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Secondary Calcium Phosphate Prevents and Cures Rickets Without Vitamin D. 1. Utilization Studies.

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These studies were undertaken (1) to demonstrate the capacity of the animal organism to utilize the calcium contained in these compounds as compared with the utilization of calcium from other sources. (2) To compare bone-forming properties of refined "pure" dicalcium phosphate,† unrefined dicalcium phosphate,‡ and other calcium compounds. (3) To determine the availability to the organism of various sources of calcium after their incorporation with alimentary fluids.

To determine the relative efficiency of different calcium compounds, feeding experiments were conducted with the albino rat.

When calcium is provided not to include phosphorus, *i. e.*, the carbonate or citrate, the retention is seriously interfered with. Whatever phosphorus is supplied as a constituent of the other ingredients of the diet, is not satisfactorily utilized. On the other hand, when the calcium is supplied as calcium phosphate, the phosphorus retention is greatly improved. In spite of this, however, the efficiency with which the calcium is utilized appears to be more dependent on the form of the calcium phosphate. The average calcium retention observed during the periods of feeding tricalcium phosphate was 30.9%, the retention values observed in the unrefined dicalcium phosphate and refined dicalcium phosphate periods averaged 46.8% and 41.2%, respectively. The superiority of the latter substances to tricalcium phosphate probably is related to their greater availability, *i. e.*, solubility in the digestive fluids.

Conclusions. 1. The calcium contained in unrefined and refined dicalcium phosphate is utilized much more efficiently than are equivalent quantities of calcium supplied in the form of carbonate or citrate. 2. That this is not due solely to the fact that phosphorus is a limiting factor in these diets is demonstrated by the fact that the calcium of refined dicalcium phosphate is utilized about 70% more efficiently than is the calcium in tricalcium phosphate. 3. Unless adequate quantities of phosphorus, as well as of calcium, are assured, progressive changes take place resulting in the decalcification

† Dicalfos, manufactured by the Bay Chemical Co., New Orleans, La.

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TABLE I.
Showing Percentage Composition of Diets Used in Refined and Unrefined Dicalcium Phosphate Metabolism Studies.*

Diet No.	150	151	152	155	156
Wheat Gluten	20.0	20.0	20.0	20.0	20.0
Sodium Chloride	1.0	1.0	1.0	1.0	1.0
Yellow Corn	77.0	75.56	75.56	74.5	76.68
Calcium Carbonate	2.0	—	—	—	—
Calcium Citrate	—	—	—	4.5	—
Tricalcium Phosphate	—	—	—	—	2.32
Dicalcium Phosphate (unrefined)	—	—	3.44	—	—
Dicalcium Phosphate (refined)	—	3.44	—	—	—
Calcium	1.065	0.903	0.944	0.911	0.673
Phosphorus	0.307	0.833	0.922	0.307	0.653
Ca : P	3.47	1.02	1.02	2.97	1.03

*This diet differed from the Steenbock diet only in that only 2% of calcium carbonate was present rather than 3%, the difference being made up in yellow corn. This change was made so as to avoid extreme bone pathology during the course of the experiments such as would have resulted from the higher calcium:phosphorus ratio.

of the bones, even to the extent of actual losses of calcium from the body. 4. The greater efficiency with which calcium is utilized when provided in the form of unrefined and refined dicalcium phosphate is demonstrated roentgenographically by the extent of calcification of the leg bones. 5. The efficiency with which the phosphorus content of the diet is utilized is dependent upon the form in which calcium is supplied. 6. In respect to the efficiency with which the bone-forming elements, calcium and phosphorus, are utilized, unrefined dicalcium phosphate and refined dicalcium phosphate rank superior to tricalcium phosphate or bone-meal, and the latter in turn ranks above the non-phosphorus-containing salts, calcium carbonate and citrate.

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The preventive and curative methods for experimental rickets were employed. The standard rickets-producing diet had the following composition: Yellow Corn, 76%; Wheat Gluten, 20%; Calcium Carbonate (precipitated chalk), 3%; Sodium Chloride, 1%. Since the precipitated chalk was not 100% calcium carbonate, the resultant calcium content of this diet was 1.13%.