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Bacteriological Study on Household Drinking Water Filters

دراسة بكترولوجية على مرشحات مياه الشرب المنزلية

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Abstract:

This study was carried out through a period at four months from October/2008 to Jaunary/2009.The goal of this work was to determine the efficacy of filters water that have low level of pathogenic bacteria. 4o samples of water were collected (randomly) from 40 different filters devices.The results showed that some types of filters are not safe in elimination of bacteria from water.That represented by: Escherichia coli, Pseudomonas aeruginosa, Staphylococcus epidermidis, Streptococcus faecalis, Staphylococcus aureus, and Vibrio cholerae with percentages 5(26.3%), 5(26.3%), 5(26.3%), 2(10.5%),1(5.3%),1(5.3%) respectively. Also the results showed that the efficacy of filters depends on the types of filters, times of use and the clean of devices.

الخلاصة:

أجريت هذه الدراسة خلال فترة 4 أشهر (الفترة من تشرين الأول/2008 إلى كانون الثاني/2009). الهدف من هذا العمل هو تحديد كفاءة مرشحات(فلاتر) مياه الشرب المنزلية في التخلص من البكتريا الممرضة. الدراسة تضمنت 40 عينة ماء والتي جمعت بصورة عشوائية من 40 جهاز ترشيح مختلف. أظهرت النتائج أن بعض انواع المرشحات غير أمينة في إزالة البكتريا, والمتمثلة

ب *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus epidermidis*, *Streptococcus faecalis*, *Staphylococcus aureus*, and *Vibrio cholerae* وبنسب:(3و26%)5,(3و26%)5,(3و26%)5,(5و10%)2,(3و5%)1,(3و5%)1 على التوالي. كذلك وجد أن كفاءة المرشحات(الفلاتر) تعتمد على أنواع الفلاتر وطول فترة استخدامها ونظافتها.

Introduction:

Water is the basic requirement of almost all living organisms. It can be contaminated then it may cause direct danger to health. So the purity and contamination of water is one of the major problems throughout the world [1,2]. As water can carry number of different organisms to a large number of consumers and over wide areas, the early recognition of the relevant contamination must be ensured. So it is necessity of healthy life that the reservoir, which supply the water for human use must be checked, whether they are supplying the pure and contamination free water or not[2].

Microbiological contamination of water has long been a concern to the public[3,4]. Drinking water will always contain bacteria. In most cases the bacteria will be dead or non viable. However there is always the possibility that there will be a more serious bacterial contamination, possibly caused by burst pipes or other issues[5].

According to World Health Organization (WHO), there were estimated 4 billion cases of diarrhea and 2.2 million deaths annually. Filtered water is the main source of safe and reliable drinking water. However, there is still a debate on the efficiency of filtration system to comply with the regulations as water that physically looks colourless, odourless and even tasteless is not sufficient to determine that the water is safe for consumption. The WHO in its 2002 report, recommended that increased emphasis be placed on home water treatment and storage, and that more research should be conducted to assess the health benefits of such interventions. Contaminants can be in the form of microorganism that barely visible in unaided eyes[6,7].

Today's water filters serve to render water cleaner, and can act in three different ways. A water filter can be a physical barrier to debris and other undesirable water components, and, like a sieve, can keep the unwanted components out [7]. A water filter can also impose chemical processes upon the water so that minerals and other compounds are precipitated out and easily removed [7]. A water filter can also use biological processes, such as the ability of certain bacteria to remove contaminants from water, and allow such bacteria to grow on their surfaces and filter the water free of contaminants [7].

There are several types of household drinking water filters:-

Carbon filters, using granular activated carbon(GAC) or a carbon block are great at removing a long list of organic contaminants and chlorine; can slightly reduce a few toxic heavy metals(mercury), but have no capacity at all to remove dissolved minerals salts(arsenic) or nitrates[8].

Gadget Filters that attach to faucet or fit in a pitcher typically use granular activated carbon or a small carbon block. These products are designed to improve taste, odor, and appearance [8].

Typical Reverse Osmosis(RO) systems will reduce, but not completely eliminate, most heavy metals and dissolved salts. RO systems perform poorly when faced with fluoride, nitrates, and radioactive particles. Contaminant removal rates are listed under optimal laboratory conditions, but in real world installations performance can vary greatly. Budget systems from home improvement stores often show drastically reduced performance in as little as six months [8].

Distillers can be an excellent choice, but a high quality distiller, designed to last decades, is very costly. Cheap countertop distillers don't last, are a bother to keep clean, and leave you exposed to volatile organic chemicals that will distill right along with the water. Asbestos fibers, if present, can also end up in the distillate. Distillers produce water very slowly, require electricity, and generate a large amount of heat [8].

Alkaline Water Machines, the latest fad in drinking water treatment, typically have carbon filters smaller than the gadget filters mentioned above, and don't remove heavy metals like lead, arsenic, asbestos, cadmium, and mercury. Or fluoride. Or nitrates [8].

Ultra-violet lights are added to many of the systems above to kill bacteria, cyst and virus. But UV is a disinfectant only, not a filter. After those bugs are killed their carcasses and endotoxins remain [8].

The goal of this project was to determine the efficacy of some types of water filters being used by most of the Iraqi families to eliminate bacteria from the drinking water.

Materials and Methods:

1.Collection of Water Samples:

In this study,40 samples of different household drinking water filters(Gadget filters, Reverse Osmosis filters and Refrigerators filters) from different areas in Hilla city, through a period at four months from October/ 2008 to January/ 2009.Water samples were collected in sterile test tubes and under a septic conditions[9].

2. Culture Media:

Common culture media (nutrient agar, blood agar, MacConkey agar, Mannitol agar, Simmons' citrate, Kligler's iron agar and gelatin liquefaction agar) were prepared according to the recommendation of the manufacture companies which reported on the containers and sterilized by the autoclave[10,11].

3. Identification of bacterial isolates:

The isolates being detected were identified according to routine diagnostic tests as recommended by (Baron,*etal*.,1994 ;Collee ,*etal.*, 1996 and Macfaddin,2000) [9,10,11].

4. Determination of viable count of bacteria:

The bacterial count was determined according to viable cell count most probable number method (MPN) as recommended by (Collee ,*etal.*, 1996)[10].

Results and Discussion:

The obtained results as shown in figure-1, indicated that 19(47.5%) of filtered water samples revealed positive results for bacterial growth, while 21(52.5%) samples showed no growth. Also results showed that 11(57.9%) of the positive samples were identified as Gram-negative bacteria represented by: *Escherichia coli*, *Pseudomonas aeruginosa*, and *Vibrio cholera*, as shown in figure-2 and table-2, all of them were rod shaped except one was in curved rod form. The other 8(42.1%) samples were Gram-positive bacteria represented by: *Staphylococcus epidermidis*, *Streptococcus*

faecalis and *Staphylococcus aureus*, as shown in figure-2 and table-2. This is in agreement with previous studies where most bacteria found in the drinking water are Gram-negative bacteria. These bacteria were naturally present in the water [2,6].

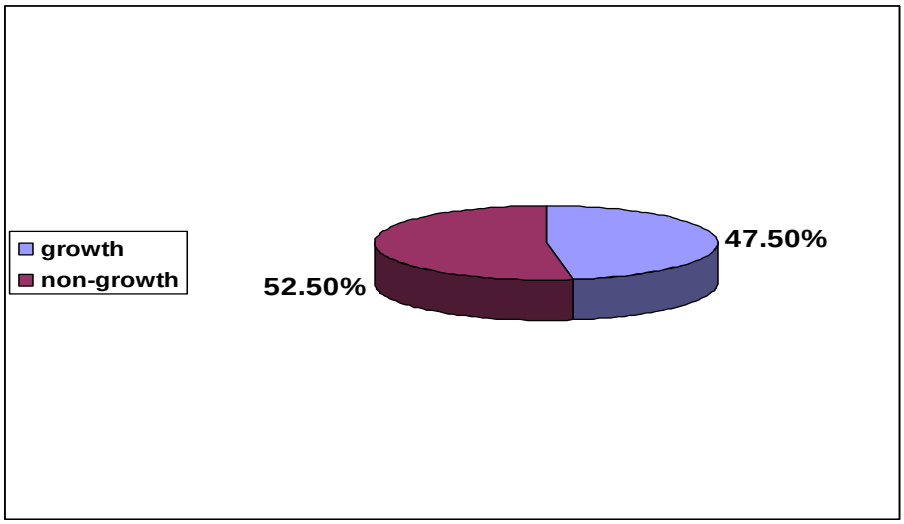

Figure-1. Percentage rate of bacterial growth among filtered water samples.

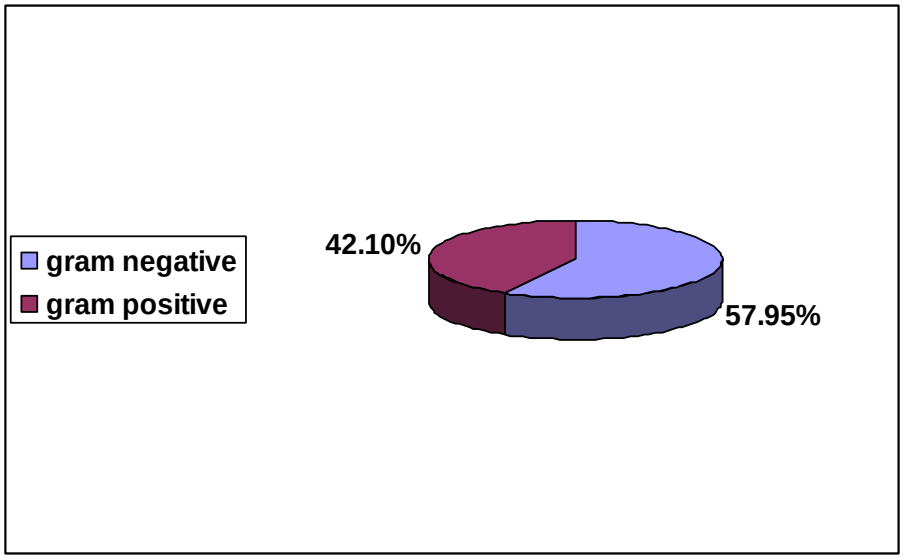

Figure-2. Percentage rate of Gram-negative to Gram-positive bacterial isolates.

Table-1, shows the results of biochemical tests being used for isolation and identification of bacteria. The results were compared with the referential results reported by Baron,*etal*.,1994; Collee,*etal*.,1996 and Macfaddin,2000 [9,10,11].

Table-1. Biochemical characteristics of isolated bacteria.

Tests	Escherichia coli	Pseudomonas aeruginosa	Vibrio cholera	Staphylococcus epidermidis	Streptococcus faecalis	Staphylococcus aureus
M	Rods single, pairs	Rods single, pairs	Curved rods	clusters	Cocci Pairs, chains	Spherical clusters
Gram's stain	-	-	-	+	+	+
Catalase	+	+	+	+	-	+
Oxidase	-	+	+	-	-	-
Gelatin liquefaction	-	+	+	+	+	+
Growth at 42°c	+	+	+	+	+	+
Motility	+	+	+	-	-	-
Pigment production	-	+	+	-	-	+
Simmon's citrate	-	+	-	+	-	+
Kligler's iron agar	A/A	k/k	k/A	k/A	k/k	k/A
Mannitol agar	-	-	-	-	-	+
Growth on MacConkey	+	+	+	-	+	-
hemolysis	-	ß	-	-	γ	β

M= morphology, + = positive,- = negative , k= alkaline , A= Acid, ß= beta hemolysis, γ = gamma hemolysis

Table-2,as depicted below shows the types, numbers and percentages rate of bacterial isolates being detected in filtered water samples which consist of Gram-negative bacteria represented by: *Escherichia coli* 5(26.3%) , *Pseudomonas aeruginosa* 5(26.3%), *Vibrio cholera* 1(5.3%), and Gram-positive bacteria represented by: *Staphylococcus epidermidis* 5(26.3%), *Streptococcus faecalis* 2(10.5%), and *Staphylococcus aureus* 1(5.3%).

Table-2. Types of isolated bacteria with their percentages rates.

Types of Bacteria	No.(%)	Bacterial Count	
		Standard values cell/ml *	Present study values 10^2 cell/ml
Escherichia coli	5(26.3%)	0/100	1.4
Pseudomonas aeruginosa	5(26.3%)	-	1.2
Staphylococcus epidermidis	5(26.3%)	-	0.9
Streptococcus faecalis	2(10.5%)	0/100	0.7
Staphylococcus aureus	1(5.3%)	-	0.4
Vibrio cholera	1(5.3%)	-	0.5
Total	19(100%)		

* Standard values according to World Health Organization (WHO) [12].

In table-2, it was clear that *Escherichia coli*, *Pseudomonas aeruginosa* ,and *Staphylococcus epidermidis* were in high percentages than other bacterial isolates, while *Streptococcus faecalis*, *Staphylococcus aureus* and *Vibrio cholera* were in low percentages. This results is in agreement

with other obtained previous studies as in (Ahmed,*etal*.,2004 and Chan,*etal.*,2007) respectively [2,6].

In fact, the presence of some bacterial types such as *E.coli* in the filtered drinking water belong to its present in large numbers among intestinal flora of humans and other warm-blooded animals, since its found in fecal wastes. As a consequence, *E.coli* detected in a high percentage more than other pathogenic bacteria, which used as an index of the potential presence of entero-pathogens in water environments [13]. As a result, its presence in drinking water must be considered as harm to human health, drinking water is not a natural environment for it. So the presence of *E.coli* in filtration water is regarded as the essential indicator of faecal pollution of human or animal origin and filtration ineffectiveness [14].

In addition *Pseudomonas aeruginosa* is the normal microflora in human and animals. *Pseudomonas aeruginosa* does not harm a healthy individual but cause problem in individual with weak immune system [15]. However, it is more reliable and safe if the drinking water does not show the presence of *Pseudomonas* spp. since the presence of these bacteria in the water due to contamination by human themselves [16].

The present study showed positive results for the presence of *Streptococcus faecalis*. This indicates that the water was not free from faecal contamination as *Streptococcus faecalis*, which is one of the main indicators for the faecal contamination in drinking water [17]. The presence of some types of bacteria like *Streptococcus faecalis* was mainly due to the pore sizes of the filters which not able to filter these bacteria from the water [18]. Furthermore, some types of bacteria such as *Pseudomonas aeruginosa* are more resistant than other types of bacteria to chlorination, tend to survive longer than other bacteria in the environment. The chlorination may be not able to kill and eliminate most of the bacteria that were present. Also the presence of any type of bacteria in chlorinated water indicates either a failure of the chlorination process or contamination after chlorination [19].

In the note of worth, and according to WHO standard bacterial count to most studied bacteria in the present study were showed high values of bacterial count as compared with standard values. The nature and types of microbes in the water samples will determine the health risk of consumer after consuming the water [4]. The total viable count showed that filtered samples were still not able to comply with the standard values for microbial quality of water for human consumption which noted given by WHO as shown in table-2 that only allowed not more than 0/100 ml in potable drinking water. There is likely most water were still exposed to the contamination of environmental bacteria even though after filtering treatment was provided [6].

Table-3, showed the types of filters, number of filters and the number of bacterial isolates. The results of this study were indicated that the type, age, and the cleaning of the water filters were considered as a risk factors that increase the chance of water contamination.

Table-3.Types and numbers of filters with the number of isolated bacteria.

Type of Filter	No. of filters	Number of Isolates
Gadget filters (single)	21	18(94.7%)
Reverse Osmosis(Triple)	15	1(5.3)
Refrigerator filters	4	0
Total	40	19(100)

Some factors like pore sizes of the water filter affect on the ability of it in removing bacteria because filtration has a good effectiveness in removing bacteria when using pore sizes less than sizes of bacteria [18]. Another factor like the age and the cleaning of the water filter play an important role in removing bacteria because of the filters carbon is the building block of life, and will allow bacteria to colonize on its surface as soon as it gets wet [18]. Also because there is nothing toxic in the cartridges of the filters to prevent bacteria growth, so it will reach detectable levels of heterotrophic bacteria after 7-8 months, and dangerous levels after 12-24 months. To

prevent bacterial aggregation and accumulation on the filter cartridges should be changed every 6 months, regardless of use [19].

The study conducted that the high number of bacteria in filtered water indicated that contamination of household drinking water is the main reason for such result. In addition, some types of filters which, consider traditional filters, showed low and limited effect in elimination of bacteria from the drinking water. Furthermore, the repeat cleaning to the filters every 6 months is recommended to be used and maintained.

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