aymara nutrition

A RECONSIDERATION OF ANDEAN NUTRITION

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by

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The Aymara Indians of the Peruvian altiplano are frequently described as undernourished, as are other indigenous highland populations. Peruvian government officials, U. S. medical teams, and other observers routinely assume an inadequate *altiplano* diet to be the root of various health problems. Hall, for example, states,

> Inadequate nutrition contributes to the high mortality caused by infectious disease. Estimates made by the [Peruvian] National Institute of Nutrition suggest that almost one-third of the rural coastal and two thirds of the rural sierra residents consume less than 75 percent of the calories and proteins essential for adequate nutrition (1969:15).

While such nutritional problems are reported for some regions, dietary analyses reveal ecological zones in which indigenous food consumption is quite adequate (see Mazess and Baker 1964 and Picón-Reátegui 1976). This paper presents a preliminary assessment of the dietary staple of a rural *altiplano* community where the native population also appears to be satisfactorily nourished.

Challapujo, a rural Aymara community in which the author resided from September 1976 to June 1977, is located eleven kilometers from the market town of Ilave in the Department of Puno, in southern Peru. Situated on the shores of Lake Titicaca, the community is at an altitude of 3800 meters. The economy is agricultural with the principal cultigens being potatoes, *quinoa* (a grain, *Chenopodium quinoa*) and barley. Each family owns two to three cattle and may also keep sheep, chickens, pigs or donkeys. Llamas and alpacas are not raised in the community. As is typical of the region, animals and their products are only rarely consumed. Their primary use is for plowing, burden carrying, or production of products or offspring to sell. (For a complete description of the community's agricultural ecology, see Brown 1978.)

The staple of the Challapujo diet is the potato, indigenous to the region. It supplies roughly 50 percent of the caloric intake in the diet and a major share of many nutrients, as discussed below. Reliance on a single crop for the bulk of daily food consumption is frequently condemned by investigators as a precarious base for good nutrition. It is the heavy dietary reliance on the potato that leads local officials, development personnel and scientific observers of the Aymara to assume that their diet is inadequate. The Challapujo diet does not offer the "well-balanced" combination of meat, cereals and vegetables traditionally posited for good nutrition (For example, see Buck, Sasaki and Anderson 1968:40). Nor does it offer frequent consumption of animal protein which is often relied on as "probably the most sensitive indicator of the quality of nutrition in a community"(Buck, Sasaki and Anderson 1968:40).

The people of Challapujo, however, appear, to the non-medically-trained observer, at least, to be remarkably robust and healthy for a population that does not follow the consumption patterns of "good nutrition". That is, obvious signs of undernourishment are not present. Kwashiorkor does not occur in the children. Other readily observable signs such as emaciation, lack of energy, depigmentation or dryness of skin or hair are also absent. These facts are not, of course, tantamount to proof of the complete adequacy of the Challapujo diet or of the total health of the population. However, they raise questions about the over-hasty condemnation of reliance on the potato. In order to clarify this issue, I have analysed the potato consumption of adult Aymara males in Challapujo. While such an analysis cannot tell us whether young children or women also consume an adequate diet, it suggests the need for a closer examination before the entire population is dismissed as undernourished.

The key to the contribution of the potato in the diet is the large quantity in which it is consumed. Active adult Aymara men between the ages of 18 and 45 were observed to consume a typical daily portion of 1500 grams of potatoes. During the months that this observation was made, the majority of potatoes were consumed in their fresh form, although some dehydrated potatoes, or chuño, were also eaten.

This figure is compatible with the amounts of potatoes and chuño reported to be consumed in the district of Nuñoa, a high altitude zone near Cuzco, Peru, by Mazess and Baker (1964) and Picón-Reátegui (1976), although they report that more than half of the potatoes consumed in Nuñoa are eaten as chuño. The more mild climate of the Titicaca Basin may reduce the rèliance on chuño in favor of the fresh potato which can be stored successfully all winter and is eaten throughout the year when the harvest has been normal. The dehydration process reduces the bulk of the potato somewhat, which Mazess and Baker (1964: 345) suggest may facilitate consuming such large quantities. However, since chuño is rehydrated to some extent before it is eaten, the bulk remains considerable.

This bulk is distributed throughout the day, with potatoes usually being consumed for breakfast and supper in soups with the additional ingredients of the grains quinoa or barley. Onions, habas (broad beans: Vicia faba) and condiments such as oregano or aji, a hot red pepper, may also be included. Soups may be water or broth based and occasionally contain bits of meat, poultry or fish or animal fats. Cheese and eggs are occasionally included in a meal but in very limited quantities. At midday, people at work in the fields consume a meal of dry boiled potatoes, sometimes with a grain added.

The other ingredients of the diet are much more variable than the potato, and exact quantities are not known. However, the information on the nutrients supplied by 1500 grams of potatoes provides a basis for preliminary judgement of the whole diet. Fifteen hundred grams of potatoes supply 30 grams of protein and approximately 1500 calories. Table I lists various nutrients present in the potato, with quantities supplied by 1500 grams and percentages of recommended daily allowances shown. Caution should be exercised in the interpretation of these figures since they are based on analysis of U.S.-grown potatoes. The many varieties and vastly different growing conditions for _altiplano_ potatoes may result in significantly different analyses. The _papa negra_, a dark purple variety, may, for example, contain significantly higher quantities of iron. However, Table I is offered here to demonstrate that over half the nutrients listed are provided in quantities that meet or exceed the recommended allowances. Yet, we are considering only approximately 50 percent of the caloric intake of the average Challapujo male, calculated as follows:

Picón-Reátegui (1976: 223-224) estimates the caloric needs of a standard man in the district of Nuñoa to be 2719 calories, ± 400 calories. His calculation is based on a "reference man" 157.7 cm in height, weighing 57.6 kg, whose subsistence activity is herding, performed approximately 8 hours per day and using 123 calories per hour. I have taken Picón-Reátegui's calorie expenditure figures for daily activities except for herding which I have assumed to be less strenuous than agriculture. Substituting Harris's (cited in Brown 1978:61) 150 calories per hour estimate for rigorous activity, I have arrived at an estimate of 3000 calories needed for the energy expenditure of a working Aymara man weighing approximately 57 kilos. (This weight is from Buck, Sasaki and

TABLE I

NUTRITION IN 1500 GRAMS OF RAW POTATOES

Nutrient	Amount in 1500 grams	Percent of U.S. RDA (1973) adjusted for 57 kg body weight••
Calories•	1500 kcal	(See Table II)
Protein•	30 g	(See Table II)
Fat•	2 g	NA
Carbohydrate•	338 g	NA
Calcium	105 mg	12
Phosphorus	795 mg	97
Iron	9 mg	62
Sodium	45 mg	NA
Potassium	6 g	NA
Vitamin A	trace	---
Thiamine	1.5 mg	123
Riboflavin	.6 mg	43
Niacin	23 mg	139
Vitamin C	300 mg	369
Vitamin B_6	28 mg	169
Copper	31 mg	192
Magnesium	.4 mg	96
Iodine	.4 mg	278
Folic Acid	231 mcg	91
Zinc	6 mg	47
Fiber	ca. 6 g	123

Source: The Potato Board 1978--all but •

• Mazess and Baker 1964: 344.

Note: The Potato Board reported exceptionally low figures for calories, carbohydrates, and fats for the potato; while their figures may be accurate, the figures from Mazess and Baker are more typical of those used in other literature.

••This adjustment suggested by Quandt (1979). Original Potato Board values are for U.S. average 70 kg males.

Anderson's (1968:42) analysis of the altiplano community of Pusi.) Potatoes thus supply roughly 1500 calories or 50 percent of the calories required in this reference man's diet. Table II shows the percent of daily requirements of protein and calories supplied. Since it was observed that healthy adults maintain their body weights and activity levels, we can conclude that the other 1500 calories are provided by the rest of the diet (Brues 1979). As noted above, well over 50 percent of the nutrients listed in Table I are provided by the potatoes.

TABLE II

CALORIE AND PROTEIN CONTRIBUTIONS OF
1500 GRAMS OF POTATOES TO THE CHALLAPUJO DIET

	Quantity supplied in 100g potatoes	* Total supplied in 1500g	Daily requirement for Aymara man	Percent of daily requirement provided
Calories	100 kcal/g	1500 kcal	3000 kcal	50
Protein	2 g/100g	30 g	46 g	65

Derivation of the protein figure is more complex. The 30 grams of protein supplied by potatoes are not all usable by the human body because of amino acid patterning. There are eight essential amino acids which must be consumed by the human body for protein synthesis*. Moreover, they must be consumed in the correct proportions and be present in the digestive tract simultaneously in order for absorption and utilization by the body to occur. (See Lappé 1971 for an excellent introductory discussion of essential amino acids.) Most vegetable proteins contain the eight essential amino acids (EEAAs) in proportions different from human needs while proteins of animal origin are closer to the human pattern and thus more efficient for us to consume. It is this limit to vegetable proteins which makes some observers hesitant about the quality of a diet which derives its protein primarily from plant sources. However, as Lappé (1971) points out, if vegetable proteins are combined to complement their mutual EEAA deficiencies, adequate protein can be gained from plant sources. Similarly, if a vegetable product is eaten in enough quantity, even the limiting amino acids will be present in sufficient amounts for the body to utilize quite a bit of protein. The proportions of the EEAAs do not vary, but the gross quantity of usable protein will obviously increase with the quantity of food. For this analysis, the EEAAs in the potato have been compared to the proportions of the same amino acids in human milk (mg per g of nitrogen). While the hen's egg is often used as a reference protein (FAO 1970: 2), human milk seems a better indicator of human needs (Brues 1979).

*Robinson (1978:43) reports that a ninth amino acid, histidine, has been shown to be necessary for adults as well as children. This paper has only dealt with the eight previously reported.

The protein in the potato must therefore be analysed for its gross protein quantity--grams of protein per 100 grams of potatoes--and for its quality or protein score. The protein score is derived from the relative proportion of the EEAAs in the protein of a food to the proportion of EEAAs in human milk protein (FAO 1957:30). The protein scores for the EEAAs of the potato compared to human milk are given in the first column in Table III. From these scores, the limiting amino acid, that present in the lowest ratio, appears to be threonine, with a score of 70. That is, the potato protein contains 70 percent of the threonine present in human milk protein. This means that only 70 percent or 21 grams of the potato protein consumed by Challapujo men is useful to the body.*

The figure for the percent of daily protein allowance given in Table II is calculated as follows: The FAO (1973, cited in Hamilton and Whitney 1979:574) suggests a safe protein allowance of .57 grams per kilo of body weight. This figure is then multiplied by the protein score of the diet divided into 100, to allow for the usability of the protein. If we assume, for the purposes of this analysis, that nothing else is eaten to raise the protein quality score, taking the score just for potatoes, we have the following:

$$.57 \text{ gm/kg} \times 57\text{kg} = 32 \text{ gm usable protein required}$$

$$32 \text{ gm} \times \frac{100}{70} = 46 \text{ gm potato protein required}$$

Thus, Table II shows that the potato supplies 65 percent of the 46 grams of protein needed if the diet has an overall protein score of 70. This 46-gram figure is generous compared to the 30-40 gm figure reported as adequate by Hegsted (cited in Picón-Reátegui 1976: 226-7) for a vegetable diet consumed by 70 kg subjects. It is likely, therefore, that potatoes supply more than 65% of the dietary protein without reducing the allotment below safe levels.

*Investigators have reported protein utilization scores or biological values of from 60 (Lappé 1971:93) to 80 (FAO 1957: 28) for the potato.

TABLE III

PROTEIN SCORES OF SINGLE FOODS AND FOOD COMBINATIONS COMPARED TO HUMAN MILK

Essential Amino Acid	Potatoes	Quinoa	Habas	1500g potatoes +100 g quinoa	1500g potatoes + 50 g habas	1500g potatoes +100g quinoa + 50g habas
Isoleucine	76	100	86	84	79	84
Leucine	75	76	97	80	81	83
Lysine	84	97	99	88	88	90
Methionine	110	160	(45•)	125	89	110
Phenylalanine	120	94	110	110	118	110
Threonine	(70)	100	72	(79)	(71)	(77)
Tryptophan	98	(63)	51	89	85	81
Valine	99	70	100	93	100	95

Source for the amino acid content of foods, mg/g of nitrogen, FAO 1970.

•Note: This score is for total sulfur containing amino acids. The methionine score for habas is .36, but some cystine (score 52) may replace the low methione(USDA 1957: 5), so the average of the two is given.

Lowest scores for each colunm (limiting amino acids) are circled.

A diet based on a protein score or biological value of 70 or more is considered satisfactory for human growth and maintenance (FAO 1957: 30) if sufficient calories and protein quantities are present. The data in Table II suggest that such is the case for Challapujo men since we know that sufficient calories must be available or the body weights and activity levels could not be maintained. It is reasonable to expect that the remaining 35 percent or less of required daily protein could be obtained from the other foods providing the other 50 percent of the calories in the diet. We can conclude, then, that the potato offers a sound basis for adequate protein consumption in the diet of Challapujo men.

It is also possible that the foods which are combined with the potato in the daily diet may increase the quality of the dietary protein, raising the overall protein score by several points, i.e. increasing the utilization of the protein consumed. This would occur if the EEAA pattern in other foods complements that of the potato. Soup and meal recipes regularly include the combinations of some quinoa, barley, habas or animal products with the staple potatoes, making such protein complementarity likely.

In order to draw conclusions about such combinations we would need the specific amounts of all foods as they are consumed together. Average quantities per day per person are not specific enough to determine the action of protein combinations since the EEAAs must be present in the digestive tract simultaneously for the combinations to result in increased protein utilization.

Table III, columns 2 and 3, show the protein scores for quinoa and habas, with the limiting amino acid scores circled. Columns 4, 5, and 6 of Table III show the results of hypothetical combinations of 1500 grams of potatoes with 100 grams of quinoa, with 50 grams of habas and with all three foods together. While the limiting amino acid in the combinations remains threonine, that of the potato, the scores go up 7 to 9 points. The results of these increased scores on food combination protein utilization are shown in Table IV. A combination of 100 grams of quinoa and 1500 grams of potatoes results in a protein utilization score of 79 as compared to quinoa (63) or potatoes (70) eaten separately. This means that while 100 grams of quinoa supplies 12 grams of protein, only 7.6 grams are usable due to the low tryptophan content. When quinoa is combined with 1500 grams of potatoes, however, the protein derived from the total 42 grams becomes 33.2 grams. This is an increase of 16 percent over 28.6 grams, the total amount of usable protein if the foods are eaten separately. Putting this 42 gram figure into the formula on page 8, above, we find that this protein combination with a score of 79 would exceed daily needs by .5 grams!

$$32 \text{ gm } \times \frac{100}{79} = 40.5 \text{ gm potato/quinoa protein required}$$

Similarly, protein score increases of 13 percent can be seen for habas and potatoes and 22 percent for all three foods together.

While the exact consumption figures used above are hypothetical, they suggest promising possibilities for the actual daily diet. Since such combinations do occur, they may be the factor which results in a sufficient protein intake for the Challapujeños. The key to understanding the adequacy of the altiplano diet lies in the study of the exact nature of these combinations and the nutritional status derived from them. The preliminary evidence, outlined in this paper, that the adult male diet is adequate due to such protein combinations is certainly justification for further study.

Seasonal variation in food combinations, exact daily quantities consumed, and eating habits for individuals of different age, sex, and activity level should be analysed. Diet variations due to differences

TABLE IV

INCREASED PROTEIN UTILIZATION FROM POSSIBLE FOOD COMBINATIONS

	Limiting amino acid	Protein score	Protein per portion	Calories per portion	Usable protein if eaten separately	Usable protein if combined
Potatoes (1500g)	Threonine	70	30g	1500	21g	-----
Quinoa (100g)	Tryptophan	63	12g	345	7.6g	------
Habas (50g)	Sulfur Containing	45	11.7g	55	5.3g	------
1500g potatoes + 100g quinoa	Threonine	79	42g	1845	28.6g	33.2g (16% increase)
1500g potatoes + 50g habas	Threonine	71	41.7g	1555	26.3g	29.6g (13% increase)
1500g potatoes + 100g quinoa + 50 g habas	Threonine	77	53.7g	1900	33.9g	41.3g (22% increase)

Table IV is modeled after Lappé's(1971)food combination charts.

in social stratification would be of minimal concern in a traditional community like Challapujo where economic variation is very slight, but age and sex variables may be important. Questions about whether the diet is minimally adequate or whether it includes a margin for stress, disease, growth, pregnancy, etc. are of particular relevance. Also, there is the question of altiplano towns like Pusi, studied by a Johns Hopkins University health team, where potatoes were reported as a staple food in only 27 percent of the households (Buck, Sasaki, and Anderson 1968: 48). Do other staples like wheat replace the nutrition of the potato, or are inhabitants of small towns like Pusi less well nourished than the more traditional residents of the countryside? Finally, the importance of applying the results of this type of research could be considerable. It is possible that the study of such food combinations could reveal that only slight alterations in proportions of foods could substantially improve or deplete a diet.

The peasants of the altiplano have survived many centuries and numerous political systems. Their traditional nutrition may be a vital part of their successful adaptation and is worthy of our continued attention.

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