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Calcium: Unusual Sources in the Highland Peruvian Diet

Abstract. *A dietary survey conducted in the southern highlands of Peru revealed two important sources of dietary calcium not previously reported. Mineral and ash calcium ingested as a food spice, and along with coca, raises the calcium intake from the low figures recorded by standard nutritional surveys to a more substantial level.*

The highland area of Peru has been specified in dietary reports as an area where the inhabitants have a low calcium intake (*1*), and studies of growth seem to support this finding (*2*). However, during our recent studies of nutrition in the southern highlands of Peru, we discovered several unusual sources of calcium which seem to provide for most people a more than adequate intake of this necessary mineral.

The results from some dietary surveys made in non-Western cultures are open to serious question because of the highly divergent dietary patterns which are encountered. These divergent patterns often mean that surveys in which standardized techniques derived from Western culture are used may cause important nutritional sources to be missed. As was clearly shown by the work in Mexico (*3*), many unexpected sources of essential nutrients may be revealed when detailed analyses of native diets are undertaken. Therefore, when we made a nutritional survey in the highlands of Peru during July 1962, a special effort was made to determine whether the techniques previously used in this area were, indeed, uncovering all sources of calcium intake.

The survey was made in the vicinity of Nuñoa, in the highest inhabited zone of the Peruvian Andes which ranges from an altitude of 4000 to 5000 m. The inhabitants are Quechua Indians, and the survey was conducted in the native-controlled community or *ayllu*, and in privately owned haciendas which lie outside of the small district capital. All the data were collected by one of us (R.B.M.) with the assistance of two Peruvian university students who were natives of the district. Spanish and Quechua were used depending on the language fluency of the respondent.

The method, applied to 39 households, was a modified 1-day recall technique in which food consumption for a single day was either observed and weighed, or the household cook was asked to indicate an equivalent of food stuffs which were then weighed. Individual intakes were calculated by dividing the quantity by the number of individuals over 3 years of age who ate within the household.

It was found that in this pastoral area of the Department of Puno, the intake of calories and other nutrients estimated by this method was greater than has been reported for other highland areas. Compared to other groups, calcium intake through regular food sources was high, approximately 430 mg per day. A study of yearly food patterns by means of questionnaires suggests that an even higher intake would have been recorded if the survey had been made during the period from December through March, since the Nuñoa indigenes reported that they consume large quantities of milk and cheese at that time.

In addition to calcium from the usual food sources, observation led to the belief that significant calcium was also being obtained from items not ordinarily considered in dietary surveys. Three items were chosen for further analysis: (i) an earth called *cal* or *catahui*, (ii) an earth called *"cha'qo,"* and (iii) an ash substance called *llipta*. Intake of these substances was recorded and a chemical analysis of samples was made at the Foods and Nutrition Laboratory, Pennsylvania State University.

The *cal* is prepared by burning calcium-containing rocks and grinding the remains into a fine powder. The powder is most often eaten mixed with *quinua* or *cañihua* in a porridge called *catahui lahua*. *Catahui lahua* is eaten at least a few times a week throughout the year by most of the Nuñoa households. A typical individual intake of *cal* at a meal would be about 5 grams. Averaged over a week, the daily intake is, therefore, within a range of 1 to 3 g. Analysis of two samples showed the *cal* to be primarily calcium carbonate, with a calcium content of 36.3 percent in one sample and of 42.0 percent in the other.

Cha'qo is a clay substance which is used in a fine water suspension as a sauce for potatoes. It is an aluminosilicate containing no calcium and is apparently without great nutritional value, although it does contain some iron.

To form *llipta*, the ashes of the stalks of two local grains, quinua and cañihua, are mixed with water to form a paste which is dried in the sun into small black cakes. A pinch from the cake is taken with every chew of coca (*4*). The average daily intake of coca is variable, but ranges from about 25 to 75 g and about 2 to 4 g of *llipta* is taken with this quantity of coca. Adult indigenes in the southern highlands chew coca with *llipta* nearly every day throughout the year. The *llipta* analyzed contained about 12 percent calcium as well as considerable magnesium. In the northern highlands there is a similar intake of coca, but *cal* rather than *llipta* is used in combination with the coca (*5*).

Two of these substances, therefore, contribute significant usable calcium to the diet of the highland adult. The *cal* eaten in this area contributes 300 to 1200 mg daily, while the daily *llipta* ingested contains somewhere between 200 and 500 mg. Although women and men in our sample used coca with the same frequency, children under 15 do not regularly chew coca and so do not ingest *llipta*. However, they do eat *catahui lahua* and with the same frequency as the adults, even though actual quantities may vary.

When calcium from these sources is added to that obtained from normal foods, it appears that natives of our study area, and perhaps much of the southern highlands, meet or exceed most of the calcium intakes recommended in the United States. Even in the northern highlands where *catahui lahua* is not reported, the *cal* chewed with coca, and perhaps coca itself (*6*) may constitute significant contributions to calcium intake. If *cal* is used in quantities equivalent to *llipta*, it alone

could provide 800 to 1600 mg of calcium daily. We, thus, suggest that since there may be unusual sources of calcium in native diets, the nutritional status of Peruvian natives be re-evaluated. We also wish to reiterate the suggestion made nearly 20 years ago (*7*) that the results of nutritional studies on non-Western groups be only tentatively accepted until the results have been carefully checked by a thorough analysis of all nutrient sources (*8*).

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Milk Analysis of the Kangaroo Rat, *Dipodomys merriami*

Abstract: *The milk of* Dipodomys merriami *has an average water content of 50.42 percent, which is low compared with milk from other mammals. The fat content is about 23.48 percent. The significance of these values is discussed in terms of the animal's water balance.*

Numerous workers have studied the various mechanisms of water conservation in desert mammals. However, there is one particular area of water balance that has been studied very little, yet might yield useful information. This is the effect of the environment upon the composition of the milk, in various species of animals, particularly its water content, and the evaluation of the results in terms of adaptive significance.

We were therefore interested in making a preliminary analysis of the milk of the kangaroo rat, *Dipodomys merriami*. Rats were collected 35 miles south of Tucson on the Santa Rita Experimental Range at an elevation of approximately 1100 meters. The collections were made during April and May, a period of great reproductive activity in the kangaroo rat from this region and, also a time of scant rainfall and low humidity in the area.

The milk samples were collected from rats which had been anesthetized with ether and injected with pitocin. Then, by manual expression, the drops of milk were collected into a blood-mixing pipette. The milk was then transferred to a sterile syringe, sealed tightly, and stored in a freezer until analyzed. Because of the small amounts in the samples, a modified method of milk analysis was used. This method was suggested by Stull (*1*).

The results are summarized in Table 1. The milk is very concentrated compared with that from the dairy cow, which contains about 88 percent water. The milk of another desert mammal, the camel, contains 87.7 percent water (*2*). However, both the camel and her calf are exposed to almost the full effects of the desert heat in the daytime, and water is utilized for temperature regulation (*3*). Similarly, this might explain the high water content, 83.55 percent (*4*), of the milk from the collared peccary, *Pecari tajacu*, another large desert mammal which is also exposed to the daytime heat. In contrast, the kangaroo rat avoids the intense, solar radiation by remaining in burrows. This burrowing habit, together with other adaptations described by Schmidt-Nielsen (*5*), make it probable that the amount of water lost by evaporation in the rat is very small. Furthermore, the newborn rat probably produces a concentrated urine similar to that of its parent; consequently, the young rat may not require a large supply of water in the milk.

The only other mammals known to have milk with such low water content are seals and whales (Table 2). Although the fat content of kangaroo rat milk is high, that of marine mammals is even higher. The functional significance of a high fat content is still questionable. Irving (*6*) has suggested that the advantages of fat stores in Arctic birds might be that fat, when compared with carbohydrate and protein, has the highest energy production for its weight; less water is required for its storage, yet when metabolized it yields the most water. Applying these principles to seals and kangaroo rats, a milk containing a high proportion of fat, in contrast to one high in either carbohydrate or protein, might be advantageous to both the mother and the young for water conservation. The mother produces a concentrated milk where little water is lost during nursing, and the young obtains a high-energy food supply that requires little water for its storage or use.

Table 1. Summary of some of the milk constituents of *Dipodomys merriami*. All samples represent a pooling from more than one rat. The contributions of each animal to the sample are not equal. The stage of lactation is unknown.

No. of rats	Sample size (g)	Fat (%)	Non-fat solids (%)	Water (%)
3	0.0791	24.65	33.50	41.85
2	.1192	18.79	23.83	57.38
4	.1172	29.61	20.90	49.49
2	.1101	20.89	26.16	52.95
Average	.1064	23.48	26.10	50.42

Table 2. Summary of the milk constituents of some marine mammals.

Fat (%)	Protein (%)	Water (%)
Harp seal (*Phoca groenlandica*)		
42.82	11.98	43.79
Hooded seal (*Cystophora cristata*)		
40.43	6.65	49.85
California sea lion* (*Zalophus californianus*)		
36.5	13.8	47.3
Blue whale (*Balaenoptera musculus*)		
38.13	12.79	47.17
Fin whale (*B. physalus*)		
30.60	13.14	54.10

* From M. E. Q. Pilson and A. L. Kelly, *Science* **135**, 104 (1962). All others from a compilation made by E. Sivertsen, *Hvalradets Skrifter No. 26* (1942).

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