

COCA CHEWING AND WORK OUTPUTS AMONG MACHIGUENGA INDIANS OF PERU

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Several reports have shown that chewing leaves of *Erythroxylon coca* is widely believed by users in South America to enhance their work capacity (Gutierrez-Noriega and von Hagen; Martin; Fabrega and Manning; Goddard, Goddard, and Whitehead; Hanna, 1970; Hanna, 1971), but the available evidence provides little or no support for this indigenous interpretation (Hanna, 1970; Hanna, 1971; Verzar; Zapata-Ortiz, 1952). Recently, while studying the typical energy expenditures of a group of Machiguenga Indians working at everyday activities, we had the opportunity to examine the relationship between work outputs and coca chewing. The Machiguenga, who live in the tropical forest at an elevation of 2,300 feet on the slopes of the Andes in southeastern Peru, subsist mainly on maize, manioc and other root crops grown in their gardens, and by hunting and foraging in the surrounding forest. We observed work rates and caloric expenditures both with and without the use of coca in two typical work situations, one, weeding moderate to heavy weeds in a hillside garden, and the other, walking a ground distance of 2,000 feet up a sloping (approximately 15 degrees) forest trail commonly used for hunting and collecting. The per minute caloric expenditures were obtained by measuring expired gas volumes with a Max Planck Respiration Gas Meter (Model 59), by determining oxygen concentrations in expired air samples with a Teledyne Oxygen Analyzer (Model 331B) by Bradfield's method (Bradfield), and by calculating caloric values with the convenient Weir formula (Durnin and Passmore, 18). Six Machiguenga men cooperated with us as subjects.

When coca leaves were used, subjects prepared a wad of usually 20 to 40 sun dried coca leaves (about 1 to 3 gms), along with a pinch of ash from the burned wood of either the chovangeriki or pwegoro trees, and a small piece (0.8-1.0 gms) of bark from the chamuero vine which they chewed together thoroughly and then kept in the mouth at one side against the cheek. On days when we measured work outputs after coca chewing, subjects had chewed coca for at least 15 minutes but no longer than 30 minutes before the start of the first measurement, and, when feasible, a second observation of the same subject was made about 45 minutes after the start of chewing. Each observation was of at least 10 and usually of 15 minutes' duration; when the subjects wore the backpack respirometer, they consistently preferred to remove the coca wads from their mouths as they found it difficult to maintain the wad while breathing through the mouthpiece. We wish to emphasize that while our subjects had become thoroughly accustomed to the equipment during a month of research, they were disinterested to alter their typical activity patterns to work with us on regular schedules. Thus, in this natural field setting repetitive observations were most difficult to obtain. The observations we have we present in the following two tables; since the samples are small, we present the results in full.

Table 1: Work Outputs in Weeding Hillside Garden

Subject	Height cms.	Weight kgs.	Cocoa Used	Total Time	Area Weeded	Time secs./	Unit expenditure	Oxygen consumed /min.	Energy output
				Mins.	Sq. yards	Sq. Yards	kcal/sq. yds.	STPD	kcal/min.
1	163	51.3	no	13:00	22.2	35.1	2.7	0.92	4.5
"	"	"	no	20:00	25.5	47.1	4.2	1.08	5.3
"	"	"	no	12:00	-----	-----	-----	1.03	5.1
2	158	49.9	no	20:03	25.0	48.1	3.9	0.98	4.8
"	"	"	no	20:00	25.0	48.0	4.3	1.09	5.4
3	162	49.4	no	23:10	42.7	32.6	-----	-----	-----
~~~~	~~~~	~~~~	~~~~	~~~~	~~~~	~~~~	~~~~	~~~~	~~~~
1	163	51.3	yes	10:15	10.0	61.2	4.5	0.90	4.4
"	"	"	yes	15:00	15.9	56.6	4.4	0.94	4.6
2	158	49.9	yes	10:00	11.1	54.1	3.3	0.75	3.7
"	"	"	yes	15:00	10.0	90.0	5.6	0.75	3.7
3	162	49.4	yes	15:00	13.4	67.2	4.1	0.74	3.7
"	"	"	yes	15:00	20.0	45.0	2.6	0.70	3.4

Table 2: Work Outputs in Walking Up 2000 Feet of Forest Trail

Subject	Height cms.	Weight kgs.	Coca Used	Total Time	Total expenditure	Oxygen consumed /min.	Energy Output
				mins.	kcal.	STPD	kcal/min.
4	156	51.7	no	13:20	120.8	1.84	9.1
"	"	"	no	13:04	120.2	1.87	9.2
5	155	50.4	no	10:02	125.9	2.55	12.5
"	"	"	no	13:53	102.5	1.5	7.4
6	159	53.1	no	12:11	105.4	1.76	8.7
1	163	51.3	no	12:04	98.5	1.66	8.2
2	158	49.9	no	14:44	122.9	1.70	8.3
~~~~	~~~~	~~~~	~~~~	~~~~	~~~~	~~~~	~~~~
1	163	51.3	yes	12:32	94.1	1.53	7.5
2	158	49.9	yes	15:53	111.1	1.42	7.0

These data show a clear trend that when coca is chewed the length of time per unit of work invariably increases while the rate of energy output tends to decrease. For weeding the mean per-minute caloric expenditure of the subjects not chewing coca was 5.0, and the rate of weeding was 42.2 seconds per square yard; the average caloric expenditure for those who did chew was 3.9, and the rate of weeding was 62.4 seconds per square yard. On the forest trail subjects who did not chew expended an average of 9.1 calories per minute and required 12.8 minutes to walk the distance, while those who did chew coca expended 7.3 calories per minute and required 14.2 minutes to walk the distance. Hypothetically, the continual use of coca for several hours, as Machiguenga do in work situations, could effect substantial reductions in their energy outputs. Certain other findings are consistent with this view. It is known that a reduction of maximal oxygen consumption is associated with coca use (Hanna, 1970). Further, lower dietary calorie intakes have been observed for coca chewers (Zapata-Ortiz, 1970).

The Machiguenga who use coca believe that it helps them to work. The rather limited data presented here suggest that their use of coca may reduce and/or limit their oxygen consumption and caloric expenditure at least partially through a slowing of work rates. Any physiological basis of such an effect remains unexplained. We recognize that the practice of coca chewing is a complex and highly variable behavior which occurs in the context of social, economic, and psychological as well as ecological and energetics conditions, and that all of these relevant conditions need to be considered in a satisfactory explanation of the behavior. The present data on changes in work outputs are sufficiently suggestive to emphasize the need for further research on this aspect of coca use.

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REFERENCES

Bradfield, Robert B., "A Technique for Determination of Usual Daily Energy Expenditure in the Field," *American Journal of Clinical Nutrition* 24: 1148-1154, September, 1971.

Durnin, John V. G. A., and Reginald Passmore, *Energy, Work, and Leisure*, Heineman Educational Books, Ltd., London, 1967.

Fabrega, Jr., Horacio, and Peter K. Manning, "Health Maintenance among Peruvian Peasants," *Human Organization* 31(3): 243-256, Fall, 1972.

Goddard, D., S. N de Goddard, and P. C. Whitehead, "Social Factors Associated with Coca Use in the Andean Region," *International Journal of Addictions* 4(4): 577-590, December, 1969.

Gutierrez-Noriega, Carlos, and Victor Wolfgang von Hagen, "The Strange Case of the Coca Leaf," *Scientific Monthly* 70(2): 81-89, February, 1950.

Hanna, Joel M., "The Effects of Coca Chewing on Exercise in the Quechua of Peru," *Human Biology* 42(1): 1-11, 1970.

Hanna, Joel M., "Further Studies of the Effects of Coca Chewing on Exercise," *Human Biology* 43(2): 200-209, 1971.

Martin, Richard T., "The Role of Coca in the History, Religion, and Medicine of South American Indians," *Economic Botany* 24: 422-438, 1970.

Verzar, F., "Nutrition as a Factor against Addiction," *American Journal of Clinical Nutrition* 3(5): 363-374, September-October, 1955.

Zapata-Ortiz, Vicente, "The Problem of the Chewing of the Coca Leaf in Peru," *Bulletin on Narcotics* 4(2): 26-33, 1952.

Zapata-Ortiz, Vicente, "The Chewing of Coca Leaves in Peru," *International Journal of Addictions* 5(2): 287-294, June, 1970.