeric substances [10]. Such conditions may exist in different areas of the kitchen: the sink, including the area around the drain, the sponges, the garbage can, etc. If wet zones are not cleaned regularly, they become reservoirs for bacteria, some of which may be unwanted species. In addition to these wet zones, that include cleaning all kitchen surfaces, are also possible places where microorganisms may accumulate. Therefore it is very important to clean them after use as well.

The main purpose of this work was to evaluate the significance of food safety in domestic environments and to evaluate home hygiene taking microbiological samples from kitchen surfaces in 100 households.

2. Materials and Methods

For microbiological testing swabs were taken from the working surfaces in the kitchen. Swabs were taken as described in the ISO standard (ISO 18593 : 2010). Swabs were taken for investigation of surfaces contamination in kitchens from the working surfaces for food preparation, wooden and plastic cutting boards. Swabs were individually packaged in sterile tubes. Dehydrated samples from kitchen surfaces were swabbed with cotton swabs wetted in 1% peptone water (Buffered Water peptone - BPW, Oxoid). Surfaces were sampled using a sterile template fined surfaces was swabbed with cotton swabs wetted in 1% peptone water (Buffered Water peptone - BPW, Oxoid). Swabs were transferred to a tube with 10 mL of sterile 1% peptone water (Buffered Water peptone - BPW, Oxoid). Swabs were transported to the laboratory at a temperature from 1°C to 4°C.

2.1 Microbiological analysis

Swabs taken from abovementioned surfaces were investigated with following methods:

1. Determination of total aerobic mesophilic bacteria - EN ISO 4833: 2008;
2. Examination of the total number of enterobacteria - ISO 21528-1: 2004, ISO 21528-2: 2004;
3. The frequency of Coagulase-positive staphylococcus - EN ISO 6888-1.

2.2 Statistical analyses

Statistical analysis of the results was elaborated using software GraphPad Prism 5.00 (Version 5.00 for Windows, Graph Pad Software, San Diego, California, USA - www.graphpad.com). All parameters were represented by descriptive statistical parameters (mean, standard deviation). Chi-square test was used to compare frequencies among unsatisfactory and satisfactory total bacterial number on examined surfaces. The significance of differences was determined at the significance level of 5% and 1%.

3. Results and Discussion

The 2003 World Health Organization (WHO) report concluded that about 40% of reported food-borne outbreaks in the WHO European Region occur in private homes [5], [11]. Therefore it is important to know how to prevent contamination and to know where the contamination occurs.

On examined working surfaces in kitchens the incidence of unsatisfactory number (> 10 CFU/cm²) of mesophilic bacteria was significantly higher (p < 0.01) than the recommended number [12]. In contrast, the incidence of unsatisfactory (> 1 CFU/cm²) number of enterobacteria was significantly lower (p < 0.01) than satisfactory number (Table 1). Increased number of mesophilic bacteria above the recommended value was determined on all examined surfaces in the kitchen and depends on various parameters (age of the respondents, the presence of children in the household, the professional qualifications of the respondents, as well as help in the kitchen) (data not shown). It is clear that Enterobacteriaceae are distributed all around the house, which is in agreement with results obtained by Curtis et al. [13] that proved that fecal contamination of the domestic environment does occur, since fecal coliforms were found at a number of sites, not only in toilets and bathrooms but also in kitchens and on a variety of objects. As observed here, places where people touch with their hands were the major reservoirs of Enterobacteriaceae, however most people reported in the questionnaire that they “washed their hands when using WC”, handling raw, cooked or ready to eat products (data not shown).

Table 1. Frequency of the total number of examined groups of bacteria on the working surfaces in examined kitchens (n = 100)

<table>
<thead>
<tr>
<th>Frequency (%)</th>
<th>Mesophilic bacteria</th>
<th>Enterobacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td>31a</td>
<td>67a</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>69a</td>
<td>33a</td>
</tr>
</tbody>
</table>

Legend:
- Within column and each parameter values were compared;
- Means with a common superscript letter differ: a = p < 0.01.
On examined wooden cutting boards there was no significant difference between the frequency of satisfactory and the unsatisfactory number of mesophilic bacteria. In contrast, the incidence of unsatisfactory total number of enterobacteria was significantly lower (p < 0.01) than satisfactory (Table 2). These results suggest that the hygiene of the examined wooden cutting boards was satisfactory, although their use in households is not recommended.

Table 2. The frequency of the total number of examined groups of bacteria on a wooden cutting boards in examined kitchens (n = 80)

<table>
<thead>
<tr>
<th>Frequency (%)</th>
<th>Mesophilic bacteria</th>
<th>Enterobacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td>57,50</td>
<td>66,25&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>42,50</td>
<td>33,75&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Legend:
- Within column and each parameter values were compared;
- Means with a common superscript letter differ: <sup>A</sup> = p < 0.01.

On the examined plastic cutting boards incidence of unsatisfactory number of mesophilic bacteria and enterobacteria was significantly lower (P < 0.01) than of satisfactory (Table 3). These results indicate that the number of examined groups of bacteria on plastic cutting boards is not a concern, and therefore the use of these cutting boards is recommended in the preparation of food.

Table 3. The frequency of the total number of examined groups of bacteria on a plastic cutting boards in examined kitchens (n = 44)

<table>
<thead>
<tr>
<th>Frequency (%)</th>
<th>Mesophilic bacteria</th>
<th>Enterobacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td>68,18&lt;sup&gt;A&lt;/sup&gt;</td>
<td>65,91&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>31,82&lt;sup&gt;A&lt;/sup&gt;</td>
<td>34,09&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Legend:
- Within column and each parameter values were compared;
- Means with a common superscript letter differ: <sup>A</sup> = p < 0.01.

The presence of coagulase-positive staphylococci on the kitchen surfaces were examined within this study. *Staphylococcus aureus* is a common contaminant and frequent cause of poisoning. The presence of *S. aureus* in the kitchen usually comes from people (with the hand, from the mouth or nose). Detection of *S. aureus* indicates insufficient consumer hygiene during food handling. According to some authors it is quite common to find *Staphylococcus aureus* in domestic environments since it is a common resident of the human nose, throat and skin [14], [15], [11] and therefore more likely to contaminate foods by direct or indirect human contact during domestic food handling [6]. Scott et al., [16] also found *S. aureus* in 34 of the 35 homes (97%) sampled and was isolated from all surfaces in one or more homes and Davis et al., [17] commented that commonly touched sites have high rates of contamination and could have an important role in indirect household transmission. In this study the presence of coagulase-positive staphylococci was determined in the quarter of examined households. In some households, the presence of coagulase-positive staphylococci was found in more than one sampled place. Coagulase-positive staphylococci were detected on work surfaces, wooden and plastic cutting boards in examined kitchens. There were no significant differences between the frequencies of coagulase-positive staphylococci in sampled areas in kitchens (Table 4). Considering the prevalence of *S. aureus*, though the intoxication caused by these contaminants are usually relatively mild, so most cases of poisoning passes not reported. This pathogen can survive on dry surfaces between two and four days, and with these places are easily transferred to the food [6].

Table 4. Frequency (%) of coagulase-positive staphylococci on surfaces in kitchens

<table>
<thead>
<tr>
<th>Frequency (%)</th>
<th>Sampling place</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Working surface (n = 100)</td>
</tr>
<tr>
<td>9,00</td>
<td>3,75</td>
</tr>
</tbody>
</table>

4. Conclusions

- Many additional surveys have confirmed the effect of basic food hygiene knowledge on hygienic practice and identify specific areas for emphasis in the development and delivery of effective food safety risk communication messages to consumers.
- The results obtained in this study have revealed the need to develop some education campaigns designed to educate consumers, regarding safe food handling practices and cleaning habits.

Acknowledgement

This paper was supported by the Ministry of Education and Science, Republic of Serbia, Project “Selected biological hazards to the safety/quality of food of animal origin and the control measures from farm to consumer” (31034).

5. References


