Effects of Long-Term Feeding of Milk and Milk Components to Rats

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Abstract

To study effects of long-term feeding of milk and of certain milk components, but with butteroil reduced to supply 30% of calories, rats were fed a diet composed principally of dried milk, or purified diets with the same protein, fat, and carbohydrate content and with the fat (corn oil) or part of the carbohydrate (cornstarch), or both, replaced by milk fat and lactose. Food intakes, weight gains, and fat-free weights of rats fed the milk diet were lower than those of rats fed the purified diets. For rats fed purified diets, gross calorie intakes were similar, but weight gains were higher for rats receiving cornstarch than for rats fed lactose. Differences in digestive calorie intakes accounted for part but not all of the differences in gain. Calcium absorption was higher for rats fed milk and lactose-butteroil diets, but not for those fed the lactose-corn oil diet, than for those fed no lactose. Carcass calcium contents of lactose-fed groups were similar and higher than those of cornstarch-fed groups. Kidney stones were found in 47% of rats fed the milk diet, 29% of those fed lactose-butteroil, in one animal fed lactose-corn oil, and in no animals fed cornstarch.

McGillivray (28), in a review on the nutritive value of milk and milk products, stated "The nutritive value of milk and its products has probably been recognized for longer than that of any other foodstuff." Nevertheless, he went on to discuss reasons some reservations toward the use of milk and milk products have recently developed because of certain of its natural constituents and because of possible contaminants.

Despite possible shortcomings, there are many reports that milk is indeed an excellent food when given to experimental animals as the principal source of nutrients for long periods of time. McCay et al. (27) found that the mean lifespan of rats fed fluid milk with manganese, copper, iron, iodine, and cod liver oil was no different from that of rats fed a mixed diet containing meat, cereal, and many other ingredients. Evans and Phillips (9) were able to raise rats through five generations on a diet of mineralized milk, and Bixby et al. (3) found mineralized milk adequate to maintain satisfactory reproduction and lactation in female rats for three generations, although young weaned from second- and third-generation females did not grow as well on the milk diet as young of first-generation females.

Studies in this laboratory showed that some carbohydrate-fat combinations affected appetite, weight gains, and fat deposition, and resulted in elevated serum cholesterol levels (26). Other studies have demonstrated an effect of carbohydrate and fat on the rate of onset of degenerative changes in tissues. Similar studies with milk and milk components might contribute data useful in evaluating the role of milk in nutrition. Accordingly, diets containing milk itself, or the principal proteins, carbohydrate, and fat of milk were fed to rats from weaning to maturity and beyond. Comparisons were made of the effects on food intakes, weight gains, carcass composition, organ size, and incidence of kidney stones and of fatty deposits in the aorta.

Experimental Procedure

Diets. Five diets were formulated (Table 1). All contained 4% nitrogen and 15% fat, an amount which furnished 30% of calories; instead of 52% as in dry whole milk. The milk diet contained, in addition to dry skim milk, 2% cellulose flour, 15% butteroil, copper, iron, manganese, magnesium, and the vitamins added to the purified diets. The remainder of the diet, approximately 10%, was cornstarch. The four purified diets contained casein and lactalbumin in milk proportions [85% of the nitrogen from casein and 15% from lactalbumin (31)] at a level to supply the amount of protein in whole milk, and approximately 50% carbohydrate. Additional magnesium was added because of reports (16, 19, 44) that the amount furnished by 4% Jones and Foster salt mixture (20) might not be an adequate intake for rats under all circumstances. In two diets, either butteroil or butter was purchased on the open market, melted, and centrifuged to remove nonfat milk solids. We thank the Eastern Utilization Research and Development Division, Agricultural Research Service, for preparation of the butteroil.

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2. Butter was purchased on the open market, melted, and centrifuged to remove nonfat milk solids. We thank the Eastern Utilization Research and Development Division, Agricultural Research Service, for preparation of the butteroil.
or corn oil supplied the fat, and the carbohydrate was cornstarch (C-B and C-Co.). In two other diets, approximately 37% of lactose (the proportion in whole milk) replaced an equal amount of cornstarch (L-B and L-Co.).

**Animals.** Weanling male BHE rats from the stock colony of this laboratory (25) were divided into five groups (30 per group), housed individually, and fed ad libitum until 400 days of age the diets already described. The animals were weighed weekly and food intakes measured. Scattered food was carefully recovered and weighed. For the first few days the animals which received the dried milk diet and, to a somewhat lesser extent, those receiving the two purified diets containing lactose had diarrhea. As found by others who fed diets containing comparable amounts of lactose (33), the animals quickly adapted to the diets and the diarrhea ceased. During the 11th wk of feeding, feces were collected, dried under infrared lamps, ground, and analyzed for nitrogen, calories, and ash. Calcium, phosphorus, and magnesium were determined in composites.

**Procedures.** At the end of the feeding period the animals were anesthetized with sodium amytal, the body cavity opened, and a sample of blood taken by heart puncture. Contents of the gastro-intestinal tract were discarded. Liver, kidneys, heart, adrenals, and thyroid were removed and weighed. Kidneys were slit open and examined for abnormalities. The aortas were dissected out, slit open, divided into thoracic and abdominal segments, stained with lipid stain (Herxheimer's Sudan IV), mounted, examined under a dissecting microscope, and graded on a scale of 0-5 three times by three different scorers. The scoring system used was adapted from that of Fisher et al. (11) and gives greatest emphasis to the degree of fatty deposits on the intimal surface and secondarily evaluates calcification of the intima. Aortas scored zero had no visible fat-staining lipid. Scores increased as fatty deposits increased; in those given a score of 5, the entire surface was covered with fatty deposits and there was some calcification. In aortas scored 0-4 no calcification was observed.

Carcasses were autoclaved at 15-lb pressure for 15 min and homogenized in a blender with a known amount of water; nitrogen, water, and ash were determined. Protein was calculated as N × 6.25 and fat by difference. Aliquots of the
carcass samples were pooled by group and calcium, phosphorus, magnesium, and cholesterol content determined. Livers were homogenized and analyzed for fat and cholesterol. Kidneys were homogenized and ash content determined. Hearts were ashed and calcium content determined.

**Methods.** Ash was determined by heating samples in a muffle furnace at 600 °C. Nitrogen was determined by the macro-Kjeldahl method, and gross energy in a Parr Bomb Adiabatic Calorimeter. Lipids were determined by the method of Folch (12), cholesterol by Koval’s method (22), calcium by the method of Harrison et al. (18), phosphorus by the method of Chen et al. (6) and magnesium by Orange and Rhein’s method (32). Statistical comparisons were made by the use of the “t” test, except for incidence of kidney stones, where the Chi-square test was used.

**Results and Discussion**

**Body weight gains, carcass composition, and digestible calorie intakes.** Thirty-eight of the rats died (mostly from respiratory diseases) or were killed when moribund before the end of the study. Data for 14 animals which survived were discarded because of a greater than 10% decrease from maximum weight. Body weight gains, fat-free weights, apparent digestibility of the energy supply, gross and digestible calorie intakes (DCI), and carcass composition for the remaining animals are shown in Table 2. Food intakes, weight gains, and fat-free body weights (Table 2) of rats fed the diet containing dried milk were significantly smaller than those of rats fed any of the purified diets. Among the latter groups, body weight gains were significantly higher for rats receiving cornstarch as the carbohydrate than those fed lactose, although there were no significant differences among fat-free body weights of the four groups.

Lower digestibility of nutrients and lower food intakes, weight gains, and body fat levels of young rats fed lactose than of rats fed various other carbohydrates for periods of a few weeks have been reported (10, 29, 37, 40). In addition, Tomarelli et al. (40) found that rats fed for 42 wk diets containing lactose had less fat than glucose-fed controls. The presence or absence of lactose in the purified diets of

<table>
<thead>
<tr>
<th>TABLE 2</th>
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</thead>
<tbody>
<tr>
<td><strong>Table 2</strong> Body weight gains, fat-free weights (FFW), apparent digestibility of energy supply (ADE), gross (GCI) and digestible (DCI) calorie intakes, and carcass composition of rats fed various combinations of dietary carbohydrates.</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
</tr>
<tr>
<td><strong>Group</strong></td>
</tr>
<tr>
<td>M (19)</td>
</tr>
<tr>
<td>L.B (17)</td>
</tr>
<tr>
<td>L.Co (21)</td>
</tr>
<tr>
<td>C.B (34)</td>
</tr>
<tr>
<td>C.C (17)</td>
</tr>
</tbody>
</table>

*Apparent digestibility of energy supply = Gross calorie intake−fetal calories × 100.

Digestible calorie intake = gross calorie intake × apparent digestibility of energy supply.

- Figures in parentheses indicate number of animals per group.
- Average initial weights of the groups were 47.49 ± 4 g.
- Standard error of the mean.
this study did not appreciably influence average gross calorie intakes (Table 2). In agreement with the data of Tomarelli (40), weight gains and per cent body fat, but not fat-free body weights, were higher for rats fed the purified diets containing cornstarch than for those fed lactose.

To determine whether differences in digestibility of the energy supply could account for differences in weight gains among the animals fed the purified diets, data for the animals fed lactose and those fed cornstarch were combined. Carcass fat plus protein calories were calculated (grams protein × 5.65; grams fat × 9.5), plotted against DCI (Figure 1), and the regressions calculated. Slopes of the lines were not significantly different. When the data were adjusted to equal digestible calorie intake by analysis of covariance, carcass fat plus protein calories still remained higher for cornstarch-fed than for lactose-fed rats. Thus, differences in digestible calorie intake accounted for part but not all of the differences in gain between the groups. Although the effect of digestibility of the energy supply, urinary calorie losses, and changes in intestinal flora have been studied individually, it seems possible that a combination of these factors will eventually provide the answer to differences in weight gains between rats fed diets containing lactose and those fed other carbohydrates. That differences in type or numbers of bacteria, or both, may affect the metabolism of the host seems certain from the report of Levenson et al., who concluded from studies with germ-free and conventionalized rats that certain intestinal microorganisms increase directly or indirectly the oxygen consumption, carbon dioxide production, and rectal temperatures of rats.

Reasons for the failure of milk-fed rats to eat as much and grow as well as those fed the purified diets (Table 2) may include differences in amounts of minerals in the diet. Robbins et al. (34) found significant interactions between levels of certain minerals in their effect on growth of rats. Also, differences in texture between the purified and the dry milk diet may have been responsible for lower food intakes by rats fed the latter diet.

Carcass content of calcium, phosphorous, and magnesium. It has been known for many years that the presence of lactose in the diet improves the utilization of some minerals, particularly calcium (1, 7), and many studies to determine the mechanism have been reported (4, 5, 8, 23, 24, 41, 45). Most of the investigators appear to agree that the effect is in calcium absorption. Fournier and Dupuis (14), however, consider that lactose also acts by participating in some manner with the bone cell. In the present study the amounts of calcium apparently absorbed were higher for the groups of rats fed the milk and the lactose-butteroil diets than for the groups fed cornstarch, but the amounts absorbed by the group fed the lactose-corn oil diet were no greater than in the group fed the cornstarch-corn oil diet. Amounts of phosphorus and magnesium absorbed were somewhat higher in all groups fed lactose-containing diets than in those fed cornstarch (Table 3).

The finding that calcium absorption of rats fed the lactose-corn oil diet was not higher than that of rats fed cornstarch-corn oil was compensated for by lower fat and higher protein retention (Table 2). Although the effect of digestibility of the energy supply, urinary calorie losses, and changes in intestinal flora have been studied individually, it seems possible that a combination of these factors will eventually provide the answer to differences in weight gains between rats fed diets containing lactose and those fed other carbohydrates. That differences in type or numbers of bacteria, or both, may affect the metabolism of the host seems certain from the report of Levenson et al., who concluded from studies with germ-free and conventionalized rats that certain intestinal microorganisms increase directly or indirectly the oxygen consumption, carbon dioxide production, and rectal temperatures of rats.

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The finding that calcium absorption of rats fed the lactose-corn oil diet was not higher than that of rats fed cornstarch-corn oil was

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TABLE 3

<table>
<thead>
<tr>
<th>Group</th>
<th>Ca (g)</th>
<th>P (g)</th>
<th>Mg (g)</th>
<th>Ca (mg)</th>
<th>P (mg)</th>
<th>Mg (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>45.14</td>
<td>40.57</td>
<td>7.80</td>
<td>11.78</td>
<td>22.84</td>
<td>4.91</td>
</tr>
<tr>
<td>L-B</td>
<td>38.98</td>
<td>34.48</td>
<td>4.46</td>
<td>10.56</td>
<td>22.83</td>
<td>3.22</td>
</tr>
<tr>
<td>L-Co</td>
<td>34.52</td>
<td>38.51</td>
<td>4.18</td>
<td>6.59</td>
<td>23.01</td>
<td>3.02</td>
</tr>
<tr>
<td>C-B</td>
<td>37.35</td>
<td>35.27</td>
<td>4.36</td>
<td>5.00</td>
<td>20.10</td>
<td>2.28</td>
</tr>
<tr>
<td>C-Co</td>
<td>35.68</td>
<td>36.06</td>
<td>4.29</td>
<td>6.60</td>
<td>21.06</td>
<td>2.22</td>
</tr>
</tbody>
</table>

Amounts of calcium, phosphorus, and magnesium ingested, apparently absorbed, and in carcases of groups of rats fed from weaning until 400 days of age a diet composed mainly of dry skim milk with 15% butteroil added (M), or purified diets containing butteroil (B), corn oil (Co), cornstarch (C), or lactose (L) in various combinations.

Based on analyses of carcass composites. Does not include amounts in liver, kidney, heart, adrenals, and thyroid.

Number of animals per group as indicated in Table 2.

Indeed, French and Cowgill (15) have reported that in a mature dog there was no effect of lactose on calcium utilization. The findings warrant further investigation, however, particularly in view of the implications of the effect on calcium utilization and because of the findings in connection with kidney stone formation (see later section).

More phosphorus was stored by lactose-fed than by cornstarch-fed animals, probably as the result of the higher calcium storage. More magnesium, both total amount and per gram of ash, was found in cornstarch-fed than in lactose-fed animals. Possibly when ample calcium is present, less magnesium is deposited in bone than is otherwise the case. Forbes (13) noted that increased urinary excretion of magnesium by rats fed diets containing lactose was more than sufficient to offset the increased absorption, so that the net effect of lactose was to decrease the magnesium balance.

Organ weight and composition. Livers, kidneys, and hearts (Table 4) of rats fed the milk diet were significantly smaller than those of the rats fed the four purified diets. When expressed as per cent of body weight or of fat-free body weight, however, there were no significant differences among the five groups. Thyroids of groups fed purified diets containing lactose were significantly smaller than those of groups fed corresponding diets containing cornstarch; when expressed as per cent of body weight they were also smaller, but only the difference between the two butteroil-fed groups was significant. When expressed as per cent of fat-free body weight, thyroids of lactose-fed groups fed either fat were significantly smaller than those of cornstarch-fed groups. There were no significant differences in adrenal weights.

Liver fat (Table 5) of rats fed the milk diet was significantly lower than that of rats fed the purified diets. The group fed the cornstarch-
Weights of livers, kidneys, hearts, adrenals, and thyroids of groups of rats fed from weaning until 400 days of age a diet composed mainly of dry skimmilk with 15% butteroil added (M), or purified diets which contained butteroil (B), corn oil (Co), cornstarch (C), or lactose (L) in various combinations

<table>
<thead>
<tr>
<th>Group</th>
<th>Liver (g)</th>
<th>Kidneys (g)</th>
<th>Heart (g)</th>
<th>Adrenals (g)</th>
<th>Thyroid (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>12.15 ± 0.40*</td>
<td>2.52 ± 0.09*</td>
<td>1.11 ± 0.03*</td>
<td>35 ± 1.4*</td>
<td>6.3 ± 0.51*</td>
</tr>
<tr>
<td>L-B</td>
<td>14.46 ± 0.57</td>
<td>2.94 ± 0.11</td>
<td>1.20 ± 0.033</td>
<td>36 ± 1.5</td>
<td>7.5 ± 0.47</td>
</tr>
<tr>
<td>L-Co</td>
<td>13.67 ± 0.54</td>
<td>3.14 ± 0.21</td>
<td>1.34 ± 0.035</td>
<td>38 ± 1.9</td>
<td>8.4 ± 0.28</td>
</tr>
<tr>
<td>C-B</td>
<td>15.56 ± 0.64</td>
<td>3.27 ± 0.18</td>
<td>1.31 ± 0.030</td>
<td>35 ± 1.3</td>
<td>10.5 ± 0.72</td>
</tr>
<tr>
<td>C-Co</td>
<td>14.80 ± 0.68</td>
<td>3.47 ± 0.28</td>
<td>1.32 ± 0.040</td>
<td>38 ± 1.6</td>
<td>10.8 ± 0.67</td>
</tr>
</tbody>
</table>

Table 4

buttermilk diet had the highest liver fat. Liver cholesterol increased as the per cent of liver fat increased and was lowest for the animals fed the milk diet and highest for those fed the purified diet containing cornstarch and butteroil.

Heart ash (Table 5) of the group fed the milk diet was higher than that of the animals fed the purified diets, and lower for groups receiving cornstarch than for those receiving lactose. There was no clear picture of the effect of the various diets on heart calcium. There was a significant difference, for example, between values for the animals fed the milk diet and those fed the purified cornstarch-butteroil diet, but other differences which might be expected to appear if the differences were due to type of carbohydrate were not apparent.

Kidney ash (Table 5) was significantly higher for all groups receiving diets containing lactose (including the milk diet) than for those receiving cornstarch, and the value for the milk diet was significantly higher than for those of groups receiving the purified diets.

Incidence of kidney stones. Calcification of the kidney and bladder calculi have been noted in rats fed milk diets for long periods of time (2, 35, 36, 38). In the present study, bladders were not examined, but kidney stones were found in some animals. Nine of 19 rats fed the milk diet (47%), five of 17 fed the lactose-butteroil diet (29%), and one of 21 fed the lactose-corn oil diet had kidney stones. No stones were found in cornstarch-fed animals. The percentage of stones for the rats fed the milk diet and the lactose-butteroil diet were significantly higher than the percentage for the lactose-corn oil-fed group, and not significantly different from each other. The percentage for the lactose-corn oil-fed rats was not significantly different from zero. The effect of diet on stone formation in rats

Table 5

Liver fat and cholesterol, serum cholesterol, kidney and heart ash, and heart calcium of groups of rats fed from weaning until 400 days of age a diet composed mainly of dry skimmilk with 15% butteroil added (M), or purified diets which contained butteroil (B), corn oil (Co), cornstarch (C), or lactose (L) in various combinations.

<table>
<thead>
<tr>
<th>Group</th>
<th>Liver Fat (mg/g) ± SE</th>
<th>Liver Cholesterol (mg/dl) ± SE</th>
<th>Serum Cholesterol (mg/dl) ± SE</th>
<th>Kidney Ash ± SE</th>
<th>Kidney Stones %</th>
<th>Heart Ash ± SE</th>
<th>Heart Ca ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>6.3 ± 0.17a</td>
<td>2.99 ± 0.16a</td>
<td>95 ± 6.3a</td>
<td>1.49 ± 0.04a</td>
<td>47</td>
<td>1.22 ± 0.018a</td>
<td>0.75 ± 0.07a</td>
</tr>
<tr>
<td>L-B</td>
<td>7.6 ± 0.38b</td>
<td>4.85 ± 0.42b</td>
<td>102 ± 8.9</td>
<td>1.35 ± 0.02b</td>
<td>29</td>
<td>1.17 ± 0.016d</td>
<td>0.59 ± 0.09d</td>
</tr>
<tr>
<td>L-Co</td>
<td>7.3 ± 0.22b</td>
<td>4.09 ± 0.15b</td>
<td>129 ± 12.6</td>
<td>1.32 ± 0.02b</td>
<td>5</td>
<td>1.17 ± 0.011e</td>
<td>0.72 ± 0.10e</td>
</tr>
<tr>
<td>C-B</td>
<td>9.1 ± 0.40b</td>
<td>6.91 ± 0.53b</td>
<td>125 ± 13.8</td>
<td>1.25 ± 0.02b</td>
<td>0</td>
<td>1.08 ± 0.023c</td>
<td>0.48 ± 0.07c</td>
</tr>
<tr>
<td>C-Co</td>
<td>7.5 ± 0.39b</td>
<td>4.63 ± 0.31b</td>
<td>142 ± 17.1</td>
<td>1.25 ± 0.03b</td>
<td>0</td>
<td>1.01 ± 0.010a</td>
<td>0.58 ± 0.09a</td>
</tr>
</tbody>
</table>

a Standard error of the mean.
b Does not include one animal with liver fat of 19.2% and liver cholesterol of 13.51 mg/gram.
c Does not include one value of 3.78%. The next highest value was 1.49.
d Does not include two values, one of 7.85 and the other of 40.34. The rat with kidney ash of 3.78% (Footnote c) was the same one with heart Ca of 7.85 mg/gram total solids.

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has been studied by Vermeulen et al. (42) by surgically inserting a foreign body in the bladder, removing it later, and weighing stones formed. They found that rats fed a powdered whole milk diet formed a greater weight of stones than rats fed a chow diet or the chow diet with lactose added. From this study they concluded that the effect of milk on stone growth was not entirely due to its lactose content. In a later study, in which they used purified diets containing 10% corn oil and with either glucose or a mixture of glucose and lactose as the carbohydrate, Vermeulen and Roberts (43) concluded that the factors accounting for the exaggerated calculus production in rats fed milk diets were its calcium and lactose content. The purified diets of their study contained, in grams per 100 g of food: calcium, 1; phosphorus, 0.75; and magnesium, 0.1. Renal deposition of apatite has been reported to be correlated inversely with the dietary level of magnesium (16), but magnesium level appears to have had little influence in the present study; diet M contained 0.16% magnesium and the other diets, including L-B on which there was stone formation, 0.08% (Table 1).

The low rate of renal stone formation for rats fed the lactose-corn oil diet is presumably linked with the lower calcium absorption (Table 3) and, hence, the smaller amount of calcium passing through the kidney. Absorbed calcium minus carcass calcium (an indication of the relative amounts of calcium passing through the kidney, but not an actual measure of calcium excretion, since initial carcass calcium was not taken into account) was 7.69 and 6.26 g for the M and L-B groups, respectively, and only 2.42 g for the L-Co group. These findings appear to indicate, then, that absorption of calcium by lactose-fed animals can be altered to the point that renal stone formation is minimized, without a change in calcium utilization. More research is needed to determine dietary factors in addition to lactose which affect renal stone formation and calcium utilization.

Serum cholesterol levels. Animals fed the milk and the purified lactose-butteroil diets had the lowest serum cholesterol values and those fed the cornstarch-corn oil diet the highest (Table 5). Many investigators have found that corn oil in the diet reduces serum cholesterol. In the absence of dietary cholesterol, however, several investigators reported a tendency for blood cholesterol levels in rats to increase with increasing unsaturation of dietary fat (21, 30, 39). Moreover, Gerson et al. (17) reported that serum cholesterol levels of five-months-old rats were markedly reduced when 10% corn oil was added to a low fat diet and fed for a 5-wk period, but that a much smaller reduction was found in 1-year-old rats fed the diet for 3.5 wk. Marshall et al. (26) reported that serum cholesterol values of rats fed stock diets or purified diets containing cornstarch were not influenced by addition of 15% lard, hydrogenated vegetable oil or corn oil, but that serum cholesterol values of rats similarly fed purified diets containing sucrose as the carbohydrate and 15% corn oil were significantly higher than those of any other group. It is apparent that serum cholesterol levels in rats vary with dietary combinations and in this study were not correlated with the incidence of lipid deposits in the aorta, or with liver cholesterol levels.

**Fatty deposits in the aorta.** Aortas from rats fed the following diets were given a score of 5 by at least one scorer (numbers in parentheses indicate number of aortas): milk (2); lactose-butteroil (2); lactose-corn oil (1); cornstarch-butteroil (1). The only scores of 0 given were to two aortas from rats fed cornstarch-corn oil. Average scores for fatty deposits in the aorta varied from 1.82 to 2.49 (Table 6). There were no significant differences in the scores for the thoracic section of the aorta. For the abdominal section the average score for the animals fed the milk diet was significantly higher than that for the rats fed the purified diet containing cornstarch and corn oil, and there was a significant difference between the cornstarch-butteroil-fed group and the cornstarch-corn oil-fed group. The value for the lactose-corn oil-fed group was lower than that for the lactose-butteroil-fed group, but the difference was not significant. Combination of the data on the abdominal aorta scores indicated no effect of lactose vs. cornstarch and a highly significant effect of butteroil vs. corn oil. Comparisons of

### Table 6

<table>
<thead>
<tr>
<th>Group</th>
<th>Thoracic section</th>
<th>Abdominal section</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>2.20 ± 0.15³</td>
<td>2.49 ± 0.18³</td>
</tr>
<tr>
<td>L-B</td>
<td>2.08 ± 0.31³</td>
<td>2.44 ± 0.18³</td>
</tr>
<tr>
<td>L-Co</td>
<td>1.86 ± 0.15³</td>
<td>2.02 ± 0.20³</td>
</tr>
<tr>
<td>C-B</td>
<td>2.12 ± 0.14³</td>
<td>2.31 ± 0.16³</td>
</tr>
<tr>
<td>C-Co</td>
<td>1.83 ± 0.18³</td>
<td>1.82 ± 0.10³</td>
</tr>
</tbody>
</table>

³ Averages of three scorings of each section by each of three scorers. The aortas were graded on a scale of 0-5 (see text) with 5 indicating the highest rate of involvement encountered.

³ Standard error of the mean.
the scores for the group receiving the milk diet and the lactose-butteroil purified diet suggest that the effect of the milk diet was due to its butteroil content or to interactions between butteroil and one or more ingredients common to the two diets. There was no correlation of the scores with food intakes, fat intakes, weight gains, carcass or liver fat, or carcass, liver, or serum cholesterol.

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References


