Effect of Bioyogurt Consumption on Fatty Metabolites of Serum and Colonic Microflora in Healthy Subjects

R. Niazmand¹, A. Niazmand², M. Sarabi², N. Arabporiani¹, and A. Doaei¹

ABSTRACT

Probiotic products highly affect the health of consumers by reducing the risk of heart attacks and improving the desirable microflora in the intestinal tract. In this study the effect of yogurt (500g/d for 3 wk) enriched with either Bifidobacterium bifidum or Lactobacillus acidophilus on the level of cholesterol, Low Density Lipoprotein (LDL) and High Density Lipoprotein (HDL) of serum and as well on the intestinal microflora were investigated in 24 healthy volunteers. Statistical analysis indicated that lower levels of cholesterol and HDL were found after consumption of either one of bio-yogurts as compared to the control states (P<0.05), whereas changes of LDL were not significant. Also, in comparison with control periods the results of microbial counts indicated that the number of fecal coliforms excreted during the consumption of either one of the yogurt types were not noticeable, while the number of Bifidobacterium bifidum and Lactobacillus acidophilus increased significantly (P<0.05).

Keywords: Cholesterol, High Density Lipoprotein (HDL), Intestinal micro flora, Low Density Lipoprotein (LDL), Probiotic yogurt,

INTRODUCTION

Nowadays it is in general recognized that an optimum balance in microbial population in one’s digestive tract is associated with sound nutrition and good health (Lourens-Hattingh et al., 2001). Bacterial population in the large intestine is very high reaching maximum counts of 10^{12} cfu/g and consisting of both beneficial and harmful species. Beneficial species play an efficacy role in production of vitamins, organic acids and bacteriocins and as well inhibit some of the diseases, while harmful ones produce toxins and carcinogen substances (Kailasapathy et al. 2008). Increasing evidence indicates that consumption of probiotic microorganisms can help maintain such favorable microfloral profile and result in several therapeutic benefits (Fernades et al., 1987; Lourens-Hattingh et al., 2001).

Adequate number of viable cells, namely the "therapeutic minimum" needs to be consumed regularly for transferring probiotic effects to consumers (Lourens-Hattingh et al., 2001).

One of the most popular dairy products used as carrier for viable Lactobacillus acidophilus and Bifidobacterium bifidum cells is bio-yogurt. Bifidobacteria are the predominant flora in breast-fed infants representing 99% of the fecal microbial flora. Lactococci, Entrococci and Coliforms represent less than 1% of the intestinal population, with Bacteriodes, Clostridia and other organisms being normally absent. With weaning and ageing of the infant, gradual changes in the intestinal flora profile occur. The proportion of bifidobacteria, lactobacilli and other beneficial bacteria declines significantly, while harmful bacterial counts increase.

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However, such good nutrition and dietary regimes as the consumption of bio-yogurt can maintain desirable microbial balance in the large intestine (Shakeri, 2003; Lourens-Hattingh et al., 2001).

There are claims that a consumption of probiotic products significantly reduces serum cholesterol (Fernades et al., 1987; Lourens-Hattingh et al., 2001; Shakeri, 2003; Bartram et al., 1994). Several interrelationships between increase in serum cholesterol levels and heart attacks are demonstrated (Dosti, 1998; Siunat, 1999).

Fat metabolism results in the production of some four substances namely: total cholesterol, Low Density Lipoprotein (LDL), High Density Lipoprotein (HDL) and triglycerides. An excess of in the above substances (more than normal limit) causes development of heart diseases as a primary event. Cholesterol accumulated in blood vascular walls causes their constriction. LDL intensifies it but HDL plays an important role in cholesterol removal and transfer (Amini et al., 2004; Dosti, 1998; Siunat, 1999; Zarate et al., 2002). Differences between HDL and LDL are in their goal cell. In fact, LDL carries cholesterol from liver to peripheral cells of the body, while, HDL carries excessive cholesterol from peripheral cells to liver changing it into bile. Since changing cholesterol to bile is the main means of its removal, HDL reduces serum cholesterol levels (Dosti, 1998). Claims are strong that certain L.acidophilus strains and some bifidobacteria species are able to lower cholesterol levels within the intestine. Cholesterol co-precipitates with deconjugated bile salts with the decline in pH as a consequence of lactic acid formation by the lactic acid bacteria. Another theory is that L.acidophilus deconjugates bile acids into free ones, which are excreted more rapidly from the intestinal tract than the conjugated bile acids (Shakeri, 2003; Fernades et al., 1987; Lourens-Hattingh et al., 2001). Some scientists suggest that propionic acids produced by probiotic species reduce cholesterol synthesis in liver (Zarate et al., 2002). In addition, it is reported that an active factor i.e. Hydroxyl Methyl Glutarate (HMG) synthesized by lactic acid bacteria, inhibits cholesterol synthesis in the body (Fernades et al., 1987; Lourens-Hattingh et al., 2001; Shakeri, 2003).

Thus, in this study, considering the importance of B.acidophilus and B.bifidum as probiotic species endowed with potential therapeutic properties, the effects of these probiotic cultures on human LDL, HDL and cholesterol levels and as well on colonic microbial flora are investigated.

**MATERIALS AND METHODS**

**Yogurt Preparation**

All products were weekly produced under sanitary food preparation conditions at the Padratoos Factory of Ghouchan (Khorasan, Iran). The products were produced using pasteurized milk. The yogurt was added with the cultures of B.bifidum (yogurt B, BB-12, chr. Hansen Co., Denmark) and L.acidophilus (yogurt L, LA-5, chr. Hansen Co., Denmark). All products were fermented at 37°C to a final pH of 4.6. The fresh product batches contained viable bacteria counts exceeding $10^9$ colony forming units (cfu)/l. Freshly prepared products were dispensed into 500 g-cups, packaged and stored at 7°C prior to daily delivery to the experimental subjects.

**Subjects**

Twenty four volunteers in good health (fifteen female, nine male; aged 20-30 y, average 23.5 y) participated in the study. Selection was carried out through completing forms as well as through a pre-study of colonic microbial counts along with and routine blood test, to ensure health of volunteers. During three week periods the subjects received 500 ml of yogurt drink per day (yogurt B and L) in a randomized order.
In addition to the yogurts taken the volunteers kept their usual dietary habits. Additionally, each volunteer kept a record of the occurrence of any abdominal discomfort during the study periods.

**Measurements**

At the end of each week test period (yogurt B and L), feces was collected and bacteriological examination done within 8h after sampling. Fecal samples were diluted in physiological serum in 1:10^4 ratios. Out of each of these dilutions 0.1 ml was plated onto the following media: Eosin methylen blue agar (Merck, Darmstact, Germany) for *Escherichia coli*, Salmonella Shigella Agar (Merck, Darmstact, Germany) for fecal coliforms and de Man Rogoso & Sharp Agar (Merck, Darmstact, Germany) for *Bifidobacteria* and *Lactobacilli*. Bacterial colonies were enumerated and identified according to their morphology, growth characteristics and the usual biochemical criteria.

Also before consumption of yogurt (B and L) and at the end of each week of test period, blood tests including HDL, LDL and cholesterol determination were carried out on the volunteers. These experiments were done by courtesy of the Medical Diagnosis Laboratory (Doctor Bigdeli, Mashhad, Iran).

**Statistical Analysis**

The results obtained during test periods were compared with data gathered before yogurt (B and L) consumption (control status) individually. Kruskal-Wallis one way ANOVA and Dunnet’s method were used to compare cholesterol, LDL and HDL as well as microbial counts in EMB, SSA and MRS media. Values are expressed as mean ± SEM (Standard Error of Mean). Also culture kinds, period of consumption and in between interaction effects were analyzed through CRP two way ANOVA.

**RESULTS AND DISCUSSION**

**Cholesterol, LDL and HDL**

The results of blood tests obtained during the test period and the corresponding control data are summarized in Table 1. As observed, serum cholesterol levels gradually declined during the test period so that at the end of the third week, there were significant differences (P<0.05) in cholesterol levels in consumers consuming the L-yogurt vs. control. No significant difference was found for the serum cholesterol levels of consumers consuming the B-yogurt.

As evident from Table 1, both probiotic species were able to reduce cholesterol levels in volunteers, but *L.acidophilus* was more effective than *B.bifidum* as also confirmed by results obtained by other scientists (Lourens-Hattingh et al., 2001). Mean comparisons showed *L.acidophilus* lowered cholesterol levels at 13.5 percent, while *B.bifidum* reduced it at 4.47%. Since viable cells consist of possible therapeutic effects, then they must tolerate digestive tract to benefit the colon. James W. Anderson et.al (1999) reported that serum...
Table 2. Results of analysis of variance of cholesterol.

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yogurt kind</td>
<td>1</td>
<td>1411.200</td>
<td>1411.200</td>
<td>2.4938</td>
<td>0.1187</td>
</tr>
<tr>
<td>Consumption period</td>
<td>3</td>
<td>3975.400</td>
<td>1325.133</td>
<td>2.3417</td>
<td>0.0803</td>
</tr>
<tr>
<td>Interaction effect between them</td>
<td>3</td>
<td>881.200</td>
<td>293.733</td>
<td>0.5191</td>
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</tr>
</tbody>
</table>

Table 3. Results of analysis of variance of HDL.

<table>
<thead>
<tr>
<th>Source</th>
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<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yogurt kind</td>
<td>1</td>
<td>32.512</td>
<td>32.512</td>
<td>1.7486</td>
<td>0.1902</td>
</tr>
<tr>
<td>Consumption period</td>
<td>3</td>
<td>121.938</td>
<td>40.646</td>
<td>2.1861</td>
<td>0.0971</td>
</tr>
<tr>
<td>Interaction effect between them</td>
<td>3</td>
<td>75.838</td>
<td>25.279</td>
<td>1.3596</td>
<td>-</td>
</tr>
</tbody>
</table>
Healthy Effects of Bioyogurt Consumption

Table 4. Results of analysis of variance of LDL

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yogurt kind</td>
<td>1</td>
<td>1073.113</td>
<td>1073.113</td>
<td>4.1358</td>
<td>0.0457</td>
</tr>
<tr>
<td>Consumption period</td>
<td>3</td>
<td>1809.938</td>
<td>603.313</td>
<td>2.3252</td>
<td>0.0820</td>
</tr>
<tr>
<td>Interaction effect between them</td>
<td>3</td>
<td>397.238</td>
<td>132.413</td>
<td>0.5103</td>
<td>-</td>
</tr>
</tbody>
</table>

It is necessary to note that yogurt containing viable *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* can lower cholesterol too, but they, because of being very sensitive, could not tolerate the digestive tract (Fernades et al., 1987; Vinderola et al., 2002). Synergistic cholesterol reducing effects between probiotic and traditional culture are known to be occurring. Along with both means of yogurt preparation other bacterial species (*Lactobacillus delbrueckii* subsp. *bulgaricus* and *S. thermophilus*) that might have acted as bifidogenic factors on the resident colonic flora were chronically transferred to the subjects (Bartram et al., 1994).

Abdominal discomforts and drowsiness were rarely (and only by a few volunteers) reported throughout the study, while on the contrary some volunteers reported even an improved function of their digestive system.

**Microbial counts**

The results of microbial counts of fecal samples of volunteers during study period and the control are summarized in Table 5. As shown there was no difference in the average EMB medium colony counts during yogurt B and L consumption and control as well as during SSA medium colony counts. It means bio-yogurt consumption did not significantly affect fecal coliform and particularly *E.coli*.

Microbial cultures in SSA medium were carried out to enumerate other fecal coliforms (red colonies), since yellow colonies in SSA medium indicate *Salmonella* and *Shigella* presence, which show microbial infection of intestine (Saedi Asl, 1999). No yellow colonies were observed in fecal samples of the volunteers. Bartram et al (1994) showed that the bacterial counts for *Escherchia coli* and *Clostridia* were also not different during consumption of yogurt enriched by *B.longum* in duration of 21 days. Their results revealed a great stability of the human fecal microflora (Bartram et al., 1994). There are some reports which demonstrate infant diarrhea, caused by *E.coli* activity, which was cured through acidophilus milk consumption (Fernades et al., 1987). Since, some researches have demonstrated that beneficial bacteria can influence the number of harmful bacteria of colon (Lourens-Hattingh et al., 2001), so, microbial flora of colon are mainly affected by dietary, age and antagonism as well as synergism effects among colonal bacteria (Shakeri, 2003; Lourens-Hattingh et al., 2001).

The results of MRS medium enumeration showed that in comparison with the corresponding control statuses, a more significant number of *Bifidobacteria* and *Lactobacilli* were excreted following the consumption of either of the yogurt preparation, (P<0.05). Uyeno et al (2008) have suggested that the human fecal bacterial community could be altered by ingesting yogurt, even though probiotic lactobacilli are present or absent in the yogurt, meaning that this does not seem to be

Table 5. Cultural counts of fecal bacteria (log cfu/g fecal) *a*.

<table>
<thead>
<tr>
<th>Media</th>
<th>Control B</th>
<th>Yogurt B</th>
<th>Control L</th>
<th>Yogurt L</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMB</td>
<td>8.909±0.13</td>
<td>8.949±0.14</td>
<td>8.910±0.10</td>
<td>8.636±0.12</td>
</tr>
<tr>
<td>SSA</td>
<td>8.310±0.18</td>
<td>7.820±0.37</td>
<td>8.400±0.28</td>
<td>7.958±0.29</td>
</tr>
<tr>
<td>MRS</td>
<td>1.960±0.92</td>
<td>5.467±0.81</td>
<td>2.397±0.93</td>
<td>5.547±0.82</td>
</tr>
</tbody>
</table>

*SEM; n=24*
a factor affecting the change. Mattila-Sandholm (1999) has emphasized that probiotic cultures play a main role in a healthy and large intestine balance. If beneficial species tolerate digestive tract and maintain their viability, they can act therapeutically and improve metabolic activity of intestine (Shakeri, 2003; Zarate et al., 2002). Vinderola et al (2002) showed that produced subspecies by such dairy starters as diacetyl, acetoin, bacteriocins can inhibit growth of some dairy microbial species. It has been reported that \textit{Lacticophilus} survives far better than the traditional yogurt culture organisms, \textit{Lactobacillus delbrueckii subsp. bulgaricus} and \textit{S.thermophilus} in yogurt under acidic conditions (Mortazavi et al., 1997; Vinderola et al., 2002). It was also found that \textit{Lacticophilus} is also more tolerant to acidic conditions than \textit{B.bifidum}. The pH of fermented milk can influence the resident cells. It was also found that \textit{Lacticophilus} and \textit{B.bifidum} showed satisfactory populations at pH values above 4. But this is not true regarding yogurt traditional cultures (Mortazavi et al., 1996; Zarate et al., 2002).

In conclusion, the result of this study demonstrated that regular probiotic yogurt consumption generally exerts positive effects on the lowering of fat metabolites in particular cholesterol. Favorable effects of yogurt enriched by \textit{Lacticophilus} were more noticeable than those of \textit{B.bifidum}. Also revealed was a great stability of the human intestinal microflora to this kind of dietary change. In all, regular probiotic yogurt consumption can increase the number of beneficial species present in colon and prosper their positive effects. In order to enhance the results, obtained in this project, further extended studies in hypercholesterolemic subjects or patients with intestinal disturbances are needed.

ACKNOWLEDGEMENT

We thank Zohorian (Padratoos Factory) for providing the yogurt preparations, Bigdeli (Diagnosis Laboratory), and Tavasoli (Microbiology Laboratory, College of Agriculture, Ferdowsi University) for providing the needed materials and equipment.

REFERENCES

اثر مصرف ماست پرویوتیک بر متابولیت های چربی سرم و فلور میکرویی روده در افراد سالم

روزابارندان، نیازمندیان، م. سراپی، ن. عربی پوریانی، ا. دهقانی

چکیده

فراورده‌های پرویوتیک اثر زیادی بر سلامت مصرف کندگان از طریق کاهش خطر حمله قلبی و بهبود فلور میکرویی مطلوب در سیر روده ای دارند. در این مطالعه مصروف 50 گرو در روز به مدت 3 هفته (غذای شده با بیفیدوکاتراتور، بیفیدوم و لاکتوپاسیلوس اسیدوفیلوس) بر مقدار کلسترول، لیپپروتنین‌های سرم و فلور میکرویی روده ای در داوطلب سالم بررسی شد. نتایج آماری نشان داد که بعد مصرف چهار نوع ماست پرویوتیک مقادیر کلسترول و LDLC در مقابلی با شاهد کمتر بود. (P<0/05 در حالتی که تغییر روند LDLC در مقایسه با شاهد کمتر بود، در مطالعه 259-267. مصرف ماست قابل توجه نبود. این در حالی است که تعداد کلیم های متفاوت در مصرف ماست ایدوی و لاکتوپاسیلوس اسیدوفیلوس به طور معنی‌داری افزایش یافت (P<0/05).