




Proceeding Paper

Evaluation of the Effects of Food Safety Training on the Microbiological Load Present in Equipment, Surfaces, Utensils, and Food Manipulator's Hands in Restaurants [†]

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Abstract: Restaurants are a place where a lot of people go to have a delicious meal and have a good time; however, it is in the hands of the restaurant staff to provide a good environment and ensure the tasty meals are microbiologically safe. Food training comes a long way in this regard to help give that quality to the consumer, but there are a lot of restaurants where workers do not have proper training for handling food or keeping the establishment's food safe. This study revealed that in general, there was more microbiological analysis non-compliant with food safety limits before the food safety training. After the training, there was a reduction in the number of values exceeding the safety limits with reductions in microbiological load of above 80%.

Keywords: food safety; hygiene; microbiological analysis; training



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1. Introduction

Ensuring food safety and preventing foodborne diseases are crucial considerations, as they pose significant challenges to public health and contribute to healthcare costs amounting to millions annually [1,2]. Numerous documented outbreaks of foodborne illnesses are linked to foodservice establishments, with a major issue being improper handling, preparation, storage, transportation, and sanitation practices. The origins of foodborne diseases span various sources, including bacteria, viruses, parasites, chemical contaminants, and allergens [3]. Consequently, there is a heightened emphasis on the verification, implementation, and continuous monitoring of codes of good practices [2,4]. It is crucial for food handlers to receive training that combines theoretical knowledge with practical examples. This integrated approach enhances learning capacity and contributes to the improvement of their daily adherence to good food safety practices [5].

This study was aimed to proportionate the knowledge of food safety and to help the workers follow the right path. It was evaluated if the training given to the food manipulators was helpful and had a significant impact in reducing the load of microbiological contamination present during the work.

In this present work we have achieved a reduction exceeding 80% in the microbiological load of *Enterobacteriaceae* and mesophilic microorganisms on equipment, surfaces, utensils, and hands in most cases. Addressing the presence of *Listeria monocytogenes* in drains proved to be another challenge that appeared to be effectively resolved through worker training. They were provided with guidance on both physical and chemical approaches tailored to specifically address this issue.

2. Material and Methods

For the present work were carried out four rounds of analysis in four restaurants: two analyses were conducted before food safety training and the other two were conducted after food safety training. In each visit, thirty-two swabs were taken from the equipment, surfaces, and utensils all together and eight swabs were taken from four manipulators (right and left hand). Also, we evaluated the presence of *Listeria monocytogenes* in drains using absorbent sponges. This study analysed mesophilic microorganisms in Plate Count Agar® (PCA), *Enterobacteriaceae* in Violet Red Bile Glucose Agar® (VRBG), *Escherichia coli* in Tryptone Bile X-Glucuronide Agar® (TBX), *Staphylococcus aureus* in Baird Park Agar® (BP) and *Listeria monocytogenes* in Chromagar *Listeria* and enrichment media Fraser I and Fraser II. The results were analysed based on the microbial criteria of Moragas, M. et al. [6] K. Soares et al. [7] and Labović et al. [8].

3. Results and Discussion

3.1. Equipment, Surfaces, and Utensils Analysis

It was evaluated global hygienic conditions among the four restaurants. Of the swabs performed, before food safety training, to equipment, surfaces, and utensils, 15% of the results for *Enterobacteriaceae* and 26% of the results for mesophilic microorganisms weren't compliant with the hygienic safety limits and for the swabs done to the food manipulator's hands 31% of the *Enterobacteriaceae* and 64% of the mesophilic values were well above the safe limits. The number of non-compliant *Enterobacteriaceae* and mesophilic microorganisms' values for equipment, surfaces and utensils were much higher before the food safety training then after the food safety training (Figures 1 and 2).

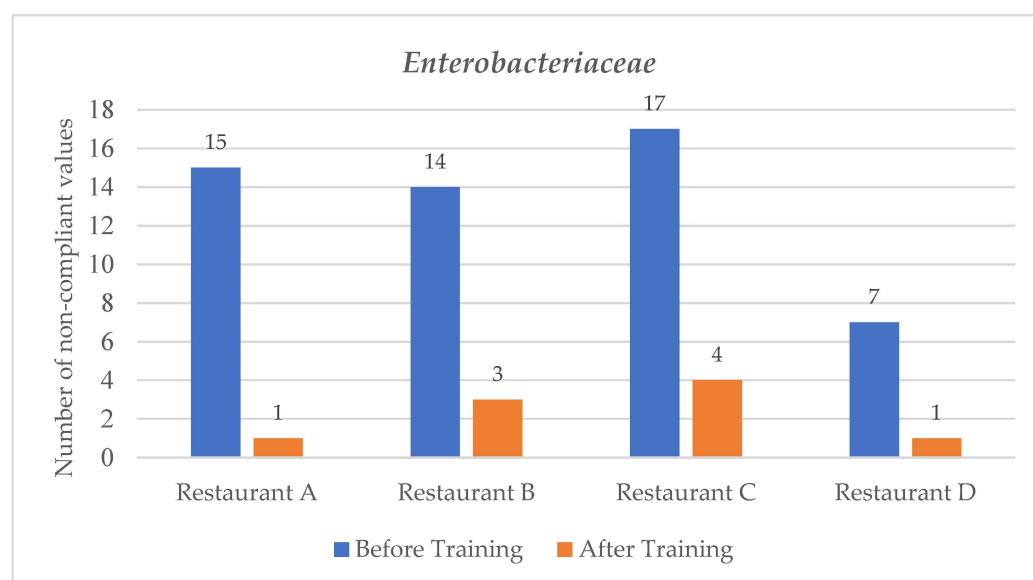


Figure 1. Number of values non-compliant with the food safety limits (Before and After training) for the *Enterobacteriaceae* analysis taken from restaurant A, B, C, and D.

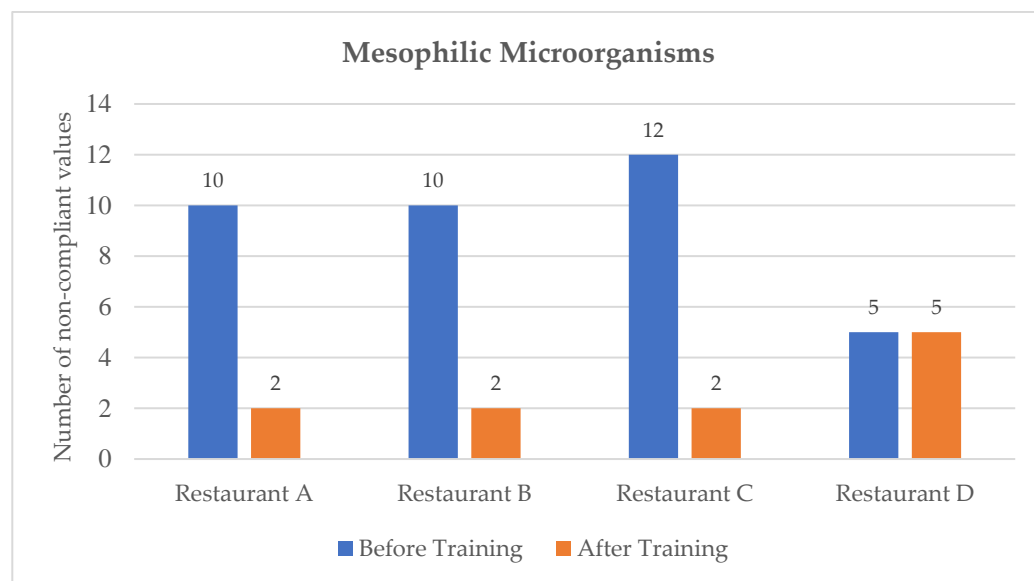


Figure 2. Number of microbiological values non-compliant with the food safety limits (Before and After training) for mesophilic microorganisms' analysis taken from restaurant A, B, C, and D.

After the employee training there was a severe reduction on Enterobacteriaceae and mesophilic microorganisms load of more than 90% (Table 1) that can be explained by the fact that before the employee food safety training there was a big lack of good hygiene practices like for example the fact that cutting boards and other surfaces weren't cleaned after handling or cutting raw food or only cleaned with water and most of the times were left there forgotten with blood. Utensils used for cutting and handling raw food were also used for other things without proper cleaning between tasks leading to cross-contamination. These stated reasons contributed to a high degree of contamination and high microbiological count. After the training the employees started to clean the surfaces, equipment, and utensils with proper disinfectant after finalizing their tasks and even some old cutting boards were replaced by new ones due to the high degree of wear and the presence of many deep cuts.

Table 1. Percentage of difference between the microbiological count means (% Mean Diff.) obtained from the analysis taken before and after formation on the restaurants A, B, C and D for Enterobacteriaceae and mesophilic microorganisms present in equipment, surfaces, and utensils.

Restaurant	A (% Mean Diff.)	B (% Mean Diff.)	C (% Mean Diff.)	D (% Mean Diff.)
<i>Enterobacteriaceae</i>	−98.0	−99.9	−99.7	+32.6
Mesophilic microorganisms	−98.7	−99.5	−96.7	−98.9

Note: (−) reduction; (+) increase.

3.2. Drains Analysis

In this study we also searched for the presence of *Listeria monocytogenes* in the drains of 4 restaurants turning out 25% of the analysis to be positive (Figure 3). After the training, where was suggested the combination of mechanical and chemical techniques, the presence of *Listeria monocytogenes* was absent (Figure 3).



Figure 3. Presence of *Listeria monocytogenes* before and after the food safety training.

3.3. Food Manipulator's Hands Analysis

The number of non-compliant *Enterobacteriaceae* and mesophilic microorganisms' values for the analysis taken from the manipulator's hands were much higher before the food safety training than after the food safety training (Figures 4 and 5).

Before the employee training there was a lack of understanding or uninterest in complying with the good self-hygiene practices. Washing the hands was most of the times neglected only washed with water and, in some cases, the workers forgot to wash their hands between different tasks which led to cross-contamination between raw and cooked meals.

Staphylococcus aureus results were mixed with only restaurant A and D having higher non-compliant values before training (Figure 6). Restaurants B and D were the ones with the most presence of *Staphylococcus aureus* (Figure 6). The analysis was always taken without gloves and as we can see only restaurant B had a substantial increase in non-compliant values explained by the fact that one of the employees allegedly had a disease that provoked the presence of constant open wounds on the hand's surface.

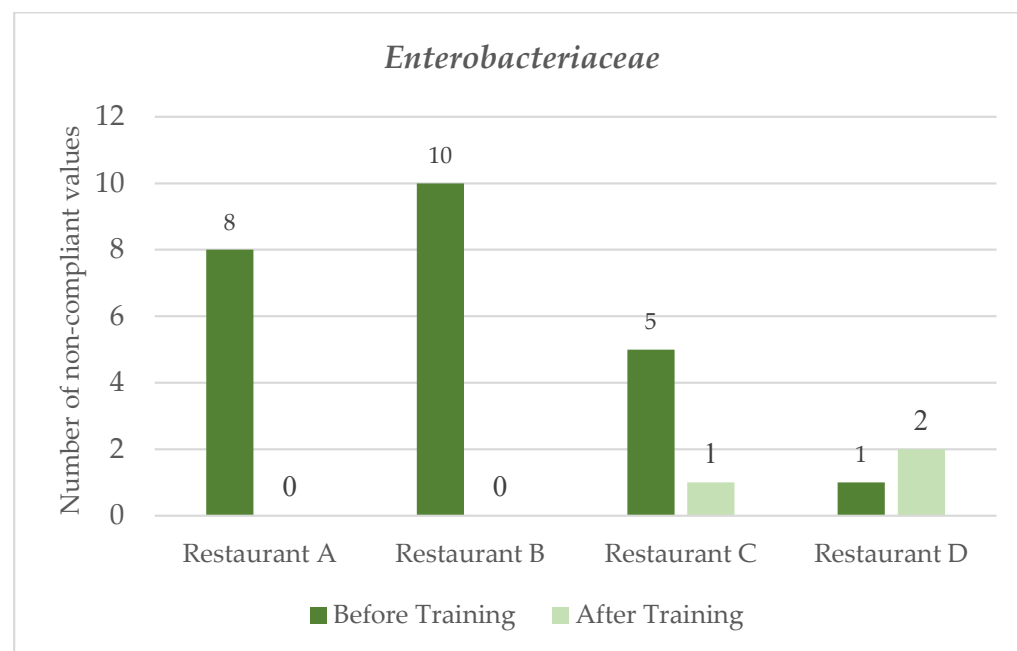


Figure 4. Number of microbiological values non-compliant with the food safety limits (Before and After training) for *Enterobacteriaceae* present on food manipulators hands for the restaurants A, B, C, and D.

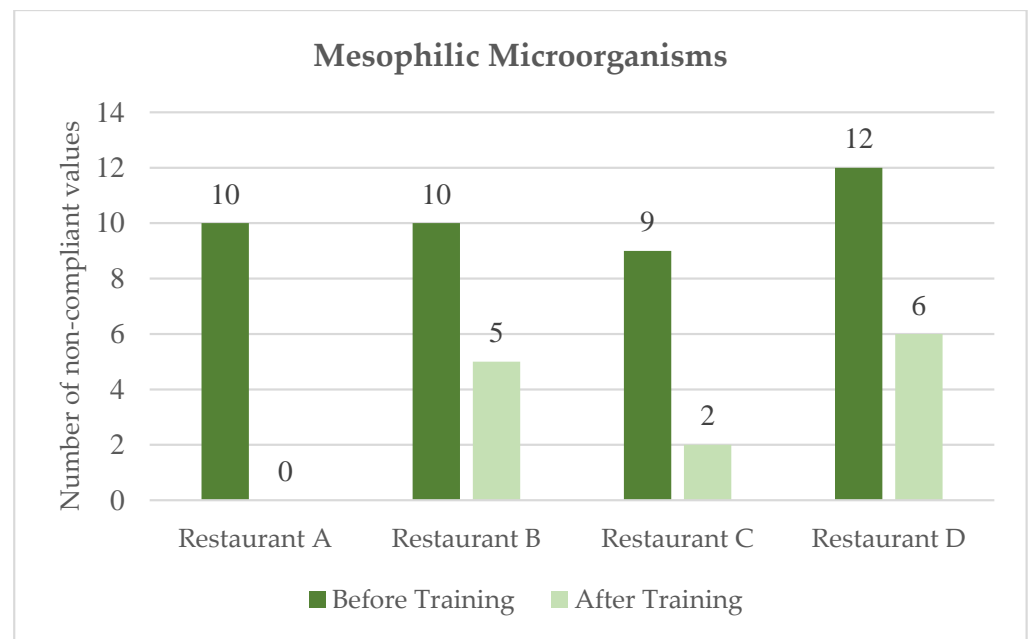


Figure 5. Number of microbiological values non-compliant with the food safety limits (Before and After training) for mesophilic microorganisms present on food manipulators hands for the restaurants A, B, C, and D.

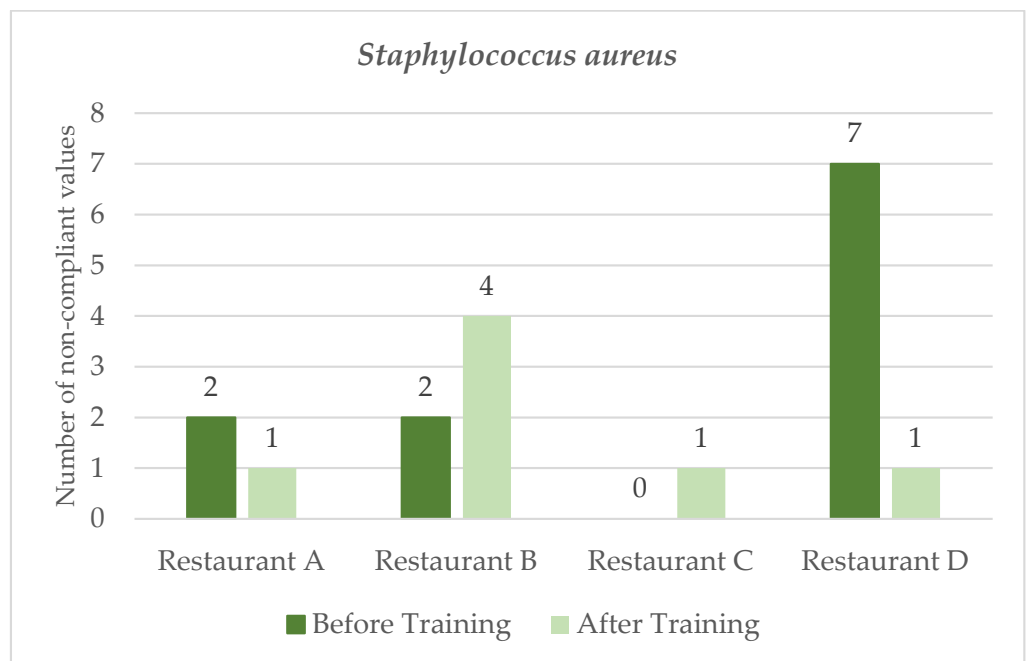


Figure 6. Number of microbiological values non-compliant with the food safety limits (Before and After training) for *Staphylococcus aureus* present on food manipulators hands for the restaurants A, B, C, and D.

After the employee food safety training they recognized the importance of using proper disinfectants for washing their hands and started doing it more frequently in correct times leading to the reductions on microbiological load of more than 80% for most of the cases (Table 2).

Table 2. Percentage of difference between the microbiological count means (% Mean Diff.) obtained in the analysis taken before and after formation on the restaurants A, B, C and D for Enterobacteriaceae, mesophilic microorganisms and Staphylococcus aureus present on the hands of food manipulators.

Restaurant	A (% Mean Diff.)	B (% Mean Diff.)	C (% Mean Diff.)	D (% Mean Diff.)
<i>Enterobacteriaceae</i>	−99.8	−100	−99.8	+125
Mesophilic microorganisms	−98.8	−35.8	−94.6	−92.2
<i>Staphylococcus aureus</i>	+190.4	+58.8	+100	−80.4

Note: (−) reduction; (+) increase.

4. Conclusions

With these results we can conclude that food safety training was crucial to make the employees more aware of the bad hygiene practices and how to do it the right way. The employees comprehended the importance of cleaning the surfaces, utensils, equipment, and hands after changing tasks or always, when necessary, with the right disinfectant product.

The combination of theoretical and on-job training was very effective as we can see by the results of 80% reduction in microbiological load in most of the cases. Was reported by the restaurant owners that some of the workers didn't pay attention to the previous formations because they were only theoretical and boring, that's why the including of practical demonstrations was efficient in enhancing the employee's learning capacity.

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