Nutritional and Healthful Aspects of Cultured and Culture-Containing Dairy Foods

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ABSTRACT
Nutritional and therapeutic qualities of fermented dairy products are reviewed. Partial hydrolysis of milk constituents (proteins, fats, and lactose) in yogurt, cheese, and other cultured dairy foods appears to contribute to their increased digestibility. Lactase and other constituent enzymes of various culturing organisms should contribute to assimilation of lactose by lactose intolerant individuals. Several lactic cultures synthesize certain B-vitamins in fermented dairy products. In contrast, directly acidified dairy products do not exhibit such enhancement in B-vitamins. The hypocholesteremic effect of milk is enhanced by fermentation or inclusion of lactic cultures. Lactobacillus acidophilus, Lactobacillus bulgaricus and other lactic organisms produce antimicrobial agents and natural antibiotics. However, production of natural antibacterial substances by different strains of the same species vary widely. These metabolites in cultured dairy products may be responsible for increased shelf life of the foods by inhibiting a wide spectrum of food spoilage organisms. Also, consumption of cultured products containing such natural antibacterial substances may provide the consumer with protection against disease organisms. Unfermented milk containing a specific culture or strain may be consumed to invest organisms for projected beneficial effects.

INTRODUCTION
The 1975 per capita consumption of various cultured dairy products in the world amounted to nearly 40 liters (26), indicating that cultured dairy products occupy an important place in the human diet in many countries of the world. In the United States, also, during the past 10 yr, although the total per capita consumption of milk has not increased, the per capita consumption of cultured dairy products has increased considerably (40). Even though the total consumption of fluid, evaporated, and condensed milk and butter has declined, consumption of cultured products and low-fat milk increased considerably (Figure 1). Low-fat and skim milk consumption increased by 265%, Cottage and other cheeses by 64%, sour cream by 91%, and yogurt by 500%. Yogurt consumption has shown the largest increase, and it has been projected that its consumption may reach the billion-pound mark by 1980 (31) and one billion dollar sales by 1986 (32). The significant increase in the consumption of cultured dairy foods during recent years, notably that of yogurt, has been ascribed to their image as wholesome, high-protein, convenient, health, or low-fat foods.

Historically, fermentation processes involved unpredictable and slow souring of milk caused by microorganisms inherent in the milk. However, modern technologies involve specific lactic microorganisms to carry out specific fermentation under exacting conditions of pH, temperature, water content, etc., to produce fermented products of superior nutritional, physical, chemical, and sanitary qualities. Lactic ferme-
tations in the manufacture of cultured dairy products enhance the nutritional qualities of the products by these organisms improving digestibility of milk constituents and also synthesizing certain B-vitamins during the process. In addition, during fermentation the lactic cultures produce metabolites such as antibiotics, anticarcinogenic compounds, anticholesteremic compounds, and enzymes with the result that the cultured products may possess not only enhanced nutritional qualities but therapeutic value as well.

**NUTRITIONAL QUALITIES OF CULTURED PRODUCTS**

In caloric content, although yogurt, sour cream and buttermilk are similar to milk or cream from which they are made (Table 1), it has been suggested that cultured products are digested more easily and, therefore, are more nutritious because the proteins, carbohydrates, and fats are predigested by bacterial cultures in their manufacture (34). Also, a recent report from the USSR indicates that cultured milk, rather than fresh milk, is the preferred weaning food for infants (69), indicating that cultured milk might be more easily digestible.

**Partial Hydrolysis of Milk Constituent in Cultured Products**

Rasic et al. (48) reported that the biological value of the proteins in yogurt increased from fermentation. Using a chick assay, Simhaee and Keshavarz (62) found yogurt protein was superior to milk protein. Breslaw and Kleyhn (8) observed that yogurt was digested more easily than the milk from which it was made.

Since yogurt contains large populations of starter organisms, some contribution of single-cell proteins and constituent enzymes of these cultures to the overall nutrient profile of the product is reasonable. Reddy et al. (49) fermented cheese whey with *Lactobacillus bulgaricus* and reported that approximately 7% of the crude protein originated from cells of lactobacilli. Erdman et al. (16) found lactobacillic protein contained essential amino acids in concentrations equal to or greater than the FAO reference protein. Recently, Hargrove and Alford (24) observed that rats fed yogurt

**TABLE 1. Nutrient content of milk, skim milk, cream, and some cultured products made from them.**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Whole milk</th>
<th>Yogurt plain</th>
<th>Skim milk</th>
<th>Buttermilk</th>
<th>Cream</th>
<th>Sour cream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>65</td>
<td>63</td>
<td>36</td>
<td>40</td>
<td>211</td>
<td>211</td>
</tr>
<tr>
<td>Protein, g</td>
<td>3.5</td>
<td>3.0</td>
<td>3.6</td>
<td>3.31</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Fat, g</td>
<td>3.5</td>
<td>1.6</td>
<td>1.1</td>
<td>.9</td>
<td>20.6</td>
<td>20.4</td>
</tr>
<tr>
<td>Carbohydrate, g</td>
<td>4.9</td>
<td>7.0</td>
<td>5.1</td>
<td>4.8</td>
<td>4.3</td>
<td>4.3</td>
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<tr>
<td>Ca, mg</td>
<td>118</td>
<td>183</td>
<td>121</td>
<td>116</td>
<td>102</td>
<td>102</td>
</tr>
<tr>
<td>Fe, mg</td>
<td>.08</td>
<td>.08</td>
<td>.05</td>
<td>.05</td>
<td>.04</td>
<td>.04</td>
</tr>
<tr>
<td>Mg, mg</td>
<td>13</td>
<td>17</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>P, mg</td>
<td>93</td>
<td>144</td>
<td>95</td>
<td>89</td>
<td>80</td>
<td>77</td>
</tr>
<tr>
<td>K, mg</td>
<td>144</td>
<td>234</td>
<td>145</td>
<td>151</td>
<td>122</td>
<td>56</td>
</tr>
<tr>
<td>Zn, mg</td>
<td>.38</td>
<td>.89</td>
<td>.40</td>
<td>.42</td>
<td>.27</td>
<td>.27</td>
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<tr>
<td>Na, mg</td>
<td>50</td>
<td>70</td>
<td>52</td>
<td>105</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>Ascorbic acid, mg</td>
<td>1</td>
<td>.80</td>
<td>1</td>
<td>.98</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Thiamin, mg</td>
<td>.03</td>
<td>.04</td>
<td>.04</td>
<td>.03</td>
<td>.03</td>
<td>.03</td>
</tr>
<tr>
<td>Riboflavin, mg</td>
<td>.17</td>
<td>.21</td>
<td>.18</td>
<td>.15</td>
<td>.15</td>
<td>.15</td>
</tr>
<tr>
<td>Niacin, mg</td>
<td>.1</td>
<td>.11</td>
<td>.1</td>
<td>.06</td>
<td>.1</td>
<td>.71</td>
</tr>
<tr>
<td>Pantothenic acid, mg</td>
<td>.3</td>
<td>.59</td>
<td>.37</td>
<td>.28</td>
<td>.26-.34</td>
<td>.32-.36</td>
</tr>
<tr>
<td>Vitamin B₆, mg</td>
<td>40</td>
<td>.05</td>
<td>42</td>
<td>.03</td>
<td>35</td>
<td>16</td>
</tr>
<tr>
<td>Folacin, mcg</td>
<td>6.0</td>
<td>11</td>
<td>1.2</td>
<td>.03</td>
<td>.35</td>
<td>.3</td>
</tr>
<tr>
<td>Vitamin B₁₂, mcg</td>
<td>.4</td>
<td>.56</td>
<td>.4</td>
<td>.2</td>
<td>.35</td>
<td>.3</td>
</tr>
<tr>
<td>Vitamin A, IU</td>
<td>140</td>
<td>66</td>
<td>tr.</td>
<td>33</td>
<td>840</td>
<td>839</td>
</tr>
</tbody>
</table>

*aReferences (2, 42, 46, 72).*

gained weight faster than those fed unfermented milk or acidified milk. However, the rats fed bulgaricus or acidophilus milk did not gain weight as fast as the rats that were fed yogurt.

Enzymes of lactic cultures degrade proteins, lipids, and lactose of milk, partially predigesting these nutrients. The lipolytic and proteolytic activities of various lactic cultures were studied by Chandan et al. (9, 12). Specific lipase activities (net $\mu$ mole fatty acids produced in 10% tributyrin emulsion/h at 37 C/ml cellular DNA) of the lactobacilli were all below 1.0 while those of streptococci, leuconostocs, and propionibacteria ranged from 2.3 to 33. Specific proteolytic activities ( $\mu$g crystalline trypsin equivalent/ml cellular DNA) of leuconostocs and streptococci were all below .10 while activities of propionibacteria and lactobacilli ranged from .2 to 3.2. Lactobacillus bulgaricus cells also possess an appreciable proteolytic activity. At the optimum pH of 5.8 to 5.9, casein was hydrolyzed approximately four times faster than whey proteins. Poznanski et al. (47) demonstrated the cooperative breakdown of casein by a protease of Lactobacillus bulgaricus and a peptidase of Streptococcus thermophilus whereas Chandan et al. (10) observed slow irreversible aggregation of whey proteins in milk by the action of lactic cultures. These studies demonstrate the relative importance of lactobacilli in protein hydrolysis and of streptococci and leuconostocs in fat hydrolysis in cultured dairy products. The hydrolytic and protein aggregation effects may contribute to the physical and nutritional properties of cultured dairy products.

B-Vitamin Content of Cultured Products

While variations in the B-vitamin content of milk arise from seasonal changes, stage of lactation, etc., differences in B-vitamins of milk products have been attributed to variation in vitamin content of the milk as well as differences in processing procedures. The B-vitamin content of cultured milk products is affected also by amount and type of microbial inoculum and subsequent incubation conditions in the product's manufacture (25). While many lactic organisms require B-vitamins for growth, several cultures are capable of synthesizing certain vitamins (Figure 2). This agrees with observations that medium, temperature, and other factors affect growth and end products of lactic cultures (14). The extent of biosynthesis or utilization of vitamins by lactic organisms is a function of temperature, length of incubation, and other processing parameters (44). Even the length and temperature of cheese ripening seem to affect the final vitamin content of the product. Shahani and his associates (57, 58) observed huge differences in vitamin content of nearly 30 varieties of cheeses and cheese products, and the differences were related to lactic cultures and their metabolic activity during ripening. In Cheddar cheese biosynthesis of certain B-vitamins was related to lactose metabolism (Figure 3). A review of the literature (Table 2) reveals that cultured products certainly contain higher folic acid, niacin, biotin, pantothenic acid, $B_6$, and $B_{12}$ than milk.

B-Vitamin Content of Cultured Vs. Acidified Products

Newer processes have been developed to
manufature yogurt, Cottage cheese, buttermilk, and sour cream by direct acidification instead of by lactic cultures. The advantages of such processes over the conventional culturing methods claimed are a) elimination of culture handling problem, b) better quality control and uniformity in production, and c) better keeping quality. However, little definitive information is available concerning nutritional qualities of products manufactured by direct acidification. In terms of caloric value based upon total protein, carbohydrate, and fat, products made by the two methods do not differ significantly. However, the cultured products generally contain slightly higher B vitamins compared to their counterpart products made by direct acidification (Table 2). Further, the cultured samples were considerably higher in folic acid than acidified products, evidently because the lactic cultures synthesize considerable quantities of folic acid during manufacturing. Also, while the acidified products reportedly have the same texture and consistency as cultured products, they are normally more bland and lack the characteristic pleasant flavor and aroma commonly associated with cultured products (33, 40, 52).

Anticholesteremic Effect of Cultured Products

As recently as 1974, Mann and Spoerry (36) observed that in spite of consuming large quantities of saturated fat and cholesterol through fermented milk and meat, the Masai tribesmen of Africa had fairly little cholesterol in their blood. Their systematic studies led to elucidation of evidence that there existed an "anticholesteremic milk factor" (AMF) in the fermented milk which was responsible for the hypocholesteremic effect. Similar observations for yogurt were later confirmed in the US (35). Although the chemical nature of the anticholesteremic factor has not been identified, it has been postulated to be hydroxymethylglutaric and/or orotic acid. Hydroxymethylglutaric and orotic acids presumably inhibit a rate-limiting enzyme in cholesterol biosynthesis. Studies of Bernstein et al. (5) observed that the AMF may exist in unfermented milk as well, but Mann (35) suggests that the concentration of such a factor(s) is higher in fermented milk than that in unfermented milk.

Whether fermentation of milk by lactic cultures increases its anticholesteremic activity needs to be investigated more fully. Nevertheless, based upon his preliminary studies, Sinha (63) reported that even unfermented sweet acidophilus milk demonstrated such an activity. He observed that feeding milk to rats had little or no effect upon their serum cholesterol while incorporation of cholesterol in the diet increased serum cholesterol. The addition of 4 million L. acidophilus DDS1 cells per milliliter of milk lowered cholesterol significantly.

Relationship of Fermented Products to Lactose Intolerance

Lactose causes nutritionally oriented problems in some individuals. The problem, called lactose intolerance, arises from the deficiency of the enzyme lactase or β-galactosidase in the intestine. The malady is detectable in all age groups. Lactose intolerant people have to restrict their intake of dairy foods containing this disaccharide. However, since infants, children, and adolescents require calcium for proper bone growth and development, a restriction in the intake of milk and milk products also would limit seriously the intake of this mineral. Consequently, suggestions have been made that lactose intolerant individuals may
TABLE 2. B-vitamin content of milk and several cultured products.\(^a\)

<table>
<thead>
<tr>
<th>Product</th>
<th>Folic acid (µg/100 g or ml)</th>
<th>Biotin (µg/100 g or ml)</th>
<th>Niacin (µg/100 g or ml)</th>
<th>Pantothenic acid (µg/100 g or ml)</th>
<th>(B_6) (µg/100 g or ml)</th>
<th>(B_{12}) (µg/100 g or ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>.13-.73</td>
<td>2.9-4.9</td>
<td>71-96</td>
<td>330-460</td>
<td>17-40</td>
<td>.27-.57</td>
</tr>
<tr>
<td>Skim milk</td>
<td>.70-.90</td>
<td>4.1</td>
<td>120-180</td>
<td>486</td>
<td>54-66</td>
<td>.34-.47</td>
</tr>
<tr>
<td>Cream</td>
<td>3.8</td>
<td>2.6-3.4</td>
<td>40</td>
<td>260-340</td>
<td>35</td>
<td>.35</td>
</tr>
<tr>
<td>Whey</td>
<td>1.1-9.0</td>
<td>4.0</td>
<td>40-120</td>
<td>280-381</td>
<td>21</td>
<td>.5-2.2</td>
</tr>
<tr>
<td>Yogurt, cultured</td>
<td>3.9</td>
<td>4.0-5.1</td>
<td>130-141</td>
<td>486</td>
<td>54-66</td>
<td>.34-.47</td>
</tr>
<tr>
<td>Yogurt, acidified</td>
<td>4.3(^b)</td>
<td>4.2</td>
<td>131</td>
<td>427</td>
<td>35</td>
<td>.35</td>
</tr>
<tr>
<td>Cottage cheese, cultured</td>
<td>2.3-5.0</td>
<td>3.2</td>
<td>70-257</td>
<td>463</td>
<td>24-56</td>
<td>.8-2.1</td>
</tr>
<tr>
<td>Cottage cheese, acidified</td>
<td>.1</td>
<td>2.8</td>
<td>42.5</td>
<td>375</td>
<td>50</td>
<td>.58</td>
</tr>
<tr>
<td>Sour cream, cultured</td>
<td>10.8</td>
<td>2.6</td>
<td>11-67</td>
<td>320-360</td>
<td>16</td>
<td>.3-.4</td>
</tr>
<tr>
<td>Sour cream, acidified</td>
<td>3.1</td>
<td>3.1</td>
<td>64</td>
<td>330</td>
<td>17</td>
<td>.3</td>
</tr>
</tbody>
</table>

\(^a\)References (33, 41, 52, 53, 54).
\(^b\)A seaweed stabilizer in the manufacture was a rich source of folic acid.

Ingested fermented dairy foods as such products would have little or no native lactose in them (19). Such products also may provide supplementary quantities of lactase elaborated by the cultures during fermentation.

Using laboratory rats as test animals, Goodenough and Kleyn (22) observed more efficient absorption of lactose when yogurt containing viable microflora was fed. Intestinal lactase activity of the animals fed yogurt was higher than in the animals that were fed other experimental diets. Also, Kilara and Shahani (29) noticed that an in vitro digestion process enhanced release of lactase from the yogurt culture (Figure 4).

**THERAPEUTIC VALUE OF CULTURED PRODUCTS**

In addition to their high nutritional properties, cultured dairy products have been reported to possess considerable therapeutic value. As early as 1908, Metchnikoff (38) postulated that *Lactobacillus bulgaricus* possessed a therapeutic value exercised by suppressing toxin production by putrefactive bacteria in the human intestine. He suggested that the longevity of Bulgarians was in part due to their ingesting large quantities of Bulgariicus milk. The role of lactic cultures and cultured products in the alleviation of human and animal disorders has been reviewed (55, 66, 68).

**Production of Antimicrobial Agents**

Although definitive information on therapeutic values of fermented products is not yet available, numerous investigators have reported inhibition of pathogenic and spoilage bacteria by lactic cultures and products fermented by these cultures (3).

**Inhibition of Food Spoilage Organisms.** The antibacterial principles elaborated by lactic cultures apparently contribute to the increase of shelf life and inhibition of foodborne pathogens. Evidence has been mounting concerning the inhibition of *Staphylococcus aureus*.
Pseudomonas putrefaciens, Escherichia coli, Clostridium perfringens, Salmonella tennessee, Vibrio parabemolycicus, and other spoilage and pathogenic organisms by lactic cultures, such as S. lactis, S. diacetylactis, Leuconostoc cremoris, and the lactobacilli. Although the exact nature of the inhibitory principle in each case has not been established, numerous workers have reported the incidence of lactic acid, acetic acid, and hydrogen peroxide in dairy products which act inhibitory toward spoilage organisms. Although milk contains only traces of benzoic acid, Chandan et al. (11) observed the occurrence of natural benzoic acid up to 50 ppm in yogurt, buttermilk, and various cheeses, indicating that most of the benzoic acid in the cultured products arises as a result of the metabolic activity of the lactic cultures.

Production of Natural Antibiotics. Several lactic organisms produce natural antibiotics. For example, S. lactis produces nisin (37), L. bulgaricus produces bulgarican (50), L. brevis produces lactobrevin (27), and L. acidophilus produces acidophilin (59, 60), acidolin (39), lactobacillin (74), lactocidin (72), and lactolin (30).

Only a limited amount of work has been attempted to isolate and elucidate identity of natural antibiotics. Using a combination of chemical extracts coupled with silica gel and Sephadex chromatography, Shahani and his associates (50, 60) isolated acidophilin from L. acidophilus and bulgarican from L. bulgaricus. Both acidophilin and bulgarican were exceedingly active against a wide variety of gram positive and gram negative organisms which included nonpathogens as well as pathogens. They observed that different strains varied greatly in production of antibiotics, and factors such as pH and temperature had a pronounced effect upon antibiotic production. Milk was an essential medium, since when these organisms were grown in other synthetic and semisynthetic media, the organisms failed to produce the antibiotic. Both the antibiotics have been characterized fairly well (50, 59, 60).

Use of Lactobacilli in Human and Animal Therapy

During recent years increased emphasis has been given to the study of the therapeutic effect of Lactobacillus bulgaricus and Lactobacillus acidophilus fermented products (yogurt, bulgaricus milk, acidophilus milk, kefir, and Koumiss) upon various human and animal disorders. Gordon et al. (23), Siver (64), Abbott (1), and Gillespie and Dimmick (20) reported that L. bulgaricus and L. acidophilus fermented milk products could be used successfully in the treatment of gastroenteritis, specific or nonspecific diarrhea, skin infections, and herpetic and aphthous stomatitis. Ferrer and Boyd (18) observed that administration of prune whip yogurt alleviated significantly the chronic constipation of geriatrics as well as improved their general health, skin tone, and chronic ileus. Shapiro (61) noted that yogurt helped to restore the normal intestinal flora previously disturbed by antibiotic therapy, and Niv et al. (45) reported that children suffering from infantile diarrhea recovered more rapidly when fed yogurt than those given neomycin-kapectate.

Twinning-McMath (71) suggested that L. acidophilus could be used to maintain a stable protective intestinal flora while pathogenic organisms were being eliminated. Earlier, Smith
(65) also observed that with the administration of acidophilus, the number of intestinal E. coli was reduced substantially and the flora in stools consisted almost entirely of L. acidophilus. Cohendy (13) observed that when milk soured with L. bulgaricus was fed to subjects with intestinal putrefaction, putrefaction decreased and stools became normal predominantly with Gram-positive flora. In a study with guinea pigs, Tomic-Karovic (70) noted that irradiation of the experimental group of animals receiving acidophilus milk did not cause abnormalities in their offspring. Also, such offspring developed better and gained more weight than those from untreated control group of guinea pigs which had not received acidophilus milk. He also observed that ingestion of acidophilus milk by mice reduced the number of deaths due to Pneumococcus sp. in the intraperitoneal cavity.

**Anticarcinogenic Effect of Cultured Products**

Although the amount of work has been considerable relative to the treatment of bacterial and viral diseases with lactobacilli, a search of the literature shows only a limited number of studies concerning the anticarcinogenic properties of lactobacilli. Bogdanov and his associates (7) were perhaps the first to observe that L. bulgaricus possessed a potent antitumor activity. Later, they isolated three glycopeptides which possessed promising biological activity against Sarcoma 180 (6).

In a study in collaboration with the Sloan-Kettering Institute for Cancer Research, several lactobacilli were tested against Sarcoma 180, and L. acidophilus DDS1 possessed definite antitumor activity. In this laboratory, studies were continued with tissue culture system as well as Ehrlich ascites tumor cells, and with Hi Line and KB line tissue culture systems, several extracts of yogurt and L. acidophilus possessed variable antitumor activity. Reddy et al. (51) and Farmer et al. (17, 58) investigated the inhibitory effect of yogurt on Ehrlich ascites tumor-cell proliferation in the peritoneal cavity of Swiss mice. They observed that mice given yogurt displayed 28 to 35% inhibition of the cell count as well as of the DNA content of the ascites fluid (Figure 5). Daily cell count and DNA content determinations revealed that maximum inhibition occurred after the 3rd day of tumor growth. Feeding milk, lactose, or lactic acid did not show any inhibitory effect. There appeared to be a direct relationship between the amount of yogurt consumed and tumor inhibition, and feeding concentrated yogurt also increased inhibition. Feeding of solids and supernatant fractions of yogurt separately revealed the inhibitory property was associated with only the solids fraction. The L. bulgaricus appeared to be more inhibitory than S. thermophilus, and culture cells killed by heat lost their tumor inhibition activity. Bailey and Shahani (4) observed that feeding milk and colostrum fermented with L. acidophilus DDS1 inhibited tumor proliferation by 16 to 41%.

**Unfermented Cultured Products**

As cultured products contain additional nutritive and therapeutic elements, it has been suggested that the consumption of such products, particularly yogurt and lactobacillus fermented products, may provide the consumer with natural resistance to disease. Fermented milks, particularly yogurt, buttermilk, acidophilus milk, or bulgaricus milk, are by nature...
somewhat tart or sour and have limited consumer appeal. Consequently, attempts have been to utilize beneficial effects of lactobacilli by making the cultures available in the form of concentrated liquid, capsules, and tablets. However, due to processing and storage losses, these products have contained lower viable counts than expected.

Advances (15, 28) in the development of frozen concentrates and freeze-dried lactobacilli have facilitated still other uses of L. acidophilus. Consumption of live acidophilus cells has been achieved by introduction of unfermented low-fat milk containing concentrated acidophilus cells. The manufacture of such a product involves the preparation of a cell concentrate by centrifugation, suspension of the concentrate in milk previously pasteurized, and packaging. The product does not ferment as long as the milk is under refrigeration during distribution and storage. Optimally, such a product permits the consumer to enjoy the sweet flavor of milk and ingest live acidophilus culture as well. During recent years several unfermented milk products containing concentrated L. acidophilus cells have appeared on the market. However, only limited information is available concerning the viability of the acidophilus cells in such products or nutritional effects of ingesting such milk.

Using LBS agar techniques (67), Gilliland et al. (21) observed that upon ingestion of low-fat milk containing L. acidophilus cells, there occurred no decrease in coliform, although the total number of facultative lactobacilli seemed to increase in the feces of human subjects. However, Sinha (63) observed that feeding to rats unfermented milk containing L. acidophilus DDS1 increased the lactobacilli and lowered the coliform count in their feces. Also, there occurred a reduction in the β-glucosidase and β-glucuronidase in rat feces, the enzymes which reportedly catalyze the chemical conversion of procarcinogens into carcinogens.

An unfermented low-fat pasteurized milk containing about 4 billion L. acidophilus DDS1 cells per liter, available commercially in this region, is being used as a study with healthy human beings to determine its nutritional role as a part of the regular diet. The study is essentially a switchback or crossover design, with half of the subjects on acidophilus milk and the other half on 1% fat milk. The study involves constant and continuous examination of blood and urine chemistry and stool chemistry, microbiology, and enzymology. Preliminary results (56) have indicated that ingestion of L. acidophilus milk reduces fecal coliform count and β-glucosidase activity and increases acidophilus count. Also, among numerous other blood parameters under study, the acidophilus ingestion seems to increase blood urea nitrogen and hemoglobin, and iron. These studies are in progress, and the complete data will constitute the subject of future reports.

REFERENCES
SYMPOSIUM: NUTRITIONAL VALUE OF DAIRY FOODS


