

QUALITY OF YOGURT

*A Cooperative Study by the Connecticut Department of Agriculture
and The Connecticut Agricultural Experiment Station*

By Lester Hankin and Donald Shields



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QUALITY OF YOGURT

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The Connecticut Dept. of Agriculture and The Connecticut Agricultural Experiment Station have both long been concerned with the quality of food products. Station scientists and staff of the Dept. of Agriculture continually examine food to determine whether it is of good quality. This bulletin reports a cooperative study by The Experiment Station and the Dept. of Agriculture of the quality of yogurt sold in Connecticut.

Yogurt has been known since the days of Abraham and Genghis Khan (6) to the present. Yogurt gained in popularity starting in 1889 when Professor Elie Metchnikoff claimed therapeutic benefits and long life for those eating yogurt (6). The yogurt available then was predominantly plain and unflavored, different from much of the yogurt sold today.

Yogurt is produced from milk soured by lactic acid bacteria that produce large amounts of lactic acid through fermentation of the milk sugar, lactose. The type of bacteria used differentiates yogurt from other fermented products such as buttermilk, cottage cheese, or hard cheese. These bacteria give plain yogurt its acidity, characteristic flavor, and custard- or gel-like consistency.

In 1954 the average per capita sale of yogurt in the United States was 45 grams

(0.10 pounds), or about one-fifth of an eight ounce serving. By 1979 it had risen to 1,185 grams (2.61 pounds) per person, or about five, eight ounce servings (1). From 1970 to 1978 yogurt sales increased three-fold. Although some still eat yogurt for special nutritional attributes, the dramatic increase in sales came about as processors added flavoring, fruit, and sugar, making sour or tart yogurt more palatable and pleasing to more people.

Styles of yogurt:

Of all yogurt sold in the United States, 88% is packaged in 8-ounce cups (4) and is usually one of four styles. All styles may contain stabilizers or other additives.

PLAIN usually contains no added flavoring and has a custard-like consistency.

SUNDAE contains fruit on the bottom of the container overlain with plain yogurt. It has a custard-like consistency, and the consumer usually mixes the fruit with the yogurt before eating.

SWISS usually has the fruit mixed with the plain yogurt in a custard-like consistency.

SHAKE usually has the fruit mixed with

the plain yogurt to a liquid consistency.

In 1977 in the United States plain yogurt accounted for about 9% of all yogurt produced, sundae style 54% and swiss style 37% (4). Also in 1977 more strawberry yogurt was produced (17.4%) than any other flavor. Plain yogurt was fifth preceded only by strawberry, raspberry, blueberry, and peach. These four flavors and plain yogurt accounted for about 60% of all yogurt produced.

Two styles of frozen yogurt are sold: hard-frozen yogurt in bulk or as novelties (sticks, bars, cups) and soft-serve yogurt (like ice cream) in cups or cones. In 1977 frozen yogurt accounted for about 18% of yogurt produced in the United States (12.5% hard-frozen, 5.4% soft-serve).

Some yogurt has no dietetic claims while others are non- or low-fat or imply a diet claim by phrases such as "Easy Dieter", "Stay 'n Shape", "Light 'n Lively", "Sweet 'n Low", and "SomeTHIN LITE".

Additives:

Many compounds other than fruit, fruit puree and flavoring may be added to any style yogurt for a diversity of consumer tastes, aesthetics, and consistency, or to enhance keeping and increase nutritional quality.

Such stabilizers or thickening agents as gelatin, carrageenens, vegetable gums (carob bean, locust bean, tragacanth guar gum), food starch and pectin produce different consistencies. The nonfat milk solids, sodium caseinate and whey solids, are added for a better consistency, and they also increase the protein content.

Sorbic acid or potassium sorbate may be added to inhibit molds. The acidulants citric acid and lemon juice provide flavor and acidity. Sugar, fructose, dextrose, honey, and corn sweeteners are used as sweeteners. If no sugar or sweetening agent is added, the only carbohydrate comes from the lactose in the milk.

Various food colors, including natural carmine color, beet juice concentrate, or artificial color may be used for aesthetic appeal. The fat content of yogurt is regulated by the type and amount of nonfat,

lowfat, or whole milk used in fermentation. The protein content varies with the amount of milk and milk solids, and carbohydrate content depends on the amount of sweetener. The amount of fat, protein, and carbohydrate determines the caloric content.

Bacteria in manufacture:

Two lactic acid bacteria (Family Lactobacteriaceae) predominate in the manufacture of yogurt: *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. *Lactobacillus acidophilus* is occasionally used, separately or with *S. thermophilus*. Yogurt usually contains live lactic acid bacteria. The ideal ratio of Lactobacilli to Streptococci is 1:1. Manufacturers may heat yogurt after fermentation to enhance shelf-life by destroying the lactic acid bacteria and any other chance contaminants. It is generally agreed, however, that true yogurt should contain living lactic acid bacteria (2).

The two lactic acid bacteria complement each other. The Streptococci grow first, remove oxygen and acidify the mixture to favor growth of the Lactobacilli. These also produce diacetyl and other compounds that give yogurt some of its flavor. The Lactobacilli growing at the lower oxygen level caused by the Streptococci produce more lactic acid, acetadehyde and other products that give yogurt its sharp flavor. If the ratio of Streptococci to Lactobacilli varies greatly from 1:1, poor consistency or flavor may result.

Since yogurt is usually acidic, contamination by other bacteria is unusual and long shelf-life can be expected. Since yogurts containing fruit are more subject to yeast and mold some manufacturers add preservatives to fruit-flavored yogurt.

Object of study:

We examined yogurts collected at retail food stores to determine what kinds were available, the age or days from manufacture to collection, the number and ratio of the two kinds of lactic acid bacteria, and microbial contamination. We also evaluated

Quality of Yogurt

Table 1. Acid-producing bacteria, yeast and molds, acidity, and declared additives in plain yogurt.

Plant permit no. 1	Age when purchased ² (days)	Acid-producing bacteria (millions)	Ratio Streptococci to Lacto-bacilli	Yeasts (no./g)	Molds (no./g)	pH	% acidity	Declared additives ⁴ solids ³ stabilizer or thickener ⁵
Alta-Dena, Maya, 3.5% fat	11	45	1:1.7	<100	<100	4.16	1.98	+
06-2238	18	730	1:1	11,000	44,000	4.46	1.96	+
Alta-Dena, Naja, lowfat, 2% fat	30	230	not tested	<100	<100	3.96	1.82	+
06-2238	30	230	not tested	<100	<100	4.25	1.65	+
Axelrod's, Easy Dieter, lowfat, natural	10	710	1:1.8	<100	<100	4.60	1.60	+
36-2345	36	160	1:0.8	900	<100	4.34	1.33	+
Borden, Lite Line, lowfat, all natural flavor	42	710	not tested	<100	<100	4.85	1.26	-
36-1396	22	900	1:0.3	<100	<100	4.08	1.77	-
Breakstone, Stay 'n Shape, lowfat, all natural	31	not tested	not tested	<100	<100	3.96	1.74	-
36-2217	11	520	not tested	<100	<100	4.31	1.38	-
36-2217	8	1010	1:1	<100	<100	4.09	1.44	-
Breyers, all natural	21	114	1:1.2	<100	<100	4.50	1.40	+
36-2217	14	430	not tested	>300,000	<100	4.30	1.15	+
Brown Cow Farm, all natural	14	640	1:0.5	<100	<100	4.09	1.55	+
Colombo, natural	11	106	not tested	<100	<100	4.12	1.76	+
25-500	12	830	not tested	<100	<100	4.23	1.69	+
34-721	No code	840	1:1	<100	<100	3.90	1.78	+
Dannon, lowfat, natural	18	154	not tested	37,000	<100	4.25	1.52	+
34-721	18	1070	1:0.9	67,000	<100	4.05	1.39	+
Dannon, lowfat, natural	5	890	1:1.8	<100	<100	4.25	1.86	+
33-05	13	580	not tested	<100	<100	4.30	2.01	+
33-05	13	1580	1:0.6	<100	<100	4.04	1.82	+
Erewhon, acidophilus	14	540	1:1.6	<100	<100	4.30	1.32	+
34-865	12	282	1:2.3	<100	<100	4.63	1.84	+
34-865	28	930	1:1.3	<100	<100	4.43	1.64	+
25-25	12	1590	1:3.2	48,000	<100	4.35	1.38	+
25-25	18	510	1:1.2	24,000	<100	4.44	1.21	+
Moondance, all natural, lowfat	10	720	1:0.3	<100	1,000	3.96	1.60	+
50-19	23	870	not tested	<100	<100	4.30	1.80	+
Rosedale, high grade, lowfat	No code	250	1:2.2	<100	<100	4.51	2.08	+
50-19	9	92	1:2.5	<100	<100	4.20	1.93	+
34-865	18	300	1:1.3	<100	<100	4.21	1.30	+
Stop & Shop, 100% natural, lowfat	10	560	1:1	<100	<100			+
34-865								
Sundance, lowfat								
not listed								
Waldhaums, all natural, lowfat								

¹Plant where product was made.
²Days from manufacture to purchase.
³Nonfat dry milk, sodium caseinate, or whey solids.
⁴None of the samples declared preservative, acidulant, artificial color or flavor.
⁵Gelatin, carrageenan, or modified food starch.
⁶This sample declared sugar as an additive.

Table 2. Acid-producing bacteria, acidity, and declared additives in strawberry yogurt.¹

Style	Plant permit no. ³	Age when purchased (days) ⁴	Acid producing bacteria (millions)	Ratio Strepto-cocci to Lacto-bacilli	pH	% Acidity	solids ⁵ or thickener ⁶	Declared additives ² pre-acidulant, or active	artificial color
A & P, natural, lowfat	34-865	13	460	1:1.1	4.02	1.32	+	+	-
Alta-Dena, Maya, 3.5% fat ⁸	06-2238	No code							
Alta-Dena, Naja, 1.5% fat	06-2238	6			4.26	1.42	+	+	-
Befft, lowfat, all natural flavor	36-1564	17	910	1:1.8	4.54	1.48	+	+	+
Borden, Lite Line, natural flavor, lowfat	36-1396	15	730	1:0.8	4.56	1.37	+	+	-
Borden, 100% natural, lowfat	not listed	20	180	1:1	4.40	1.31	+	+	-
Borden, 100% natural, lowfat	not listed	1	34	1:1.3	4.26	1.24	+	+	-
Breyers, all natural, walnut	36-2217	27	142	not tested	3.98	1.32	+	+	-
Breyers, all natural	36-2217	13	560	not tested	4.40	1.17	+	+	-
Breyers, all natural	36-2217	22	460	1:0.9	4.22	1.23	+	+	-
Colombo, all natural	25-500	20	400	1:0.5	4.51	1.18	+	+	-
Cumberland Farms, lowfat, all natural flavor	25-500	27	330	1:0.5	4.31	0.95	+	+	-
Dannon, natural, lowfat	36-1564	9	420	1:0.6	4.43	1.68	+	+	-
Grand Union, lowfat	34-721	11	250	not tested	4.05	1.38	+	+	-
Hood, Firm 'n Fruity, all natural, lowfat	36-2345	20	3	1:0.9	4.27	1.26	+	+	-
LaYogurt, 100% natural	not listed	9	70	1:1	4.14	1.61	+	+	-
LaYogurt, 100% natural	34-865	29	310	not tested	4.40	1.36	+	+	-
LeShake, all natural, lowfat	36-2631	19	550	1:1.1	4.33	1.35	+	+	-
Light 'n Lively, all natural flavor, lowfat	36-2631	24	1080	1:0.02	4.26	0.92	+	+	-
Light 'n Lively, all natural flavor, lowfat	36-2631	38	580	1:0.2	4.39	1.17	+	+	-
Moser Farms, all natural, lowfat	not listed	24	2	not tested	4.05	1.11	+	+	-
Moser Farms, all natural, lowfat	not listed	13	1690	1:0.05	4.40	2.42	+	+	-
Natural and Kosher	not listed	18	350	1:0.6	4.53	1.18	+	+	-
New Country, all natural flavor & color, lowfat	34-865	13	330	not tested	4.00	1.36	+	+	-
New Country, all natural flavor & color, lowfat	34-865	10	670	1:1.6	4.14	1.35	+	+	-
Shop-Rite, Some'nd'ice, lowfat	06-19	36	32	1:1.1	4.39	1.60	+	+	-
Stippity, nonfat, 100% natural	36-2098	7	630	1:0.4	4.10	1.38	+	+	-
Stop & Shop, lowfat	36-2098	8	80	1:0.7	4.45	1.35	+	+	-
Stop & Shop, lowfat	34-0670	25	67	1:0.4	4.58	1.33	+	+	-
Sweet 'n Low, nonfat	34-865	15	270	1:0.5	4.45	0.82	+	+	-
Sweet 'n Low, nonfat	34-0670	32	340	1:0.8	4.64	1.39	+	+	-
Sweet 'n Low, nonfat	34-0670	36	940	1:0.5	4.65	1.36	+	+	-
Waldbaum's all natural, lowfat	36-2098	No code	15	not tested	4.05	1.29	+	+	-
Yoplait, 100% natural	36-2098	22	80	1:0.75	4.04	1.51	+	+	-
Yoplait, 100% natural	34-865	8	460	1:2.2	4.23	1.22	+	+	-
Yoplait, 100% natural	26-525	12	380	-	4.23	1.23	+	+	-
Yoplait, 100% natural	26-525	22	480	1:0.3	4.45	1.28	+	+	-

¹All of the samples contained less than 100 molds/gram and less than 100 yeasts/gram except Colombo (second one in Table) which had 12,500 yeasts/gram and Natural and Kosher which had 15,000 yeasts/gram. Only two samples contained measurable numbers of coliform bacteria but their significance in fruit yogurt is questionable.

²None of the samples declared artificial flavor; all contained strawberries or strawberry preserves and all contained a sweetener.

³Plant where product was made.

⁴Days from manufacture to purchase.

⁵Nonfat dry milk or sodium caseinate, gelatin, agar, gums, or food starch.

⁶Lemon Juice or citric acid.

⁸This sample contained visible molds when purchased; thus it was not tested.

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Table 3. Nutrients in 227 grams or 8 ounces of plain yogurt.

Brand	Fat		Protein		Carbohydrate		Calories	
	Claim	% of claim found	Claim	% of claim found	Claim	% of claim found	Claim	% of claim found
Alta-Dena, Maya, 3.5% fat	10	68	13	78	18	152	210	100
Alta-Dena, Naja, lowfat, 2% fat ¹	5	50	14	83	20	114	180	88
Axelrod's Easy Dieter, lowfat*	2	37	13	62	18	116	150	82
Axelrod's Easy Dieter, lowfat*	2	50	13	96	18	102	150	88
Borden, Lite Line, lowfat*	2	65	11	87	20	96	140	90
Breakstone's Stay 'n Shape, lowfat*	4	25	12	73	16	136	150	87
Breakstone's Stay 'n Shape, lowfat*	4	40	12	88	16	132	150	89
Breyers, all natural	7	27	11	74	14	155	160	89
Breyers, all natural	7	16	11	74	14	171	160	86
Breyers, all natural	7	29	11	53	14	162	160	87
Brown Cow Farms, all natural	11	69	10	65	13	131	190	84
Colombo, natural	7	69	9	79	13	146	150	97
Colombo, natural	7	27	9	79	13	109	150	68
Dannon, lowfat*	4	50	12	68	17	120	150	87
Dannon, lowfat*	4	24	12	92	17	117	150	88
Dannon, lowfat*	4	65	12	65	17	114	150	88
Erewhon, acidophilus	9.5	18	6.4	181	11.8	118	159	73
Erewhon, acidophilus	9.5	32	6.4	172	11.8	154	159	90
Eriyan, whole milk	-	-	-	-	-	-	-	-
Food, Nuform, lowfat*	3	50	13	62	17	140	140	101
Food, Nuform, lowfat*	3	50	13	55	17	132	140	94
Layogurt, 100% natural	4	43	12	73	16	168	173	91
Moser Farms, lowfat*	4	53	12	121	17	69	150	82
Moondance, lowfat*	2	60	12.5	100	17	120	120	118
Moondance, lowfat*	2	20	12.5	103	17	114	120	110
Rosedale, lowfat*	4	40	11	99	15	105	130	93
Rosedale, lowfat*	4	33	11	87	15	106	130	88
Shop Rite, lowfat*	5	30	11	65	14	144	150	81
Stop & Shop, lowfat*	4	70	12	83	17	105	150	91
Sundance, lowfat*	3	37	13	77	18	122	150	91
Sundance, lowfat*	3	40	13	68	18	134	150	95
Waldbaum's, lowfat	4	48	12	80	17	101	150	82
Average ²	4.9	43.0	11.5	85.2	16.0	126.0	152.3	89.6

¹* signifies a product claiming lowfat or diet-implied on label.

²Eriyan not included in average.

³No claims made for Eriyan, but 9.5 g fat, 12.9 g protein, 6.5 g carbohydrate, and 161 calories were found.

Table 4. Nutrients in 227 grams or 8 ounces of strawberry yogurt.

Brand	Style	Fat		Protein		Carbohydrate		Calories	
		Claim	% of claim found	Claim	% of claim found	Claim	% of claim found	Claim	% of claim found
A & P, lowfat*	sundae	2	75	10	49	52	102	270	91
Alta-Dena, Maya, 3.5% fat ¹	sundae	4	43	11	-	39	-	280	-
Alta-Dena, Naja, 1.5% fat**	sundae	4	70	12	78	40	103	240	91
Befit, lowfat*	swiss	2	105	10	111	39	96	220	94
Borden, Lite Line, lowfat*	swiss	2	60	9	97	46	92	230	96
Borden, 100% natural, lowfat*	sundae	2	55	9	86	45	99	230	95
Borden, 100% natural, lowfat*	sundae	2	45	9	64	45	171	230	148
Breyers, all natural, walnut	sundae	6	25	8	96	39	107	240	92
Breyers, all natural	sundae	6	38	8	74	47	111	270	81
Breyers, all natural	sundae	6	52	8	74	47	123	270	102
Colombo, all natural	sundae	6.4	47	8	80	36.8	116	224	100
Colombo, all natural	sundae	6.4	70	8	69	36.8	121	224	101
Cumberland Farms, lowfat*	swiss	3	37	10	98	36	114	220	97
Dannon, lowfat*	sundae	2	50	10	81	49	101	260	93
Grand Union, lowfat*	swiss	2	37	9	64	48	99	240	93
Hood, Firm 'n Fruity, lowfat*	swiss	1.6	45	9	9.6	44.8	108	224	105
Layogurt, 100% natural	shake	5.3	40	10.7	81	42.7	112	267	92
Layogurt, 100% natural	shake	5.3	100	10.7	81	42.7	111	267	91
LeShake, lowfat*	shake	1.8	177	7.1	73	27.5	121	155	110
LeShake, lowfat*	shake	1.8	40	7.1	73	27.5	114	155	112
Light 'n Lively, lowfat*	swiss	2	33	10	71	46	113	240	101
Light 'n Lively, lowfat*	swiss	2	50	9	90	46	110	240	95
Light 'n Lively, lowfat*	swiss	2	70	9	79	48	110	250	100
Moser Farms, lowfat*	sundae	2	75	10	71	52	99	270	92
Moser Farms, lowfat*	sundae	2	33	10	74	52	97	270	90
Natural and Kosher	sundae	7	29	8	81	35	125	240	92
New Country, lowfat*	swiss	3	37	10	61	43	113	240	85
New Country, lowfat*	swiss	3	26	10	78	43	99	240	86
Shop Rite, Somethin'Lite, lowfat*	shake	0.89	76	11	87	46	96	240	88
Sippity, nonfat*	shake	2	55	6.2	87	25.8	126	230	88
Stop & Shop, lowfat*	swiss	2	50	11	76	48	94	133	119
Stop & Shop, lowfat*	swiss	2	50	11	105	48	87	250	90
Sweet 'n Low, nonfat*	swiss	0.3	-	9	71	48	87	250	89
Sweet 'n Low, nonfat*	swiss	0.3	-	9	71	48	87	250	89
Sweet 'n Low, nonfat*	swiss	0.3	-	9	91	28	112	150	115
Waldbaum's lowfat*	sundae	2	26	10	69	28	112	150	107
Yoplait, 100% natural	shake	5.3	43	9.3	81	52	93	270	87
Yoplait, 100% natural	shake	6.7	43	9.3	114	42.7	113	254	93
Yoplait, 100% natural	shake	6.7	43	9.3	114	42.7	104	267	92
Average		3.1	55.4	9.3	80.8	42.2	109.3	233.3	97.7

¹Sample not analyzed since moldy when purchased.

²* signifies a product claiming lowfat or diet-implied.

³Although Sweet 'n Low claimed no fat, 0.43% was found in the first one and 0.25% in the second sample.

⁴Not included in calculation of average.

the accuracy of nutritional claims regarding protein, fat, carbohydrate, and calories and determined differences between regular and low fat or those suggesting a dietary advantage.

METHODS

Microbial determinations included the number of lactic acid bacteria, coliform bacteria, yeasts and molds, and the ratio of Streptococci to Lactobacilli. Chemical determinations included pH, acidity expressed as percent lactic acid, fat, protein, ash, and total solids.

From late December, 1979 to March, 1980 samples were collected at retail food stores and included 32 plain, 37 strawberry, and 10 hard-frozen yogurts.

Samples were placed in ice for transport to the laboratory, and frozen yogurt was kept frozen. For microbial analysis the samples were first thoroughly mixed, and then an 11 gram portion was mixed with 99 ml of sterile phosphate solution (5). Appropriate dilutions for plating were made in sterile phosphate solution. Acid producers were determined on a medium (8) incubated at 35 C in a GasPak system (BBL, Cockeysville, MD). Acidified potato dextrose agar (Difco, Detroit, MI) was used for determining the number of yeasts and molds and Violet Red Bile agar (Difco) for assaying the numbers of coliform bacteria (5). Chemical analyses were made according to Standard Methods (5) and Official Methods of Analysis (7). Although both pH and acidity (titratable) as percent lactic acid were determined, titratable acidity is of more value than pH in determining the quantity of organic acids in foods since pH is a measure of hydrogen ion concentration and organic acids may not ionize completely (3). Manufacturers use pH to determine when the yogurt has reached the desired acidity.

Since style, consistency, and quality or intensity of flavor are matters of personal choice, no attempt was made to grade yogurts for flavor or consistency.

Most yogurts make nutritional claims for a one-cup or 8-ounce serving. A few show nutritional claims by other units; claims for frozen yogurt are usually for an

individual bar or 8 fluid ounces. For ease in comparing products and styles, we calculated the nutrients shown in Tables 3 through 6 per 8 ounces (227 grams).

The calories per 8 ounces were calculated as $2.27 \text{ times } \% \text{ fat} \times 8.79 + [\% \text{ total solids} - (\% \text{ fat} + \text{ash})] \times 4$. Carbohydrate content per 8 ounces was calculated as $2.27 \text{ times } (\% \text{ total solids} - \% \text{ fat} - \% \text{ protein} - \% \text{ ash})$. Carbohydrate content includes both the carbohydrate from milk, lactose, as well as any added sweetener, sugar, honey, fructose, etc.

RESULTS AND DISCUSSION

FRESH YOGURT

Brands and plant permit numbers.

We examined 19 different brands of plain yogurt (Table 1) from 14 different manufacturers made at 15 different plants. Different types (regular, lowfat) were made at the same plants. Thirty brands of strawberry yogurt made by 15 manufacturers (Table 2) at 16 plants were tested. Again different types and styles were made at the same plant.

The plant permit numbers in Tables 1 and 2 designate where the product was made. A plant permit number does not have to be indicated on the label if a company is making and selling the product under its own name. Note that several brands are produced by the same company and packaged and distributed under separate labels.

Code dates:

Most containers had on the label the last date (code date) the product should be offered for sale. This date is set by the processor. Since manufacturers told us their code periods or number of days between manufacture and the code date, we were able to determine the age or days from manufacture to purchase. In Tables 1 and 2 we show in days the age of the sample when purchased. Some samples did not have a code date imprinted on the container. For plain yogurt the average age was 16.9 days (range

8 to 42 days), and for strawberry it was 18.3 days (range 1 to 38 days).

Lactic acid bacteria:

A good consistency and adequate flavor is determined by a 1:1 ratio of Streptococci to Lactobacilli. No samples were completely devoid of either of the two bacteria (Tables 1 and 2); but two LeShake samples (Table 2) contained few Lactobacilli. One Moondance sample (Table 1) had many Lactobacilli but this product claims to feature *L. acidophilus*. Although in one case (Erivan, Table 1) the claim was for a pure *L. acidophilus* culture, we found about as many Streptococci as Lactobacilli.

The number of acid-producing bacteria (lactic acid bacteria) ranged from 2 million to 1,590 million per gram (Tables 1 and 2). The average for plain yogurt was 456 million per gram and for strawberry 366 million per gram. No sample was completely devoid of acid-producing bacteria, which shows that none were heat-treated after manufacture.

Acidity and pH of yogurt:

The acidity expressed as percent lactic acid in plain yogurt and the sundae strawberry yogurt was greater than the Swiss and shake strawberry. These data show that the plain and sundae styles were usually more tart than the other styles. This is not unexpected since the sundae style consists of plain yogurt which is placed over the fruit which contain organic acids.

Acidity measured as pH averaged 4.26 for plain yogurt and 4.23, 4.36, and 4.36 for sundae, Swiss, and shake style strawberry yogurts. Thus, Swiss and shake strawberry yogurt had a higher pH and thus less acid than the plain and the sundae strawberry yogurt.

There will not be a simple linear relationship between pH and titratable acidity because the amount of nonfat dry milk added varies among products and brands. Nonfat dry milk not only increases the titratable acidity, but also increases the buffering capacity, so that the more nonfat dry milk added the higher will be the pH

value for a given conversion of carbohydrate to lactic acid during the fermentation (2).

A yogurt containing more Lactobacilli than Streptococci is expected to be more acid since Lactobacilli produce more lactic acid than the Streptococci. Plain yogurts containing more Lactobacilli than Streptococci had an average pH of 4.29 compared to 4.40 for the others.

Additives:

Many plain yogurts contained solids, usually as nonfat dry milk, to improve consistency (Table 1). Some products also contained a stabilizer or thickener to stiffen consistency. Only one sample (Borden, Lite Line) contained a sweetener, sugar.

Almost all strawberry yogurts declared a stabilizer or thickener (Table 2) Sixteen declared added acidulants, probably to add flavor. Ten declared artificial color. Three samples (Alta-Dena and Hood) declared natural colors other than provided by the strawberries or preserves. The added natural colors were beet juice extract, natural carmine, and turmeric spice.

Microbial contaminants:

Only seven of 32 samples of plain yogurt contained excessive numbers of yeasts, and only three contained viable molds (Table 1) All plain yogurts contained less than 10 coliform bacteria per gram. In only two of the strawberry yogurts was yeast contamination detected (Table 2, footnote 1), and in none was mold contamination detected. Eleven samples declared sorbate. The two samples with yeast contamination did not declare a preservative.

Nutrients:

In both plain and strawberry yogurt fat was generally about half of the amount claimed (Tables 3 and 4). The actual protein, on the other hand, was close to that actually claimed, averaging 85% for plain and 81% for strawberry.

Quality of Yogurt

Table 5. Acid-Producing bacteria, Acidity, and Nutrients in frozen strawberry yogurt.

Brand	Plant permit no.	Acid producing bacteria (millions)	Ratio Streptococci to Lactobacilli	pH	% Acidity
Baskin Robbins	not listed	280	1:0.9	4.70	1.05
Borden, Lite Line, all natural	36-8651	520	1:0.4	4.95	0.79
Carvel, Loyo	not listed	85	1:0	5.08	0.86
Dannon, Lowfat	36-3356	190	1:0.7	4.44	1.07
Hood, Firm 'n Fruity, all natural	09-05	9	1:0.7	4.30	1.06
Sealtest, 98% fat free, all natural	36-0058	11	1:1.3	4.75	0.99
Stop & Shop, all natural, lowfat	25-05	550	1:0.7	4.46	1.17
Tuscan, lowfat, chocolate coated bars	not listed	580	1:0.1	5.63	0.53
Village Treat, all natural	09-180	77	1:0.4	5.40	0.56
Yosicle, all natural, lowfat bars	not listed	320	1:0.8	4.40	1.24

Brand	Fat		Protein		Carbohydrate		Calories	
	Claim	% of claim found	Claim	% of claim found	Claim	% of claim found	Claim	% of claim found
Baskin Robbins ¹	-	-	-	-	-	-	-	-
Borden	1.7	65	6.9	93	38.0	167	190	153
Carvel	5.7	88	10.2	97	58.1	115	-	-
Dannon	1.7	100	6.1	97	36.4	166	182	154
Hood	3.5	131	5.2	100	45.0	151	225	147
Sealtest	2.9	103	8.7	74	64.0	100	320	90
Stop & Shop	3.5	60	5.2	163	43.2	156	225	143
Tuscan	19.4	162	5.5	82	44.3	166	360	164
Village Treat ¹	-	-	-	-	-	-	-	-
Yosicle	2.8	71	8.3	133	47.0	126	249	119
Average ²	5.2	97.5	7.0	105	47.0	143.4	250.1	138.6

¹No claims made for Baskin Robbins or Village Treat. For Baskin Robbins we found 3.4 g fat, 5.4 g protein, 66.3 g carbohydrate, and 317 calories. For Village Treat we found 2.3 g fat, 5.8 g protein, 66.6 g carbohydrate, and 314 calories.

²Average includes only those products making a claim.

The amount of carbohydrate was generally more than claimed, averaging 26% more in plain and 9% more in strawberry yogurt. Calories were generally close to the claim, averaging 90% for plain and 98% for strawberry yogurt.

There was a wide variation among brands in agreement between nutrients claimed and found. For example, the fat in plain yogurt (Table 3) ranged from 16% of claim to 70%. The range in carbohydrate was from 69 to 171% of the claim.

FROZEN STRAWBERRY YOGURT

Microbial content:

All ten frozen yogurt samples examined contained live lactic acid bacteria (Table

5), but generally only a third the number in plain or strawberry yogurt. Probably some of the lactic acid bacteria were killed by freezing. Although most samples contained more Streptococci than Lactobacilli, the flavor compounds (diacetyl, acetaldehyde) produced by these bacteria may not be as important in the highly flavored frozen yogurt as in fresh plain yogurt.

All samples from dairy plants were devoid of yeasts, molds, and coliform bacteria. The two samples (Baskin-Robbins and Village Treat) collected at dairy bars from bulk containers, however, contained contaminants, which may reflect microbial contamination from handling in the dairy bar rather than manufacturing.

Table 6. Average nutrient composition per 227 grams (1 cup) of regular and diet-implied plain and strawberry yogurt and frozen strawberry yogurt compared to other dairy products.

Nutrient	TYPE OF YOGURT									
	PLAIN				STRAWBERRY					
	Regular (10) ¹		Diet (21)		Regular (10)		Diet (26)		Frozen (10)	
	claim	found	claim	found	claim	found	claim	found	claim	found
Calories	167	145	145	132	252	239	226	220	250	343
Fat	7.9	3.3	3.4	1.5	6.0	2.4	2.0	1.2	5.2	6.4
Protein	9.9	8.6	12.2	9.9	8.8	7.3	9.5	7.6	7.0	7.2
Carbohydrate	13.9	20.5	17.0	19.7	41.2	47	42.5	45.0	47	65.4

Nutrient	COTTAGE CHEESE ²				MILK		ICE CREAM	ICE MILK
	creamed	creamed + fruit	lowfat	lowfat + fruit	whole	lowfat	vanilla	vanilla
					(3.3% fat)	(1% fat)	(10% fat)	(4.3% fat)
Calories	234	281	163	196	138	109	459	318
Fat	10.2	7.7	2.3	1.7	7.6	2.7	24.4	9.8
Protein	28.4	22.5	28.1	22.2	7.5	8.9	8.2	8.9
Carbohydrate	6.1	30.2	6.2	30.3	10.6	12.5	54.1	50.2

¹ See Tables 3 and 4 for those yogurts designated as diet-implied or regular products. Number in parenthesis indicates number of samples.
² Data for cottage cheese, milk, ice cream, and ice milk from U.S.D.A. Handbook 8-1, Composition of Foods: dairy and egg products. United States Dept. of Agriculture, Agricultural Research Service, Washington, D.C., 1976.

Acidity:

The acidity of frozen yogurt (Table 5) was less than in fresh yogurt and the pH was higher.

Additives:

Frozen yogurt, like the fresh, contained additives such as sugar and stabilizers. Additionally, they also contained additives not found in fresh: cellulose, glycerides, neutralizers, and egg yolk.

Nutrients:

The average fat and protein content was as claimed (Table 5). Carbohydrate averaged about 43% more than claimed, and calories

about 38% more than claimed. The most fat found was in the Tuscan chocolate-covered yogurt, probably from the chocolate.

COMPARISON OF NUTRIENT CONTENT OF REGULAR AND LOWFAT YOGURT:

The data in Table 6 for plain and strawberry yogurt are separated from those with labels claiming low fat or suggesting fewer calories. About 50 to 60% less fat was claimed for these products and these claims were substantially correct. These products on the average contained more protein, 23% more for plain and 8% more for strawberry, than did the regular yogurts.

The products with low fat or suggesting fewer calories, however, generally contained more carbohydrate than did the regular yogurt. This group of plain and strawberry yogurts claimed about 10 to 13% fewer calories but had only 8 to 9% fewer

calories. Thus, the diet products did not have, on the average, substantially fewer calories.

A comparison of nutrient content between yogurt and other dairy products such as cottage cheese and milk is shown in the lower portion of Table 6. A similar comparison is also shown for frozen yogurt with ice cream and ice milk.

CONCLUSIONS

Plain, unflavored and strawberry yogurts sold in Connecticut had acceptable microbial quality and contained many viable lactic acid bacteria. More samples of plain yogurt were found with yeast and mold contaminants than were found in strawberry yogurt. This difference, however, can be attributed to preservatives in the strawberry yogurt.

Plain yogurts contained few additives, and nine samples claimed only milk was used. Some contained added solids which may improve consistency and nutrition by providing extra milk protein. The strawberry yogurts generally contained more additives than did the plain yogurts.

The fat content for all yogurts was considerably lower than claimed. Otherwise, the nutrient content was as claimed. The difference in calories between regular and diet or lowfat yogurt was only about 8%.

The frozen yogurts were of good microbial quality and provided many live lactic acid bacteria, although fewer numbers than fresh yogurt. The caloric content of the frozen yogurt was about 60% higher than the fresh yogurt.

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LITERATURE CITED

1. Dairy Situation (DS-376) July 1979. U.S.D.A. Economics, Statistics, and Cooperatives Service. Washington. D.C.
2. Davis, J.G. 1974. Yogurt in the United Kingdom: chemical and microbiological analysis. Dairy Industry 39: 149-150, 152, 154, 157-177.
3. Jay, J.M. 1978. Modern Food Microbiology. D. Van Nostrand Co. New, York, N.Y.
4. Marketing Profile: Yogurt, frozen yogurt (soft-serve), hard frozen yogurt, 1978. American Cultured Dairy Products Inst., Washington, D.C.
5. Standard Methods For the Examination of Dairy Products. 1978. 14th ed. E.H. Marth. ed. American Public Health Assoc., Washington, D.C.
6. Steinberg, A.F. 1979. Yogurt, the cinderella product. American Dairy Review 41: 74-75, 50F, 50H.
7. Official Methods of Analysis. 1975, 12th ed. W. Horwitz, ed. Association of Official Analytical Chemists, Washington, D.C.
8. Wade, W.E., K.L. Smiley, and C.S. Boruff. 1946. An improved method for differentiating acid-forming bacteria. J. Bacteriol. 51:787-788.