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Calcium Enriched Meat Compared with Milk as Source of Calcium Phosphorus and Protein.

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Not infrequently need arises for an efficient substitute for milk as a source of calcium in the diet of infants and growing children. Complete substitution is often necessary for those who are allergic to milk proteins and for those who are maintained on a ketogenic diet extremely low in carbohydrate as a means of therapy for either epilepsy or a urinary tract infection. Many children tire of milk early in life and so fail to consume enough of this food item to satisfy their daily requirements for calcium. In some parts of the world milk is entirely unavailable to large sections of the population, making a suitable substitute desirable.

Although many green vegetables, such as spinach, chard and beet greens, are as rich in calcium as milk on a dry-weight basis, they do not constitute a satisfactory food source of this element because much of the calcium occurs in already unavailable form or combines in the gastrointestinal tract with oxalic acid contained in the plants to form insoluble calcium oxalate.[1] The calcium of fresh carrots, lettuce and string beans[2] and whole soy beans[3] is far less available than that of milk, no matter how thoroughly the vegetables are cooked. It has been demonstrated that the percentage utilization of the calcium in di-calcium phosphate[4] and in calcium gluconate[5] is approximately the same as that of milk calcium, but attempts to induce young children to satisfy their calcium needs over long periods of time by consuming such salts directly rarely proves satisfactory. It has been reported that lactose, in contrast to other carbohydrate foods, increases calcium utilization significantly in growing children and lower animals.[6]

The present study was undertaken to compare the nutritional value of a calcium-enriched ground beef diet with that of milk from the viewpoint of calcium, phosphorus and protein utilization. By various additions the 2 diets were adjusted to contain the same quantities of protein, fat, carbohydrate, water, calcium, phosphorus and vitamins so far as this could be done. Two boys, 12 and 14 years of age respectively, who had been maintained on adequate hospital diets furnishing more than 1 g of Ca daily for several weeks were placed on the milk-containing diet for 15 days and then on the Ca-enriched meat diet for 12 days while Ca, P, and N_2 balance were being determined. The subjects were comparatively inactive, neither being able to walk. The 12-year-old boy was partially incapacitated by progressive muscular dystrophy. The 14-year-old boy had suffered from extensive poliomyelitis of both lower extremities 2 years previously. During these 2 periods the daily diet contained 2.35 g of protein, 45 mg of Ca and 41 mg of P per kg of body weight. Following the second period, the protein was reduced to 0.5 g per kg of body weight daily without change in the Ca and P intake for a period of 16 days to determine the effect of different levels of dietary protein on Ca and P absorption and excretion.

[1] Wohl, M. G., *Dietotherapy*, Saunders, Philadelphia, 1945, Chapter 8 by Holmes, J. O.

[2] Shields, J. B., Fairbanks, B. W., Berryman, G. H., and Mitchell, H. H., *J. Nutrition*, 1940, **20**, 263.

[3] Shroeder, L. J., Cahill, W. M., and Smith, A. H., *J. Nutrition*, 1946, **32**, 413.

[4] Kempster, E., Breiter, H., Mills, R., McKey, B., Brends, M., and Outhouse, J., *J. Nutrition*, 1940, **20**, 279.

[5] Steggerda, F. R., and Mitchell, H. E., *J. Nutrition*, 1939, **17**, 253.

[6] Mills, R., Breiter, H., Kempster, E., McKey, B., Pickens, M., and Outhouse, J., *J. Nutrition*, 1940, **20**, 467.

Young litter-mate rats about 35 days of age were divided into 2 dietary groups, one receiving milk, the other cooked lean meat with added Ca gluconate. Data on the males and females were kept separately. Three groups of animals were maintained on the meat diet and 3 on the milk diet for 6 weeks. Another group in each category was kept on the diet for 8 weeks.

At the end of the period the animals were killed by decapitation 24 hours after all food had been removed from the cages. Blood samples from individual rats in each group were pooled for serum protein, Ca and P determinations. The femurs alone were weighed and analyzed in approximately half of the rats on each diet. The entire carcass of each of the remaining rats was analyzed for total fat-free dry weight and for Ca and P.

Results. The serum protein, Ca and P levels at the end of the various experimental periods showed no significant differences attributable to differences in diet in either the rats or the human subjects. All values were well within normal range.

Despite the comparatively high Ca intake, each of the 2 boys showed a slightly negative Ca balance with both diets, when 2.35 g protein per kg was given daily. At the same time, the P and protein balances were positive. The average per kg daily balances for the 12-year-old boy expressed in mg were as follows: Milk diet: N_2 +51; P +2.3; Ca —5.1; meat diet: N_2 +73; P +5.5; Ca —3.6. Corresponding figures for the 14-year-old boy were as follows: Milk diet: N_2 +63; F +2.8; Ca —4.2; meat diet: N_2 +76; P +6.9; Ca —1.7. Corresponding figures for each subject on the meat diet with 0.5 g protein per kg instead of 2.35 g were as follows: 12-year-old boy: N_2 —13.8; P +5.6; Ca —7.1; 14-year-old boy: N_2 —1.8; P +13.8; Ca +3.6.

The retentions of N_2, Ca and P by the rats as judged by analyses of the femurs alone or by the whole carcass were found to be equally as good for the groups given the pureed cooked beef muscle mixed with Ca gluconate and phosphates as for those given milk solids as the source of these constituents. During the experimental period the meat-fed rats (33 animals) showed an average increase of 206% over the initial weights, whereas the average increase for those receiving the milk diet (31 animals) was 172%. The total caloric intake per day averaged 46 for the meat-fed and 41 for the milk-fed rats.

The average wet weight of the cleaned femurs of the meat-fed rats was 615 mg and that of the milk-fed animals was 583 mg. Averages for the a. total dry-weight, b. fat-free dry-weight, c. organic matter and d. total ash of the femur of the meat-fed animals were as follows: a. 357; b. 348; c. 129; d. 228 mg. Corresponding average figures for the femur of the milk-fed rats were as follows: a. 306; b. 302; c. 115; d. 202 mg.

Whole carcass ash analyses showed the following values per 100 g wet body weight: meat-fed (22 rats): average per rat 3.67 g total ash containing 29.6% Ca and 16.9% P; milk-fed (23 rats): average per rat 3.82 g total ash containing 27.8% Ca and 16.7% P. In one group of 6 meat-fed rats whose diets were made to contain the same amount of lactose as that in the milk diet the total ash per rat averaged 3.82 g as against 3.58 g ash in the nonlactose-containing meat diet. Throughout the study, the average values for male animals were consistently larger than those for females, excepting in percentage composition.

Summary. The nutritional value of a Ca-enriched meat diet has been investigated from the viewpoint of protein, Ca and P utilization. This has been compared experimentally with a milk diet containing the same quantities of essential food constituents. Balance studies were carried out in 2 young hospital patients. Total carcass and separate femur analyses were also made in rats on the 2 types of diet. The results of these studies indicated clearly that the Ca-supplemented meat diet was equally good as the milk diet as a source of Ca, P, and protein.