

LESSONS FROM HISTORY

Coca: High Altitude Remedy of the Ancient Incas

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The use of coca leaf for medicinal purposes is a centuries-old tradition of the native peoples of South America. Coca products are thought by many laypersons to provide risk-free benefits to users participating in strenuous activities at high altitude. Physiologic studies of coca have increased understanding of its possible mechanism of action as well as its potential impact on high altitude activities. This present work explores the role of coca throughout the history of the Andean peoples and explores whether this ancient remedy has a place in modern medicine. A focused summary of research articles with particular relevance to the field of wilderness medicine is also included to better provide the reader with lessons not only from history but also from another culture.

Key words: altitude sickness, anthropology, coca, travel, wilderness

Introduction

Each year more people are participating in remote wilderness activities and are exposed to the physical and environmental challenges inherent to the backcountry.¹ There were more than 1.1 million visitors to Machu Picchu (altitude 2430 m) in 2013 along with sold-out permits for the high altitude Inca trail.² Concurrently, there is mounting interest by the public to eschew synthetic pharmaceuticals in favor of what they perceive to be the benefits of natural or traditional treatments.³ Coca leaf tea has been anecdotally mentioned by travelers and climbers to South American countries for the presumed symptomatic relief of acute mountain sickness (AMS). The leaf of the indigenous coca shrub (Figure), among its numerous components, includes the stimulant alkaloid cocaine. Its use is widespread both in the distant past and in modern times among native South Americans, especially among those living at high altitude.⁴ Even though there are no definitive data supporting coca use for the alleviation of symptoms incurred at high altitude, travelers continue to use this product rather than pharmaceuticals with proven benefits.⁵ This work examines the existing knowledge regarding coca leaf products within a historical context and recommends future study of its use at altitude.

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Historical Context

DISTANT PAST

Coca grows wild across regions of Central and South America. Archaeological evidence has pointed to cultivation of coca circa 1900 to 1750 BC in central Peru.⁶ The antiquity of coca chewing has been confirmed through carbon dating of mummified human remains in northern Chile. Archaeological evidence shows that the Alto Ramirez culture was using coca circa 1000 BC.⁷ These records suggest that for more than 3000 years, coca has been an important part of the daily life of Andean peoples.

THE SPANISH

Sixteenth century Spanish conquistadors noted that the Incas used coca for a multitude of purposes, including ritual, social, and physiologic uses.⁸ The most widely publicized function of the plant is its function in increasing work capacity, including the reduction of bodily fatigue and the alleviation of thirst and hunger.⁹ After years of preliminary exploration and military skirmishes, 168 Spanish soldiers under Francisco Pizarro and their native allies conquered the Inca in the 1532 Battle of Cajamarca.¹⁰ Soon thereafter, unsuccessful attempts were made by the Spanish conquerors to eliminate the use of coca in native cultures.¹¹ Given their lack of success in eradicating coca, the Spanish then began to exploit coca growth. Subsequently, the use of



Figure. Coca plant. Photo used with permission from Stefano Pagnoni.

coca became even more widespread throughout the former Incan empire.¹² Shortly after the Conquest, the custom of giving agricultural workers coca leaves as part of their daily wage also began—a custom that persists to this day.¹¹

Altitude sickness was recognized as early as the sixteenth century by Spanish Jesuit missionary to the Americas, Jose de Acosta.¹³ In his tome, “*Historia Natural y Moral de Las Indias*” published in 1590, he describes the sickness that people experience when traveling to high altitude. He even notes that those who suffered most had come directly from the lowlands and the coast.¹⁴

WESTERN HISTORY

By the nineteenth century, coca had made its way into European and United States medicinal arsenals. Interest was prompted by an article written in 1859 by Dr Paolo Mantegazza, an Italian neurologist.¹⁵ Mantegazza had practiced for years in Peru and proposed that coca was capable of reducing fatigue, enhancing mood, and supporting sexual activity.¹⁶ In 1863, Angelo Mariani, a Corsican chemist, created “*Vin Mariani*,” an amalgam of wine and coca extract. It was soon one of the most popular prescription medications throughout Europe for a wide variety of ailments.¹⁷ Editorials about this medication even made their way into the *British Medical Journal* in the 1870s.¹⁸

During that era, recommendations for coca were also being advertised in the United States for psychological issues,¹⁹ substantiated by the writings of Sigmund Freud.²⁰ The potential success of coca in Western medicine is difficult to fully assess, given the lack of enthusiasm in the whole coca leaf after the isolation of cocaine. To this day, physicians and pharmacologists concentrate on understanding cocaine, the purer isolate of the coca shrub, rather than the myriad other pharmacologic compounds found in coca. Of the 14

alkaloids known to be contained in the plant, the bulk of research has been concentrated on the cocaine alkaloid.²¹ Scientific knowledge of coca with its plentitude of alkaloids most likely has suffered given the controversy over and fascination with cocaine.

Pharmacology of Coca

Cocaine is the principal alkaloid found in cultivated varieties of coca plants, and is also the most studied and discussed in the literature. On average, whole coca contains 0.6% cocaine in its dried leaves;²² however, there are 18 other alkaloids that exist within this plant.²³ Although the effects of using coca products are most likely a summation of effects gained from all constituents, the pharmacology of cocaine drives the responses experienced by users.²⁴ Cocaine is a tropane alkaloid that biologically acts as a serotonin-norepinephrine-dopamine reuptake inhibitor.²⁵ Organ systems and functions affected by acute and chronic uses of cocaine include psychological, neurological, renal, cardiac, pulmonary, gastrointestinal, obstetrical, and otolaryngological.²⁶ Historical studies of whole coca have shown that subjects had small increases in temperature, heart rate, blood pressure, and metabolic rate after they were administered coca leaves.²⁷

Investigations of Coca’s Physiologic Influences

As early as 1970, Hanna^{28,29} published a series of studies that attempted to capture the influences of coca chewing on cardiovascular and respiratory function during work performance. The first study compared habitual coca users with nonusers during periods of submaximal work.²⁸ There were some cardiovascular differences seen in the coca user group; however, Hanna believed that the size and design of the study precluded any conclusions being made. A follow-up study was then performed to examine in greater detail the influence of coca chewing on cardiovascular and respiratory function during work performance.²⁹ Subjects included 7 coca chewers and 5 nonusers who participated in periods of exercise at an altitude of 4000 m on a bicycle ergometer. Mean responses of oxygen consumption, ventilation, heart rate, systolic pressure, and diastolic pressure were measured between the test subjects. Hanna’s final conclusion after the second study was that there was no appreciable difference between the experimental and control groups, and that any real effects of coca chewing on the user resulted from the perception of either less effort being produced or less fatigue being generated rather than actual physiologic changes.

Given the inconclusive evidence of coca’s effects, further studies attempted to address the physiologic role

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