Yogurt and physico-chemical parameters of water

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Abstract: Besides other environmental factors, water is of major importance both to human society and to biological diversity, currently in retrogression. The alarm signal is due not so much to the physical exhaustion of water as to its pollution. The aim of the present work is to study the effect of yogurt as probiotic on water purification. water samples (from the tape water) were collected, half of the samples were used as control(pre-injection) and the other half of the samples (post-injection) injected by 0.01 ppt yogurt for six days. The physicochemical parameters of water samples were measured. Also, water is exposed to bacteriological examinations. The yogurt injection caused an increase in pH-value and alkalinity, a decrease in salinity, chlorinity and total dissolved solids, and no changes in temperature, taste and odor. In addition, it was observed that the trace element concentrations in water decreased. The bacteriological examinations revealed that water before and after yogurt injection is suitable for usage by human. The study shows that the yogurt plays a major role in finding successful solutions for a lot of environmental problems as well as water pollution treatment.

[Zeinab Z. K. Khater. **Yogurt and physico-chemical parameters of water**. *J Am Sci* 2014;10(9):146-152]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 20

Key words: Yogurt, probiotic, physicochemical parameters, water pollution treatment, biological purification.

1. Introduction

Yogurt is produced by adding two starter cultures, *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* to milk **(Tamime and Marshall, 1997)**. During the fermentation, hydrolysis of the milk proteins occurs, the pH drops, the viscosity increases, and bacterial metabolites are produced that contribute to the taste and possibly to the health promoting properties of yogurt. Several health benefits have been reported for traditional yogurt **(Boudraa *et al*., 1990; Marteau *et al*., 1990; Bakalinsky *et al*., 1996; Rachid *et al*., 2002)**, and this healthy image is enhanced by supplementation with probiotic bacteria. Probiotic bacteria are defined as "live microorganisms that when administered in adequate amounts confer a health benefit on the host" **(FAO, 2001)**. Fermented foods that have potential probiotic properties are produced worldwide from a variety of food substrates **(Farnworth, 2005)**. Probiotics have been used for the treatment of various types of diarrhea **(Sarker *et al*., 2005; Szymanski *et al*., 2006)**, urogenital infections **(Reid *et al*., 2003)**, and gastrointestinal diseases such as Crohn's disease **(Bousvaros *et al*., 2005)** and pouchitis **(Kuehbacher *et al*., 2006)**, although there is still no consensus about their effectiveness **(Lin, 2003; Reid and Hammond, 2005; Senok *et al*., 2005)**. Lactic acid bacteria including lactobacilli and bifidobacteria are the most common bacterial species considered as potential probiotics **(Sanders, 1997)[Farnworth *et al*., 2006]**.

Water, that for a long time has been considered sufficient and whose existence has been given for granted, may become a limitation factor of the economic development in the future decades. The raising pressure is currently due to the extension of pollution, the exhaustion of some underground reserves, the lowering of subsoil water level and the decline of aquatic ecosystems. The danger is due not so much to the physical exhaustion of the water, but to its pollution, phenomenon primarily caused by the antropic impact. We refer both to pollution caused by industry, agriculture, domestic activities, and to the insufficient purification of waste waters, finally released into emissaries **(Iconomu and Redinciuc, 2004)**.

Biological treatment is an important and integral part of any wastewater treatment plant that treats wastewater from either municipality or industry having soluble organic impurities or a mix of the two types of wastewater sources. The obvious economic advantage, both in terms of capital investment and operating costs, of biological treatment over other treatment processes like chemical oxidation; thermal oxidation etc. has cemented its place in any integrated wastewater treatment plant. Biological treatment using aerobic activated sludge process has been in practice for well over a century. Increasing pressure to meet more stringent discharge standards or not being allowed to discharge treated effluent has led to implementation of a variety of advanced biological treatment processes in recent years **(Mittal, 2011)**.

Therefore, the aim of this study is to improve the physical, chemical properties of water by subjecting samples to probiotics as a new, safe biological method for animal, man and environment.

2. Material and methods

1- Sampling sites:

Samples were collected from a tape water of El-Henawy area, Zagazig, Egypt.

2- Analytical procedures:

Water samples were taken from the site where some of the samples were subjected to yogurt as probiotic with aeration for one, three and six days. All the samples were analyzed for water quality (chemical and physical characteristics of water). Trace elements; zinc (Zn), lead (Pb) and cobalt (Co) were also analyzed in water samples.

A- Water analysis:

I- Physico-chemical analysis of water:

Water samples were taken, then placed in a clean 6000 ml sampling glass bottle, according to **Boyd (1990)**.

*** Temperature**:

Temperature was measured at the site of sampling, using a mercury thermometer of 0 to 50˚C range **(Gupta, 2000)**.

*** Odor and Taste:**

Odor and taste can be determined according to **Gupta (2000)**.

*** pH-value**:

pH was measured by using glass electrode pH-meter (Digital Mini-pH-Meter model 55) **(Khater, 2011)**.

*** Total dissolved solids:**

Total dissolved solids can be determined according to **Ibraheim and Khater (2013)**.

*** Chlorinity**:

It can be measured by using digital chlorimeter (model HI 93711) **(Khater, 2011)** .

*** Salinity:**

It can be measured by using digital salinometer (model Atago Hand Refractometer) **(Khater, 2011)** .

***Alkalinity:**

Alkalinity can be determined according to **Ibraheim and Khater (2013)**.

II-Trace elements in water:

Twelve water samples were collected from a tape water for trace element analysis, nine of which were exposed to yogurt as probiotic, and the others were put in cleaned bottles and stored until analysis was carried out. Trace element concentrations in water were determined by atomic absorption spectrophotometer (Perkin Elmer, 2280). The samples were prepared and analyzed in sequential for zinc, cobalt and lead according to **APHA (1985).**

III- Bacteriological examinations:

Bacteriological examination were done in Department of Bacteriology, Faculty of Veterinary Medicine, Zagazig University according to **Shah and Lankaputhrab (1997)**.

B- Statistical analysis:

The statistical analysis was performed using the analysis of variance (ANOVA) to determine the differences between treatments mean at significant level of 0.05. Standard deviations were also estimated. All statistics were run on the computer using SPSS program. All graphics and tables were made by using Origin 8 and Microsoft word (2007). The methods used for analysis of the results were done according to **Bishop (1980)** and **McCreadie *et al*. (2006)**.

3. Results

A-Water analysis:

I- Physico-chemical analysis of water:

Comparing the average means of the same physicochemical parameters of water samples in the different pre and post- injected levels, the data recorded in table (1) and [fig]. (1-6) showed a remarkable variations in it.

Table (1): The physico-chemical parameters (Mean ± SD) before and after yogurt injection.

Parameters / Yogurt injection	Pre-injection	One day post-injection	Three days post-injection	Six days post-injection
Odor	no	no	no	no
Taste	no	no	no	no
Temperature (℃)	24±0	24±0	24±0	24±0
pH value	6.95±0	6.95±0	7±0	7±0
Salinity (‰)	29±0	29±0	28±0	27±0
Chlorinity(‰)	16.07±0	16.07±0	15.51±0	14.96±0
Total dissolved solids (ppt)	1±0	1±0	0.6±0	0.6±0
[Alkalinity] (ppm)	100±0	110±0	135±0	200±0

* Data are represented as mean ± SD, (n = 12).

**Means with the same letters in the same row are significantly different ($p<0.05$), using ANOVA.

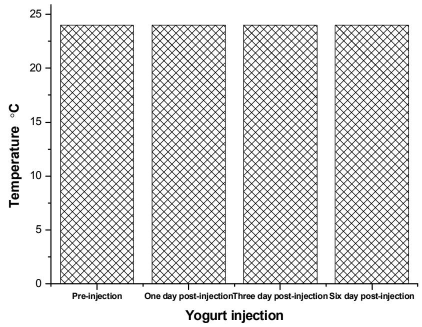

Fig. (1): The temperature(Mean ± SD) of water before and after yogurt injection.

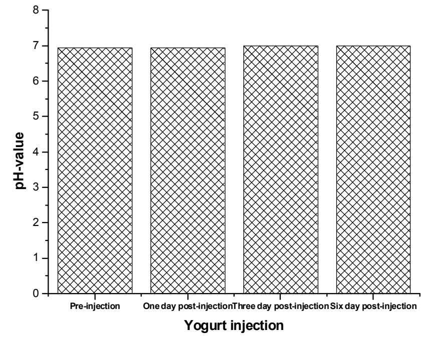

Fig. (2): The pH-value (Mean ± SD) of water before and after yogurt injection.

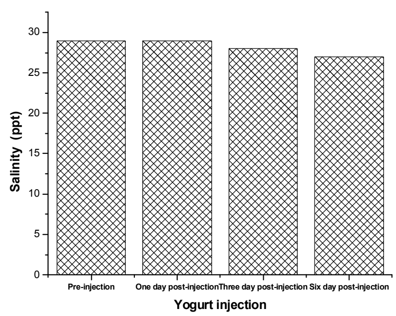

Fig. (3): The salinity(Mean ± SD) of water before and after yogurt injection.

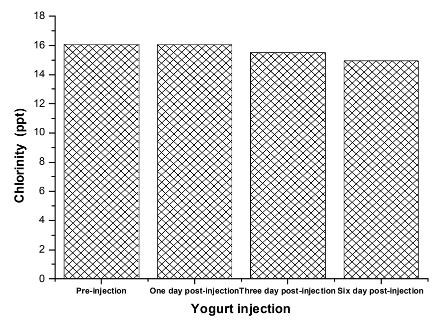

Fig. (4): The chlorinity (Mean ± SD) of water before and after yogurt injection.

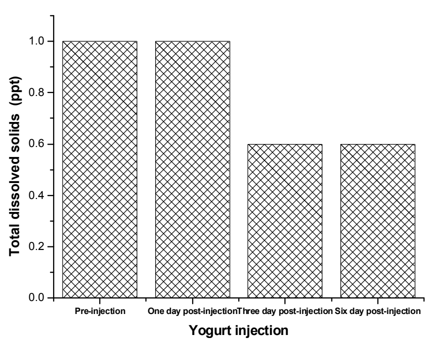

Fig. (5): The total dissolved solids (Mean ± SD) of water before and after yogurt injection

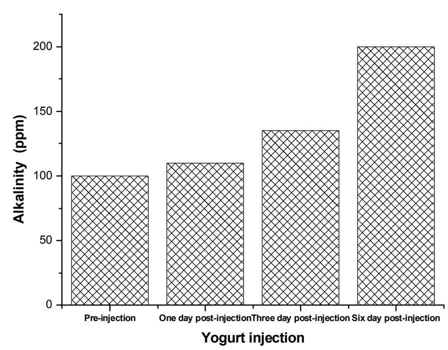

Fig. (6): The alkalinity (Mean ± SD) of water before and after yogurt injection.

II-Trace elements in water:

Comparing the average concentrations of trace elements in the different injected levels, the data recorded in table (2) and fig. (7) showed remarkable decrease and variations in trace element concentrations in water samples before and after yogurt injection. The concentrations had the order: Zn>Pb>Co.

Table (2): The trace element concentrations (Mean ± SD) of water before and after yogurt injection.

Yogurt injection / Parameters	Pre-injection	One day post-injection	Three days post-injection	Six days Post-injection
Zinc (Zn) ppm	0.0224±1.4142E-4[ab]	0.0140±4.9498E-4[a]	0.0012±4.2426E-4[a]	8E-4±0[b]
Cobalt (Co) ppm	0.0036±4.2426E-4[a]	0.003±0[b]	0.0028±2.1213E4[a]	0.0013±0[ab]
Lead (Pb) ppm	0.0068±4.2426E4[ab]	0.006±5.6569E-4[cd]	0.0018±0.0011[ac]	0.0015±9.8994E4[bd]

* Data are represented as mean ± SD, (n = 12).
**Means with the same letters in the same row are significantly different (p<0.05), using ANOVA.

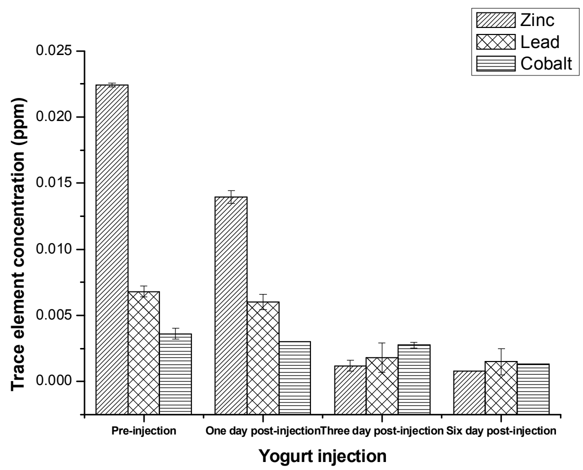

Fig. (7): The trace element concentrations (Mean ± SD) in water before and after yogurt injection.

III- Bacteriological examinations:

Bacteriological examinations revealed that all water samples before and after the injection of yogurt were suitable for human usage (Coliform count was less than $1x10^{-2}$/100 ml water).

4. Discussion

Water pollution is due to the change in physical, chemical and biological properties which is either directly or indirectly caused by human activity and their derivatives **Ibraheim and Khater (2013)**. In the early years of the twentieth century the method of biological treatment was devised, and now forms the basis of wastewater treatment worldwide. It simply involves confining naturally occurring bacteria at very much higher concentrations in tanks. These bacteria, together with some protozoa and other microbes, are collectively referred to as activated sludge. The concept of treatment is very simple. The bacteria remove small organic carbon molecules by 'eating' them. As a result, the bacteria grow, and the wastewater is cleansed. The treated wastewater or effluent can then be discharged to receiving waters – normally a river or the sea **Davies (2005)**.

Temperature:

Water temperature is one of the most influential environmental factors affecting the metabolism of living organism **(Herzing and Winkler, 1986)**.

In this study, there was no change in water temperature in the various examined levels due to yogurt injection and this range of water temperature was favorable for human **ANZECC (2000)** and bacteria action **Davies (2005)**.

Odor and taste:

In the present study, there were no odor and taste in all the examined levels before and after the yogurt injection and this is agreed with that of **Meloni and Oy (2013)**.

pH- value:

In the present study, the pH values at all the examined levels were always at the neutral side and there was insignificant effect of the yogurt injection. It is agreed with that of **Davies (2005)** and **Meloni and Oy (2013)**. The data obtained in this study indicate that the pH at all the study levels lies within the favorable limits (6.2-8.3) needed for the growth and survival of living organisms and comply with results of **Adeyemo *et al.* (2008); Korai (2008) and Pandey and Tiwari (2009).**

Salinity& chlorinity:

From the present data, it is clear that the salinity and chlorinity contents decreased in the yogurt injected levels and this agreed with **Davies (2005)** and **Peterson (2008)**. The range of salinity in the study(<3 mg/l) was suitable for living organisms growth and survival., as mentioned by **ANZECC (2000); Ibraheim and Khater (2013)**.

Total dissolved solids (TDS):

From the data reported in this study, it is clear that the values of TDS were decreased after the yogurt injection and this agreed with **Davies (2005)** and **Peterson (2008)**.

Alkalinity:

From the present data, it is clear that the alkalinity increased in the yogurt injected levels and this agreed with **Davies (2005)** and **Peterson (2008)**. The range of alkalinity (20 mg/l) in the present study was not recommended, as mentioned by **ANZECC (2000); Ayoola and Kuton (2009)**; **Sithik *et al.* (2009)**.

Heavy metals in water:

Zinc (Zn):

The mean concentrations of Zn in this study were below the legal limits (3 mg/l) recommended by **WHO (2008)** at all the study samples. These results are nearly similar to those obtained by **İncekara (2009)**; **Miclean *et al.* (2009) and Khater (2010)**, whereas they are lesser than those reported by **Akoto and Adiyiah (2007); Obasohan (2007)**; **Frankowski *et al.* (2009)**. Moreover, the mean concentrations of Zn decreased after the injection of yogurt.

Lead (Pb):

The mean levels of Pb obtained here were lower than legal limits (0.01mg/l) reported by **WHO (2008)** in all the study samples. The concentrations of Pb in the present study were lesser than those recorded by **Muwanga and Barifaijo (2006)**; **Abulude *et al.* (2007)** and lower than those obtained by **Awofolu (2006); Frankowski *et al.* (2009)**. However, the yogurt injection for 6 days decreased the mean concentrations of Pb.

Cobalt (Co):

In this study the mean Co concentrations were higher than the permissible levels (0.0014 mg/l) recommended by **ANZGFWQ (2000a)** at all the study samples. Comparative Co levels were recorded by **Muwanga and Barifaijo (2006)**; **Abdul Ghaffar *et al.* (2009) and El-Sayed *et al.* (2011)**. Also, as in Zn and Pb, the yogurt injection for 6 days decreased the mean concentrations of Co.

Moreover, the concentrations of the studied trace elements were decreased in all water samples after the yogurt injection for six days, and this may be attributed to the direct effect of the probiotic bacteria of yogurt on chemical characteristics of water. It is agreed with those of **Davies (2005)** and **Peterson (2008)**. Also, The decrease can be explained thus, the microbe oxidizes trace elements biologically thus utilizing the reaction for its living functions and energy economy (biological purification process) or precipitates chemically these elements in its cells, mainly on the surface or in its filament, but the precipitated metal is not utilized by the microbe (biologically catalyzed precipitation reaction of trace elements) **Meloni and Oy (2013)**.

5. Conclusion

The biological treatment of water using probiotic bacteria has a vital role in treating the polluted water. This is one of the interesting findings in this field of research. This encourages more research in this field to overcome the negative effects of water pollution on human. It should be adapted to suit environmental conditions so that its use can be maximized. Finally, it can be concluded that biological treatment gives an optimum configuration for those wastewater treatment applications where the organic and inorganic impurities are at a relatively higher concentrations.

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7/5/2014