MICROBIOLOGICAL EVALUATION OF YOGURT PRODUCED COMMERCIALLY IN ONTARIO

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Abstract

One hundred and fifty-two commercially-produced yogurts were subjected to microbiological examination for lactobacillus/streptococcus ratio, staphylococcus count, coliform count, enterococcus count, yeast and mold count, and psychrotrophic count. These yogurts were produced by 13 different manufacturers and sold in Ontario. The desired 1:1 ratio of lactobacillus to streptococcus was found in 15.1% of the samples. Streptococci were predominant in 40.8% and lactobacilli in 44.1% of the samples. Staphylococci were found in 27.6% of the samples, enterococci in 36.2%, and coliform in 13.8%. Yeast counts in excess of 1000/g were noted in 26.3% of the samples and mold counts >10/g in 17.8% of the samples. Psychrotrophs at levels >1000/g were found in 11.8% of the yogurts examined.

The increasing popularity of yogurt has to some degree been a consumer response to the appearance of yogurts containing added sugar, fruit, and flavorings. Unfortunately these additions improve yogurt as a medium for growth of yeasts and molds and may also contribute to microbial contamination even though most bacteria, particularly those of public health significance, soon die out because of the marked antagonism exerted by the lactic acid bacteria and the acid pH *(2, 4, 5)*.

In respect to yogurt technology it is generally agreed that yogurt should contain approximately equal proportions of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* to achieve the characteristic pleasant but sharp acid flavor in high quality mature yogurt.

For these reasons fruits and flavors added to yogurt must be subjected to a rigorous quality control program as well as control of cultures and sanitation during manufacture. Results of a study reported here are intended to acquaint the dairy industry and regulatory agencies with the microbial quality of yogurt appearing on the Ontario market.

Materials and Methods

Products

One hundred and fifty-two commercially-produced yogurts were obtained from retail outlets in Ontario during the months of June, July, and August of 1971. The samples which represented 13 different manufacturers included 15 plain and 137 fruit or fruit-flavored yogurts (Swiss style). All products were transported to the laboratory within 2 hr of purchase, held at 5 C, and analyzed within 48 h.

Analyses

Yogurt samples were subjected to seven microbiological analyses: *(a)* lactobacillus-streptococcus ratio; *(b)* staphylococcus count; *(c)* coliform count; *(d)* enterococcus count; *(e)* yeast count; *(f)* mold count; and *(g)* psychrotrophic count.

Approximately 170 g yogurt were transferred to a sterile Waring blendor and mixed thoroughly for 3 min at high speed. A sample was diluted by similarily mixing 11 g with 99 ml of buffered sterile water (pH 7.2). Further dilutions were made as required. Smears were prepared from the original mixed sample.

(a) Lactobacillus-Streptococcs ratio. Following staining with L-W modified stain *(3)* the lactobacillus-streptococcus ratio was determined microscopically.

(b) Staphylococci. The presence of staphylococci was determined by spreading 1 ml of the original sample over 4 plates and 0.5 ml and 0.1 ml of the diluted sample on single plates of Baird-Parker egg yolk tellurite agar. Plates were examined following incubation at 37 C for 24 and 48 h. Typical staphylococcal colonies were picked for confirmation by gram staining and a coagulase slide test *(1)* using lyophylized bactocoagulase plasma (without EDTA, Difco).

(c) Coliforms. Violet red bile agar (Difco) was used for the detection of coliform organisms with incubation at 37 C for 24 h.

(d) Enterococci. Enterococci were enumerated on Reinbold's blue tetrazolium-citate azide medium *(5)* with incubation at 37 C for 48 h.

(e) Yeasts and molds. Acidified potato dextrose agar was used for yeast and mold determinations. Incubation was at 25 C for 5 days.

(f) Psychrotrophs. Standard plate count agar was used to detect psychrotrophs with incubation at 5 C for 10 days.

Results and Discussion

Samples were grouped according to brand names. Each of the groups from A to H inclusive represented one brand of yogurt and contained from 15 to 27 samples while Group I included 5 different brands and contained 20 samples. Results are summarized in Table 1.

Lactobacillus-Streptococcus ratio

As noted in Table 1, the desired 1:1 ratio of lactobacillus-streptococcus cells occurred in 15.1% of the samples. The remaining samples were divided almost equally with streptococci being predominant in 40.8% and lactobacilli in 44.1% of the samples. The high incidence of undesirable ratios could be due to poor culture control at point of manufacture or to handling and storage conditions during manufacture

TABLE 1. MICROBIOLOGICAL ANALYSES OF YOGURTS SHOWING RANGE OF COUNTS/GRAM AND PERCENTAGES OF SAMPLES FALLING WITHIN SELECTED RANGES

	Group									
	A	B	C	D	E	F	G	H	I	Total samples
No. samples	15	16	16	17	17	17	17	17	20	152
Plain samples	0	0	0	2	1	0	3	2	7	15
L:S ratio[a]										
% 1:1	13.3	12.5	18.8	11.8	11.8	5.9	35.3	11.8	15.0	15.1
% S >L[b]	0.0	75.0	18.8	70.6	11.8	82.4	17.7	64.7	25.0	40.8
% L >C[c]	86.7	12.5	62.4	17.6	76.4	11.7	47.0	23.5	60.0	44.1
Staphylococci										
range	<1-3	<1-960	<1-62	<1	<1-240	<1-5	<1-3	<1-45	<1-380	<1-960
% <1	93.3	66.7	68.8	100	11.8	76.5	88.2	82.4	70.0	72.4
% >1	6.7	33.3	31.2	0	88.2	23.5	11.8	17.6	30.0	27.6
Coliforms										
range	<1-10	<1-110	<1-2	<1-5	<1-12	<1-4	<1-5	<1-55	<1-5	<1-110
% <1	93.3	75.0	93.8	82.3	82.4	88.2	82.4	88.2	90.0	86.2
% >1	6.7	25.0	6.2	17.7	17.6	11.8	17.6	11.8	10.0	13.8
Enterococci										
range	<1-2	<1-2,200	<1-41	<1-15	<1-400	<1-6	<1-2	<1-100	<1-110	<1-2,200
% <1	86.7	18.8	68.8	70.6	41.2	52.9	88.2	70.6	75.0	63.8
% 1-100	13.3	56.2	31.2	29.4	35.3	47.1	11.8	29.4	20.0	30.3
% >100	0.0	25.0	0.0	0.0	23.5	0.0	0.0	0.0	5.0	5.9
Psychrotrophs										
range	<10-170,000	<10-240,000	<10-1,200	<10-7,000	<10-1,200	<10-8,200	<10-10	<10-18,000	<10-200,000	<10-240,000
<10	73.3	50.0	81.3	70.6	88.2	58.8	94.1	76.5	45.0	70.4
10-1000	13.3	31.3	12.5	23.5	5.9	23.5	5.9	11.7	30.0	17.8
>1000	13.4	18.7	6.2	5.9	5.9	17.7	0.0	11.8	25.0	11.8
Yeasts										
range	<2-30,000	<2-320,000	<2-240,000	<2-1,800	<2-3,000	<2-11,000	<2-20	<2-100,000	<2-300,000	<2-320,000
<100	46.7	50.0	68.8	88.2	82.4	47.1	100.0	64.7	40.0	65.1
100-1000	6.6	6.2	12.5	5.9	5.9	29.4	0.0	11.8	0.0	8.6
>1000	46.7	43.8	18.7	5.9	11.7	23.5	0.0	23.5	60.0	26.3
Molds										
range	<2-550	<2-30,000	<2-610	<2-6	<2-30,000	<2-190	<2-4	<2-2,000	<2-900	<2-30,000
<2	53.3	31.3	62.6	88.2	64.7	53.0	94.1	64.7	60.0	63.8
2-10	40.0	43.7	25.0	11.8	5.9	23.5	5.9	0.0	15.0	18.4
>10	6.7	25.0	12.4	0.0	29.4	23.5	0.0	35.3	25.0	17.8

[a]Lactobacillus - Streptococcus ratio
[b]% of samples in which streptococci are predominant in numbers
[c]% of samples in which lactobacilli are predominant in numbers

and marketing. Regardless of cause, the large proportion of samples with undesirable ratios indicates a need for more care in processing and handling of yogurt in Ontario.

Staphylococci

Eight of the nine groups of samples contained staphylococci with counts ranging from <1 to 940/g. More than one quarter of the samples analyzed contained staphylococci. Fifteen of the 17 samples in Group E were contaminated with staphylococci and two of these contained coagulase-positive staphylococci. The only other instance where coagulase-positive staphylococci were present was in Group B.

Coliforms and enterococci

Coliform counts ranged from < 1 to 110/g. The counts were not large but were surprising when one considers that the data of Davis et al. *(2)* and Goel et al *(4)* indicated that yogurt was not a good medium for coliforms. Davis found no coliforms in the samples he analyzed whereas Goel et al. found that the numbers of coliforms introduced by inoculation decreased rapidly and were almost extinct after 4 days. Both groups of workers used yogurt of the same pH range as were found in the work reported here. Results of Goel et al. may be explained by the findings of Walker et al. *(7)* who worked with staphylococci and observed that naturally occurring pathogenic staphylococci were better adapted to adverse conditions than were laboratory cultures.

Approximately one-third of the samples had enterococcus counts ranging from 1 to 100/g. Four groups had yogurt samples with counts of 100/g or more. The relatively high incidence of coliforms and enterococci is disturbing because it is considered to be indicative of unsanitary processing conditions.

Yeasts and molds

Presence of yeasts or molds in yogurt also is indicative of poor sanitary practices in manufacturing or packaging. Yogurts with added sugar or fruits are especially susceptible to yeast growth. Data in Table 1 for both yeasts and molds indicate a problem area for manufacturers of yogurt in Ontario. If one uses the standards suggested by Davis (2) of < 10 yeasts and < 1 mold/g as being satisfactory and > 100 yeasts or > 10 molds/g as being unsatisfactory, then one quarter of the samples analyzed were unsatisfactory owing to yeast contamination and almost one-fifth were unsatisfactory owing to mold contamination. Another 8.6% of the samples tested for yeast would fall into a doubtful classification. Group G shows no doubtful or unsatisfactory samples with reference to yeast and no unsatisfactory samples in the case of mold. This indicates that yeast and mold contamination can be controlled in commercially produced yogurt.

Psychrotrophs

Eighteen of 152 samples had phychrotrophic counts > 1000/g. Five of the 18 samples registered counts in excess of 100,000/g. Although high psychrotrophic counts are indicative of poor quality, the problem is not serious in Ontario yogurt as 90% of the samples fell within acceptable limits.

CONCLUSION

The overall picture of yogurt quality in Ontario as measured by microbiological evaluation appears to indicate a need for emphasis on quality control within processing plants. The level of coliform, staphylococci, yeast and mold counts indicates that excessive contamination occurs during manufacture and packaging of the product. The relatively high temperatures (80 to 90 C for 15 to 30 min) used in processing milk for yogurt manufacture precludes survival of these organisms.

The large number of samples containing an excess of either streptococci or lactobacilli indicates poor culture control or improper storage conditions of yogurt in merchandising channels.

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