ORIGINAL ARTICLE

Microbial Contamination of Kitchen Instruments as a Minatory to Human Health

FARZAD SHAYEGHI[1], ESFANDIAR MATINI[2], NASER RAHBAR*[3], NIMA MOJRI[4], SADAF SADAT HOSSEINI[5],HOSSEIN ESMAEILI[6],MARZIYEH ABDOLLAHI[7], FATEMEH JAFARNEJAD SADAGHYANI[8], HELIA RAHMANI[9], NILOUFAR BADKOUBEH[10],RENITA KHANLARI[11],MOBIN BAHRAEI[12],ROQAYEH HAKIMI[13], ROJIN BAGHERI[14], SEYED ALI HOSSEINI ZAVAREH[15]

[1,2,3,6,15]Medical Department, Islamic Azad University of Medical Sciences, Tehran, Iran
[4,5]Paramedicine department, Islamic Azad University of Medical Sciences, Tehran, Iran
[7,11,12]Modern Science Department, Islamic Azad University of Medical Sciences, Tehran, Iran
[8]Hygiene department, Islamic Azad University of Medical Sciences, Tehran, Iran
[9]Physiology Department, Kurdistan University of Medical Sciences, Sanandaj, Iran
[10,13,14]Paramedicine Department, Islamic Azad University of Medical Sciences, Tehran, Iran
Correspondence to Naser Rahbar E mail: naserrahbar36@gmail.com, Tel: +989121096994

ABSTRACT

Background: As all we know, nourishment is one of the human's essential requirements in order to provide energy and furthermore play an important role in people's daily activities. By the daily and frequently use of kitchens to provide and process foods and its relationship with human health, it's necessary to evaluate the rate of contaminations.

Aim: To evaluate the rate of microbial contaminations which involves the instruments and equipment that exist in almost every kitchen.

Methods: In this descriptive cross-sectional study, a total of 9965 samples were taken from different instruments of many domestic kitchens, restaurants, hotels, and food processing kiosks which are selected randomly before. The specimens were examined precisely by use of principal scientific sources and standard bacteriological methods which are mentioned farther. Generally all the species with their bacterial load of up to 100,000 CFU/gr were designated detrimental and were brought on table-2; even though those between 50,000 and 100,000 CFU/gr were repeated for sampling and reassessed. Although under 50,000 colonies of bacteria/gr are also considered normal and were excluded from the samples.

Result: The results reveals a total of 10 different bacterial isolates like *Staphylococcus aureus* (15.05%),*Staphylococcus epidermidis* (16.50%), *Escherichia coli* (18.27%), *Shigella spp.* (0.91%), *Bacillusspp*. (13.02%), *Enterobacter* spp. (9.40%),*Pseudomonas* (2.11%), *Enterococcus spp. (2.37%)*, etc. and amount of fungal contaminations (12.81%) exist in some instruments. The results obtained in this study proves some microbes are able to draw on some discomforts for people and can be harmful to social health; thus by informing and warning people of bad consequences which comes afterward by improper disinfection of utensils like dishes, pans, pots, spoons and forks, etcas well as using correct cleaning methods for these instruments, can be usefulto decrease the transmission of infections properly.

Key words: Microbial contamination – Social health – Kitchen instruments –Utensils – Spoon & fork – Sponge

INTRODUCTION

According to World Health Organization (WHO), an estimated 600 million – almost 1 out of 10 people in the world – become ill after consuming contaminated food and a number of 420 000 people die yearly [Jalalmaneshet al.], Children under 5 years old carry 40% of the foodborne disease burden, with 125 000 deaths every year. Diarrhoeal diseases are the most common illnesses resulting from the consumption of contaminated foods, causing 550 million people to get ill and 230000 cause of deaths every year. Therefore in this survey an attempt ismade to recognize and evaluate the microbial contaminations imperiling the social and individual health. Absolutely unsafe foodsarecontained harmful microorganisms such as bacteria, viruses, parasites, etc. and according to WHO more than 200 diseases ensued thereinafter, ranging from diarrhoea to cancers[1].As all we know, foodborne pathogens are derived from environment and transfer to foodsduring preparations or through post-cooking steps. A study performed in Budapest, Hungary [byTóth et al.] declared that the level of hygiene in the serving kitchen significantly affects the microbial status of meals. In other hand, some researchers [Evans EW et al.] have proved that Inadequate and irregular hygiene practices may increase foodborne illness risk to older adults, chiefly by the way of in-use cleaning equipment. An investigation into the potential for cross-contamination [Humphrey et al.], reveals the use of intact shell eggs which was contaminated with ***Salmonella enteritidis***, by simple procedures such as cracking and mixing of eggs, result in contamination of fingers, utensils and surrounding work surfaces.Moreover, the other study [Hilton et al.] have proved that sponges and dishcloths can providesuitable conditions for harboring a large number of bacteria as a result of their surface characteristics and also could be able to establish the contamination on the objects and surfaces they meet. So it is clear that wiping kitchen equipment up with clothes may results in the contamination of equipment.

According to Aket al. survey, wood cutting boards, due to sufficiently wide cracks exist on its surface (result in entrapping bacteria) and absorbing moisture,can carry and transport more microbial contamination than plastic cutting

boards. It is obvious that the cross-contamination of kitchens would occur by raw nutriment such as raw meat and poultry, unwashed vegetables and etc.[as mentioned by the studies of Dang-Xuanet al. &de Wit et al.], moreover, some investigations [Zottola et al.] found that solid surface of crockeries and cutleries can provide some protection of the cells against physical removal of them by washing and cleaning. The other study performed in USA, have worked on microbial biofilms in the food processing industry. The authors have revealed that some microbial microorganisms which adhere to foods or equipment surfaces, may not be easily killed by chemical sanitizers, thus they can imperil the clients or consumers health and cause further complications. In some food processing kiosks which located in public, many factors may affect safety foods as result in customer's status; for instance, inefficient food protecting against flies which may carry foodborne pathogens, or by the waste water and garbage discarded nearby, it may provide nutrients for insects and rodents. In addition, despite of not keeping raw materials in separate areas, some of the chefs working in the local restaurants wear jewelry while cooking food, thereby microbial microorganisms would be probably transfer in a reciprocal manner.

As it has mentioned previously, many bacterial and fungal microorganisms can spread through the equipment and surfaces in kitchens and furthermore may be lead to some difficulties such as food poisoning (as a result of its toxic pattern) and infectious disease thereinafter. In turn, it may cause some health costs to the people who are involved. So in this research, we have made an attempt to evaluate and recognize the bacterial and fungal contamination of instruments exist in almost every kitchen. We hope the results obtained in this study could be useful to reduce the amount of contamination and subsequent detriments occur consequently.

MATERIALS AND METHODS

Materials and surfaces: In this descriptive cross-sectional study a number of 9965 samples have collected from kitchen instruments, such as the countertop, washing sink, dishcloths and wire sponges, dish rack, plates, cutleries, pans, pots, pitchers, glasses, spatula, ladle, colander, frying oil basket, frying oil pot, whetstone and cutting board. During the sampling, an effort has made to select the instruments or points which have high expectancy and opportunity in transmission of foodborne pathogens eventuated to some cross-contamination and problems thereinafter. For sampling from such instruments many places such as domestic kitchens, restaurants, hotels and food processing kiosks is chosen randomly in different areas on Tehran. In addition, a consent decree has been provided and is taken from the owner or responsible of each premises morally.

Sampling and laboratory methods: For sampling equipment, we apply the sterilized cotton swabs (which is soaked with distilled water and inserted into the test tubes). After sampling, the specimens have passaged on transport culture media due to decreasing bacterial overgrowth and preserving them from deterioration. The specimens transferred to laboratory as soon as possible. Previously we had provided many culture medias such as Nutrient agar, Blood agar, MacConkey agar and EMB agar for passaging the specimens and were keeping in refrigerator. Before passaging the samples on culture medias, the prepared medias taken out from the refrigerator in order to reach room temperature. After passaging, in order to bacterial growing, the culture medias which were passaged on, were put into the incubator on 37 degrees Celsius (for 24-48 hours).

Isolation and identification of bacterial isolates: Finally in order to evaluate the bacterial growing and colony forming, the preserved culture medias are examined precisely. When it manifested that the bacterial colonies had been grown on culture medias, all the species with their bacterial load of up to 100,000 CFU/gr were designated detrimental and Gram staining method used to determine Gram positive and Gram negative bacteria. All the bacteria could be grown on Nutrient agar medias; after using Gram staining technique, they were passaged on specific agars; Blood agar for Gram positive bacteria and also on MacConkey and EMB agar medias for Gram negatives. Afterward, for determining the specious of bacteria, these biochemical tests have been done; as mentioned below:

For detecting the specious of Gram negative bacilli such as *Shigella*, *Enterobacter spp*., *pseudomonas*, etc. Catalase, Oxidase, Urease test and TSI (Triple Sugar Iron Agar) culture media were being used.

For detecting the specious of Gram positive bacteria such as *Enterococcus spp*., *Staphylococcus aureus, Bacillus spp.*and etc. Catalase, Coagulase and MSA culture media were being used too.

RESULTS

In this survey a total of 9965 samples comprising 4691 contaminated and 5274 decontaminated specimens have been examined and assessed carefully. Finally a total of 8 different bacterial isolates such as ***Staphylococcus aureus***, ***Staphylococcus epidermidis***, ***Escherichia coli***, ***Shigella* spp.**, ***Bacillus spp.***, ***Enterobacter spp.***, ***Pseudomonas***, ***Enterococcus spp.***and amount of mix bacterial and fungal contaminations were observed, as demonstrated in table 2. Generally the highest rate of contamination was due to ***E.coli*** (18.27%) and lowest was ***Shigellaspp.*** (0.91%). Alsothe predominant load of bacteria and fungus found in dishcloths and wire sponges with 17.50% (821 out of 4691 samples) and the lowest rate was due to frying oil baskets (48 out of 4691 samples, 1.02%).

According to the table number1, wire sponges and dishcloths (821 out of 846 cases, 25 cases non-contaminated), washing sinks (721 out of 752 cases, 31 cases non-contaminated), kitchen countertops (745 out of 822 cases, 77 cases non-contaminated) and cutting boards (603 out of 711 cases, 108 cases non-contaminated) had the highest rate of contamination; absolutely they might have certain role in publishing such microorganisms and contaminations to other things.

Table 1. Absolute and relative frequency table of contaminated and non-contaminated instrument

Sample items	n	Non contaminated	Contaminated
Wire sponge & Sponge dishcloths	846	25 (2.96%)	821 (97.04%)
Knife	520	124 (23.85%)	396 (76.15%)
Spoon & Fork	682	607 (89%)	75 (11%)
Pot	618	404 (65.37%)	214 (34.63%)
Pan	437	242 (55.38%)	195 (44.62%)
Dinner plate	680	565 (83.09%)	115 (16.91%)
Salad plate	216	148 (68.52%)	68 (31.h48%)
Spatula & Ladle	626	515 (82.27%)	111 (17.73%)
Frying oil pot	208	114 (54.81%)	94 (45.19%)
Frying basket	212	164 (77.36%)	48 (22.64%)
Cutting board	711	108 (15.19%)	603 (84.81%)
Kitchen countertop	822	77 (9.37%)	745 (90.63%)
Dish rack	816	715 (87.62%)	101 (12.38%)
Colander	714	615 (86.13%)	99 (13.87%)
Glass	406	301 (74.16%)	105 (25.84%)
Jug	275	207 (75.27%)	68 (24.73%)
Kitchen washing sink	752	31 (4.12%)	721 (95.88%)
Whetstone	424	312 (73.58%)	112 (26.42%)
Total	9965	5274 (52.925%)	4691 (47.075%)

Table 2. Absolute and relative frequency table of microorganisms isolated from Kitchen's instruments

Microorganisms	*S. aureus*	*S. epidermidis*	*E.coli*	*Shigella spp.*	*Bacillus spp.*	*Enterobacter*	*Pseudomonas*	*Enterococcus*	*Mix*	*Fungi*	*Total*
sample items	N.(%)	N.(%)	N.(%)	N.(%)	N.(%)	N.(%)	N.(%)	N.(%)	N.(%)	N.(%)	N.
Wire sponge & Dishcloths	152 (18.51%)	50 (6.09%)	111 (13.52%)	-	-	49 (5.97%)	24 (2.92%)	-	84 (10.23%)	351 (42.76%)	821 (17.50%)
Knife	57 (14.40%)	67 (16.91%)	61 (15.40%)	12 (3.03%)	64 (16.17%)	33 (8.33%)	7 (1.77%)	17 (4.30%)	36 (9.09%)	42 (10.60%)	396 (8.44%)
Spoon & Fork	-	45 (60%)	12 (16%)	-	-	8 (10.67%)	-	4 (5.33%)	6 (8%)	-	75 (1.60%)
Pot	10 (4.68%)	25 (11.69%)	36 (16.82%)	-	78 (36.44%)	-	-	-	53 (24.77%)	12 (5.60%)	214 (4.65%)
Pan	34 (17.43%)	26 (13.33%)	64 (32.82%)	-	-	23 (11.80%)	-	21 (10.77%)	10 (5.13%)	17 (8.72%)	195 (4.16%)
Dinner plate	18 (15.66%)	11 (9.57%)	26 (22.60%)	-	37 (32.17%)	-	-	-	15 (13.04%)	8 (6.96%)	115 (2.45%)
Salad plate	12 (17.65%)	10 (14.70%)	21 (30.89%)	-	-	9 (13.24%)	-	-	10 (14.70%)	6 (8.82%)	68 (1.38%)
Spatula & Ladle	21 (18.92%)	17 (15.32%)	28 (25.23%)	-	-	18 (16.22%)	-	8 (7.20%)	12 (10.81%)	7 (6.30%)	111 (2.36%)
Frying oil pot	-	16 (17.02%)	21 (22.34%)	-	12 (12.76%)	6 (6.38%)	-	-	25 (26.60%)	14 (14.90%)	94 (2%)
Frying oil basket	6 (12.5%)	8 (16.67%)	24 (50%)	-	5 (10.41 %)	3 (6.26%)	-	-	-	2 (4.16%)	48 (1.02%)
Cutting board	115 (19.07%)	138 (22.90%)	76 (12.60%)	5 (0.83%)	105 (17.41%)	74 (12.27%)	12 (1.99%)	16 (2.65%)	38 (6.30%)	24 (3.98%)	603 (12.85%)
Countertop (bench)	101 (13.57%)	132 (17.71%)	147 (19.73%)	4 (0.54%)	121 (16.24%)	98 (13.16%)	8 (1.07%)	17 (2.28%)	81 (10.87%)	36 (4.83%)	745 (15.88%)
Dish rack	8 (7.92%)	14 (13.86%)	41 (40.60%)	-	-	-	-	-	16 (15.84%)	22 (21.78%)	101 (2.15%)
Colander	10 (10.10%)	12 (12.12%)	46 (46.47%)	2 (2.02%)	24 (24.24%)	-	-	-	5 (5.05%)	-	99 (2.11%)
Glass	8 (7.61%)	18 (17.14%)	11 (10.48%)	-	32 (30.48%)	19 (18.09%)	-	-	17 (16.20%)	-	105 (2.24%)
pitcher	10 (14.70%)	19 (27.94%)	6 (8.82%)	-	21 (30.89%)	-	-	-	12 (17.65%)	-	68 (1.45%)
Washing sink	118 (16.37%)	134 (18.58%)	124 (17.20%)	17 (2.36%)	97 (13.46%)	89 (12.34%)	48 (6.66%)	21 (2.91%)	19 (2.63%)	54 (7.49%)	721 (15.37%)
Whetstone	26 (23.21%)	32 (28.58%)	2 (1.79%)	3 (2.68%)	15 (13.40%)	12 (10.71%)	-	7 (6.25%)	9 (8.03%)	6 (5.35%)	112 (2.39%)
Total	706 (15.05%)	774 (16.50%)	857 (18.27%)	43 (0.91%)	611 (13.02%)	441 (9.40%)	99 (2.11%)	111 (2.37%)	448 (9.56%)	601 (12.81%)	4691 (100%)

DISCUSSION

By considering the abundant use of these facilities and equipment for the sake of cooking and preparing foods, and its affiliation to human health, it is necessary to evaluate the amount of contamination pertained to kitchen instruments. As demonstrated in table 1, the maximum contamination is found on kitchen equipment were related to Wire sponges& Sponge dishcloths and the minimum were in Spoons& Forks. In our disquisition, 18 occasions in domestic settings, restaurants, delicatessens and food processing kiosks were predesignated and assessed for bacterial and fungal contaminations which we had assumed that may have essential role in every things cross-contamination brought outcome discomforts to people.

The results obtained in this study and by other investigators, revealed that there are expanded contaminations among these devices. Humphrey et al. had got on for food-borne pathogens originated from dishcloths and sponge type dishcloths. The results of above study revealed that only 4% of specimens were contaminated with **S. aureus**, whiles in our study was just 18.51%; this variation may occur due to differences among the number of samples, taken in both studies. In addition we have found more different bacterial isolates and fungal contaminations. Also in other survey performed on Brazil [Rossi et al.], the authors have studied on microbiological contaminations and disinfection procedures of kitchen sponges, a total of 80 samples were gathered and generally 4 different bacterial isolations as ***heterotrophic microorganisms*** (76.75%), ***fecal coliforms****(76.25%)*, ***Staphylococcus coagulase-positive*** (2.5%) and the ***Salmonella sp.*** (2.5%) were detected. Despite of **Salmonella sp.** privation in our bacterial harvest, some varieties of isolations were common in both studies; like ***E.coli***,***S. aureus*** and etc. However, in regarding to Reller et al. survey, the presence of ***Salmonella sp.*** (facultative

anaerobic Gram-negative Bacilli, which reside in the intestinal tract of human beings and warm blooded animals) may probably issue from many foods which have been identified as vehicles for the transmission of this pathogen to humans, particularly foods from animal origin, but also foods of non-animal origin which may be subject to faecal contamination, as a particular importance include eggs, pig meat, poultry meat, milk, chocolate, fruit and vegetables may provoke cross-contamination procedures. Also, neither fungal contamination were detected in above study. As mentioned previously and by regarding to table 2, the maximum contamination of wire sponges and dishcloths is related to fungus (42.76%); likewise it can conclude that the washing liquid have inadequate efficacy on wiping them out [Turgay et al.].

In this survey, the highest rate of knives contamination was due to ***S. epidermidis*** (16.91%) and also the lowest rate was **Pseudomonas spp.** (1.77%). A remarkable note transpired from table 2, is much greater pollution of knives against spoons& forks (76.15% vs 11%). A similar study was carried out in Burkina Faso [Barro et al.], the investigators worked on Hygienic status assessment of dish washing waters, utensils, hands and pieces of money (coin, bill) from street food processing sites. Absolutely they revealed that Coliforms bacteria like ***E.coli*** and amount of ***S. aureus*** were grew on all the specimens (100%) taken from knives, although in our study this percentage were 15.40% for ***E.coli*** and 14.40% for ***S. aureus***. Moreover, the authors of above study declares that ***Salmonella sp.*** and ***Shigella spp.*** were high in butcher's knives, whilst just the 3.03% of our knives contamination were related to ***Shigella spp.*** and also neither ***Salmonella spp.*** have been found. Additionally, in comparison with the study of [Erickson et al.] and the above study we can deduce that **E.coli** is the most prevalent bacteria exist in knife samples. In other study performed around the microbial content of the domestic kitchen, 46 houses had been selected and sampled over a wide range of sites. According to the results of this study, Speirs et al. had found ***Bacillus spp.*** positive for the cutleries (knife, spoon &fork), however in ours, no *Bacillus spp*. were found on spoons and forks. Also, in regarding to table 2, amount of ***pseudomonas*** contamination (1.77%) detected on knife samples; but there were no stains of this bacteria on the knives of above study.

In[16], the researchers have sampled from 32 occasions of 35 houses in New Jersey. They figured out that 89% and 83% of kitchen washing sinks consecutively contaminated by ***Staphylococcus spp.*** and ***enterobacteriacea spp***; also 24% of them were positive for ***Pseudomonas spp.*** too;but according to table 2, we have just found approximately the same bacteria in different percentages (34.95% for ***Staphylococcus spp.*** and 6.66% for ***Pseudomonas spp.***). ***E.coli*** (with 17.20%) and ***Shigella spp.*** (with 2.36%) were just the two *Enterobacteriacea spp.* found in our research.

Also the Speirset al. have gotten on assessing the kitchen washing sinks bacterial contamination; in the comparison, ***Staphylococcus spp.***, ***Bacillus spp.***, ***Enterobacter spp.***, ***E.coli*** and ***Pseudomonas spp.*** were observed in both researches; even though many inequalities manifested actually, for instance, despite of our results, some ***Klebsiella sp.***, ***Yersinia enterocolitica*** and ***serratia spp.*** were found in above study. As a matter of fact, presence of ***Yersinia sp.*** could be relative on keeping domestic animals in house sitting environments. Also in opposite side, some kind of our bacterial and fungal isolates, like ***Shigella spp.***, ***enterococcus sp.*** and fungal contamination have not been found in their study.

In regarding to Speirs et al. study, cutting boards (chopping board) were assessing through the microbial contamination. The results revealed that ***Staphylococcus spp.*** (38.90%) were the most microorganism found and ***E.coli*** & ***Klebsiella spp.*** (each one with 0.9%) were the least bacteria cultured; although we have found ***E.coli*** with 12.60% and neither ***Klebsiella*** sampled. Considerably, a compliant discovery occurred in both studies is to notice ***Staphylococcus spp.*** as the most bacteria existed on the surface of cutting boards. Finally, despite of detecting some bacterial (consist of ***Shigella sp.*** and ***Enterococcus sp.***) and fungal contamination, the other results of both studies are approximately the same.

As declared on the results of this study, cutting boards comprises a high rate of microbial contamination. In our sight, it probably comes about its particular and poriferous structure of plastic and wooden cutting boards which entrap the particles and molecules of various nutriments, like vegetables and meets, etc; thus it has been expected that amount of adenosine three phosphate (ATP)remain on their surface [as mentioned by Studerus D et al.]. Accordingly, it can be a main source for bacterial accumulation and increase the possibility of things cross-contamination.

According to table 1, a total of 75 samples have been caughtfrom cleaned cutleries (spoons & forks) which generally 11% of them were contaminated; at highest rate they were polluted by ***S. epidermidis*** (60%), followed by ***E.coli*** (16%), ***Enterobacter sp.*** (10.67%) and ***Enterococcus sp.*** (5.33%); however Barlow et al. showed that***Pseudomonas sp.*** designated as prevailing load of bacterial contamination. Also ***Citrobacter sp.*** (3.3%) have been detected in above article too. Perhaps its existence, according toLynn Maori's et al. survey may beholden as using multiple wasted waters chiefly by the most vendors whom use dish washing waters in buckets placed on the floor and note that they are rarely renewed and generally observed to be dirty. Moreover in the research of Barlow et al.***Bacillus spp.*** have been found with the percentage of 0.2% which may emerge through exposing to dust in open areas. In comparison with our study we have found neither ***Salmonella sp.*** nor ***Klebsiella sp.*** and ***Streptococci sp.*** Strainsreverse to their results. The other attainments are almost the same.

For the results of spatula & ladle samples, actually there are consonant similarities in comparing to utensils, so we can generalize above course to them.

Scott et al. assessed 35 kitchen countertops for microbial accumulations, therefore a great load of***Staphylococcus spp.***(83%), ***Enterobacter spp.*** (67%) and ***Pseudomonas spp.*** (11%)have been detected, but generally there are found a vast harvest of bacterial and fungal microorganisms in our results including: ***Staphylococcus spp.*** (31.28%), ***Bacillus sp.*** (16.24%) ***Enterococci sp.*** (2.28%) and ***Pseudomonas spp.***

(1.07%). As all we know, ***Bacillus spp.***is aGram-positive, rod-shapedbacteria whichexhibit a wide range of physiologic abilities that allow them to live in every natural environment. Besides, they can reduce themselves to oval endospores and can remain in this dormant state for years. ***Bacillus sp***. commonly are issued from unsterile soil and are a threat for those one in contact with infected animals, animal products or unwashed vegetables. Also they result from ingestion of contaminated foods in which the bacteria have multiplied to high levels under conditions of improper storage after cooking. Thus they can easily move through such equipment and endanger the human health.

For the case of frying oil baskets and frying oil pots, we look on a grate resemblance with the percentage, exception of 2 disparity, founding some ***S. aureus*** isolation (15.5%) over frying oil basket samples and also detecting more fungal contaminations in frying oil pots against the frying oil baskets. Obviously for the particular and reticular shape of frying oil baskets, it is expected to take themselves less amount of frying oils in contrast with frying oil pots; moreover, inefficient and incorrect washing of frying oil pots may lead in remaining some frying oils (generally compound of palm oiland other ingredients) which provide a suitable condition for molds, yeasts and other fungal contaminations [S. C. Enemuor].

In this survey, ***Escherichia coli*** has owned the highest rate of dish racks and colanders contamination with 40.60% and 46.47% indeed. As revealed on the study of Barlow et al. most washing waters could be highly contaminated by ***E.coli***, fewer by ***S. aureus*** and in a fewer count by **Salmonella** & **Shigella**, therefore cleaned colanders and dishracks may be polluted by dish washing waters too. Also in whetstone specimens all of 8 different bacterial isolates have been detected, accordingly. This may happened due to frequently use during cutting and slicing meat, poultry and etc. and even not to clean or wash them after utilizing. According to table 2, ***S. epidermidis*** was the most bacteria lodge on whetstones (28.58%); probably trying the knives edge for sharpness measuring may allow this bacteria to pass around.

In this study, ***E.coli*** and ***Enterococcus spp.*** respectively were the most and the least microorganisms sampled from many utensils (618 pots – 437 pans – 680 dinner plate – 216 salad plate), however in another study performed by Barlow et al. in UK, the most and the least microbial pollution were related to ***Pseudomonas sp.*** and ***Streptococcus sp.***. In comparison some ***S. epidermidis*** and fungal contaminations have been detected in our results and no ***Pseudomonas sp.*** were found in related to utensils cases. Farther the alternative results are the same.

Finally for the glasses and pitchers (jug), ***Bacillus spp.*** has owned the highest rate of contamination with 30.48% and 30.89% respectively.In addition, other authors like Barlow et al. which have assessed the hygiene status of dish washing waters, utensils, hands and others from street food processing sites, it has been asserted that some significant microbial contamination as well as ***Shigella***,***Salmonella***, ***thermotolerant Coliforms*** and etc. would transfer to nutrition and other instruments through consumers and vendors hands eventuated insome disorders and illnesses. By considering above debate, it's manifested that respecting to individual hygiene and kitchen equipment purity, has a high importance in restrict of cross-contamination and preventing the bad consequences lead thereinafter.

CONCLUSION

In regarding to the results and discussion of this study, one can find the high capacitance of these bacterial and fungal contamination on many washed or uncleaned kitchen utensils which may have a high substantial role in transferring such microorganisms to other surfaces and furthermore cause food poisoning and other related food-borne disease like gastrointestinal disorders and etc. Other harmful bacteria such as ***Helicobacter pylory***, ***Salmonella sp.***, ***Campylobacter*** and ***Yersinia*** may have been found on these utensils and imperiling the human's health. Thus, a sufficient cleaning and washing of such equipment could be a prevention to those disorders.

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REFERENCES

1. Jalalmanesh S, Darvishi M, Rahimi M, Akhlaghdoust M. (2017). Contamination of Senior Medical Students' Cell Phones by Nosocomial Infections: A Survey in a University-Affiliated Hospital in Tehran, Shiraz E-Med J. 18(4):e59938.
2. Chen Y, Wen Y, Song J, Chen B, Wang L, Ding S, Ding L, Dai J. (2019). Food Handling Behaviors Associated with Reported Acute Gastrointestinal Disease That May Have Been Caused by Food. Journal of Food Protection, 82(3), 494-500. https://doi.org/10.4315/0362-028X.JFP-18-163.
3. Tóth, A. J., Szakmár, K., Dunay, A., Illés, C. B., & Bittsánszky, A. (2018). Hygiene assessments of school kitchens based on the microbiological status of served food. *Acta Scientiarum Polonorum, Technologia Alimentaria*, *17*(2), 159–168. https://doi.org/10.17306/J.AFS.2018.0564
4. Evans EW, Redmond EC. (2019). Domestic Kitchen Microbiological Contamination and Self-Reported Food Hygiene Practices of Older Adult Consumers. Journal of Food Protection, 82(8), 1326-1335. https://doi.org/10.4315/0362-028X.JFP-18-533.
5. Humphrey, T. J., Martin, K. W., & Whitehead, A. (1994). Contamination of hands and work surfaces with Salmonella enteritidis PT4 during the preparation of egg dishes. *Epidemiology and Infection*, *113*(3), 403–409. https://doi.org/10.1017/S0950268800068412
6. Hilton, A. C., & Austin, E. (2000). The kitchen dishcloth as a source of and vehicle for foodborne pathogens in a domestic setting. *International Journal of Environmental Health Research*, *10*(3), 257–261. https://doi.org/10.1080/09603120050127202
7. Ak, N. O., Cliver, D. O., & Kaspar, C. W. (1994). Cutting boards of plastic and wood contaminated experimentally with bacteria. *Journal of Food Protection*, *57*(1), 16–22. https://doi.org/10.4315/0362-028X-57.1.16
8. Dang-Xuan, S., Nguyen-Viet, H., Pham-Duc, P., Grace, D., Unger, F., Nguyen-Hai, N., … Makita, K. (2018). Simulating cross-contamination of cooked pork with salmonella enterica from raw pork through home kitchen preparation in Vietnam. *International Journal of Environmental Research and Public Health*, *15*(10), 1–15. https://doi.org/10.3390/ijerph15102324
9. de Wit, J. C., Broekhuizen, G., & Kampelmacher, E. H.

(1979). Cross-contamination during the preparation of frozen chickens in the kitchen. *Journal of Hygiene*, *83*(1), 27–32. https://doi.org/10.1017/S0022172400025791

10. Zottola, E. A., & Sasahara, K. C. (1994). Microbial biofilms in the food processing industry-Should they be a concern? *International Journal of Food Microbiology*, *23*(2), 125–148. https://doi.org/10.1016/0168-1605(94)90047-7
11. Rossi, E. M., Scapin, D., & Tondo, E. C. (2013). Survival and transfer of microorganisms from kitchen sponges to surfaces of stainless steel and polyethylene. *Journal of Infection in Developing Countries*, *7*(3), 229–234. https://doi.org/10.3855/jidc.2472
12. Reller, M. E. (2017). Salmonella Species. *Principles and Practice of Pediatric Infectious Diseases*, (1), 837–842. https://doi.org/10.1016/B978-0-323-40181-4.00146-8
13. Turgay, O. (2016). *Internet Journal of Food Safety V . 6 : 17-22 MICROORGANISMS IN KITCHEN*. (March 2005), 17–22.
14. Barro, N., Bello Abdoul, R., Savadogo, A., Ouattara Cheik Amadou, T., Ilboudo, A., & S, T. A. (2006). Hygienic status assessment of dish washing waters, utensils, hands and pieces of money from street food processing sites in Ouagadougou (Burkina Faso). *African Journal of Biotechnology*, *5*(June), 1107–1112.
15. Erickson, M. C., Liao, J., Cannon, J. L., & Ortega, Y. R. (2015). Contamination of knives and graters by bacterial foodborne pathogens during slicing and grating of produce. *Food Microbiology*, *52*, 138–145. https://doi.org/10.1016/j.fm.2015.07.008
16. Speirs, J. P., Anderton, A., & Anderson, J. G. (1995). A study of the microbial content of the domestic kitchen. *International Journal of Environmental Health Research*, *5*(2), 109–122. https://doi.org/10.1080/09603129509356839
17. Scott, E., Duty, S., & McCue, K. (2009). A critical evaluation of methicillin-resistant Staphylococcus aureus and other bacteria of medical interest on commonly touched household surfaces in relation to household demographics. *American Journal of Infection Control*, *37*(6), 447–453. https://doi.org/10.1016/j.ajic.2008.12.001
18. Studerus D, Hampe EI, Fahrer D, Wilhelmi M, Vavricka SR. (2018). Cross-Contamination with Gluten by Using Kitchen Utensils: Fact or Fiction? Journal of Food Protection, 81(10), 1679-1684. https://doi.org/10.4315/0362-028X.JFP-17-383.
19. Barlow, C. G., & Bloomfield, S. F. (1982). An investigation of microbial contamination in the home. *Journal of Hygiene*, *89*(2), 279–293. https://doi.org/10.1017/S0022172400070819
20. Lynn Maori, Nandita De. (2010). Bacterial contamination of crockery and cutlery within the kiosks restaurants of the Federal University of Technology, Yola.. African Journal of Microbiology Research, 4(3), 147–153. Article Number - 7F4F1FA11571
21. S. C. Enemuor. (2012). Environmental and fungal contamination of palm oil sold in Anyigba Market, Nigeria. *African Journal of Microbiology Research*, *6*(11). https://doi.org/10.5897/ajmr11.1287.