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Empirical Aztec Medicine

Aztec medicinal plants seem to be effective if they are judged by Aztec standards.

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The medicinal concepts of the Aztecs at the time of the Spanish Conquest were a mixture of magic, religion, and science. Disease could be attributed to a specific deity; for example, blisters and eye diseases were believed to be caused by *Xipe Totec* (*1*). Illness could also be attributed to the efforts of evil sorcerers (*2*). Treatment involved religion, magic, positive medical intervention, or a combination of these (see cover and Fig. 1) (*3*).

Studies of Aztec medicine have usually focused on the religious and magical characteristics of the treatment [see references in (*2*)]. Most of those dealing with the medicinal herbs used by Aztec physicians are out-of-date, sketchy, or simply translations of original Nahuatl texts (*4–6*). Hallucinogenic drugs, however, have been studied in more depth, and these studies have essentially confirmed the effects produced and the identity of the plants described in native sources.

The successful use of anthropological sources in the identification of potential hallucinogens suggested that it would be possible to use these sources, together with modern knowledge, to evaluate the effectiveness of other Aztec medicinal plants. This article deals with a number of medicinal plants which have been identified botanically and analyzed chemically. The chemical components are evaluated to determine whether they could produce the effects ascribed to the plant by the Aztec *ticitl* (physicians). A thorough review of hallucinogens has appeared recently (*7*), and this category of medicinal plants is not dealt with here.

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Sources of Information

The oldest source of information on medicinal herbs available is an herbal written in Nahuatl by Martin de la Cruz in 1552 and translated into Latin by Juan Badiano (Fig. 2) (*8*). The herbal was prepared as a gift to King Charles I of Spain to obtain his goodwill for the Colegio de Santa Cruz de Tlatelolco, a school run by the Franciscans to train young Aztecs in Christianity, which was then under attack by other religious orders who felt that the Franciscans were too sympathetic to the old ways of the Indians.

Friar Bernardino de Sahagun, who arrived in Mexico in 1529, spent most of his life writing an encyclopedic work on the Aztecs. The information was developed through questionnaires submitted to informants. The questionnaires were answered and written down in Nahuatl by scribes. Three sets of data were developed: the first (*Primeros Memoriales*) at Tepepulco, the second (*Codex Matritense*) at Tlateloco, and the most extensive (*Florentine Codex*) at Tenochtitlan. On the basis of these documents, Sahagun wrote a version in Spanish, *Historia General de las Cosas de Nueva España*, which was published after his death (*9, 10*).

Francisco Hernandez, personal physician to Phillip II of Spain, was sent to Mexico, where he spent the years between 1571 and 1577 gathering material on the plants, animals, and minerals of the New World. The material he gathered formed a basis for the work *Historia Natural de Nueva España*. The complete work was never published and was lost during the fire at the Escorial Palace. A truncated version by Reccho was published in 1651. Subsequent versions have been published, based on a rough draft found in Madrid a century later (*11*).

Francisco Ximenez, a Dominican friar, worked at the hospital in Huaxtepec. This was the site of an Aztec botanical garden and the repository of a copy of Hernandez's original work. In 1615 Ximenez published a version of Hernandez's work, which he augmented with material gathered in the course of his own practice (*12*).

All these sources have deficiencies for our purpose, because we are primarily interested in the pure native view about medicine. Hernandez had the views on disease which were current in Europe, and he fitted information given to him by native informants into the framework of this ideology. He classified plants by terms such as "warm," "cold," and "moist," but whether the natives used such classifications is debatable. He discussed therapeutic properties in terms of the Hippocratic doctrine of humors, although conflicts arise between European theory and Aztec practice. This contradictory evidence has led to much dispute concerning the origin of the present "hot-cold" folk theory of disease (*13*). Ximenez's work suffers from similar deficiencies.

Sahagun's work adheres much more closely to the information he obtained from the Aztecs. However, from internal evidence it seems that his in-

formants were responding to a set of specific questions rather than to an open-ended question (*14*), and the facts elicited were thus influenced to an unknown extent by the Spanish 16th-century *weltanschauung* reflected in the questions. The Spanish version of Sahagun is not an exact or literal translation of the Nahuatl protocols, and thus the *Florentine Codex*, which was written in the language of the informants themselves, is more reliable.

The *Badianus Codex* (*8*) should be the most authentic source of all, since it was both written and translated by natives, but it, too, presents some problems. There is internal evidence that the author had access to European herbals, and the vocabulary which Badiano was forced to use in Latin might not be the exact equivalent of the Nahuatl vocabulary (*15*). A further weakness may be that it is the work of a single author, and his theories may not have been as generally held as those espoused in the *Florentine Codex*, which was a collegial effort.

Methodology

The principal difficulty in this study is to correctly identify the plant mentioned in the sources. This is partly due to the practice of using the same Nahuatl name for obviously different plants. For example, there are 37 plants called *iztac-patli* (white medicine) and 21 called *cihuapatli* (women's medicine) in the work by Hernandez. Hernandez tried to clarify the situation by adding place names to the Aztec word. This system of nomenclature is probably due to Hernandez rather than to his native informants (*16*). The use of multiple names can result in the same plant being identified by different sources as belonging to different genera or families. An additional handicap is presented by descriptions which are not clear or illustrations which are not sufficient for an unambiguous identification. In an attempt to minimize this problem, I consider here only plants whose botanical identification is agreed on by at least three sources.

Even if the botanical identification is correct and the plant contains the proper chemical ingredients, the dosage given may be either excessive or insufficient. This question is more difficult because the amount of medicine to be taken is rarely stated or is given in an imprecise manner by the sources. In this article it is assumed that if the proper chemical substance is present, the dosage prescribed would be adequate to produce the desired result.

Although the religious or magic aspects of Aztec medicine have been greatly emphasized, much empirical research was done by Aztec doctors and their predecessors. The botanical gardens which so astonished the Spanish conquerors had been established as early as 1467 by Motecuhzoma I (*17*). These gardens were maintained primarily to provide the medical profession with raw materials for medicinal formulas and for experimentation. Beginning with Motecuhzoma I, the emperor's envoys had a mission to seek out additional species (*18*).

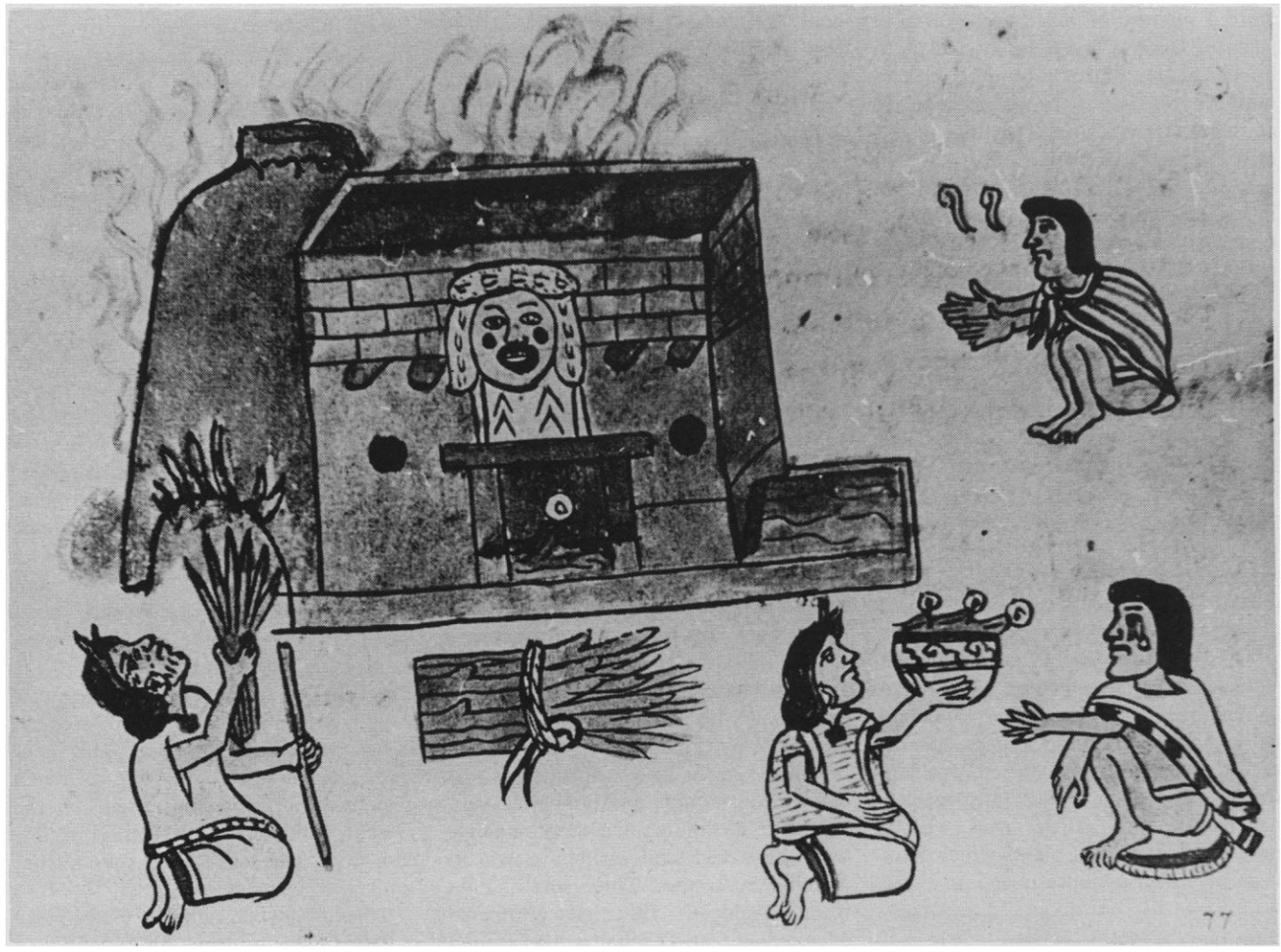

Fig. 1. Steam bath with the face of the goddess Teteo Innan, a goddess of medicine. Doctors and a patient are represented outside. [Source: *Codex Maggliabecchiano*, written after the conquest of Mexico, p. 77].

Evidence of the effectiveness of native medicine is given both by the comments of Spanish conquerors and by the quick adoption in European pharmacopoeias of sarsaparilla, palo santo, and sassafras, all of which are mentioned by Nicolas Monardes in the herbal which he wrote in 1565 (*19*).

It would be inappropriate to judge the effectiveness of these drugs by modern medical standards or even by 16th-century European standards. The effectiveness should be evaluated in the context of the beliefs of the Aztec informants. For example, the Aztecs believed that fever was caused by interior heat, which could be eliminated by a diuretic, a purgative, or a digestive (*4*, p. 64). If an herb they prescribed for fever, such as *totoncaxihuitl* (*Cassia occidentalis*), is in reality a purgative, then the herb should be considered to be an effective drug. Whether a purgative is also a fever reducer is not relevant for the purpose of evaluating the empirical investigative quality of Aztec medicine. The ability of the *ticitl* should be judged according to their view of the etiology of disease. If the plant recommended by Aztec medicine for a particular ailment contains chemicals which have been accounted therapeutic for that ailment within the last 70 to 80 years, then the empirical observation is even more successful.

Table 1 is a list of medicinal plants which seem to have been clearly identified botanically according to our criterion and for which information on chemical composition is available. The choice of plants, subject to the conditions given, is fairly random, except for the exclusion of hallucinogenic drugs. Thus, Table 1 has a conservative bias because, by and large, hallucinogenic drugs mentioned in Aztec sources have been found to contain active principles.

Evaluation of Therapeutic Effectiveness

No problem is presented if, in fact, the substance contains chemicals which produce the effects predicted by native sources. It is more difficult to evaluate negative evidence, that is, cases where reported plant constituents would not produce the effects claimed. There are three possible explanations for this: (i) the plant is ineffective; (ii) effective substances are present, but they have not been isolated because the plant has not been studied fully; and (iii) the botanical identification is not accurate.

Artemisia mexicana (effective). Thujone and thujyl alcohol are components of oil of wormwood, which was used formerly as a tonic and anthelmintic; santonin is an anthelmintic; and camphor is a mild irritant, stimulant, and colic reliever (*20*, p. 242; *21*, p. 387; *22*, p. 112; *23*, p. 763).

Bocconia frutescens (effective). Chelerythrine and sanguinarine are active local irritants. They have been used as expectorants. Water extracts of *B. frutescens* exhibited diuretic, anti-inflammatory, and antimicrobial activity (*20*, p. 1378; *23*).

Bromelia pinguin (effective). Pinguinain is a proteolytic enzyme with an antiedematous effect (*25*, *26*).

Carica papayu (effective). Papase is an enzyme which topically will remove clotted blood, purulent exudate, and necrotic tissue from surface wounds and ulcers. Therefore, it should be effective for rash. Internally, it is a protein digestant, and thus it is a digestive. Carpaine is said to slow the heart and depress the nervous system (*20*, p. 211; *23*, p. 781; *27*, p. 1000; *28*).

Casimiroa edulis (effective). Evaluation of this substance is more difficult since several extrapolations are needed. Histamine is a vasodilator but it is not active orally. *N,N*-Dimethyl histamine or casimiroidine might, however, be active orally. Fagarine has been used experimentally as an analog of quini-

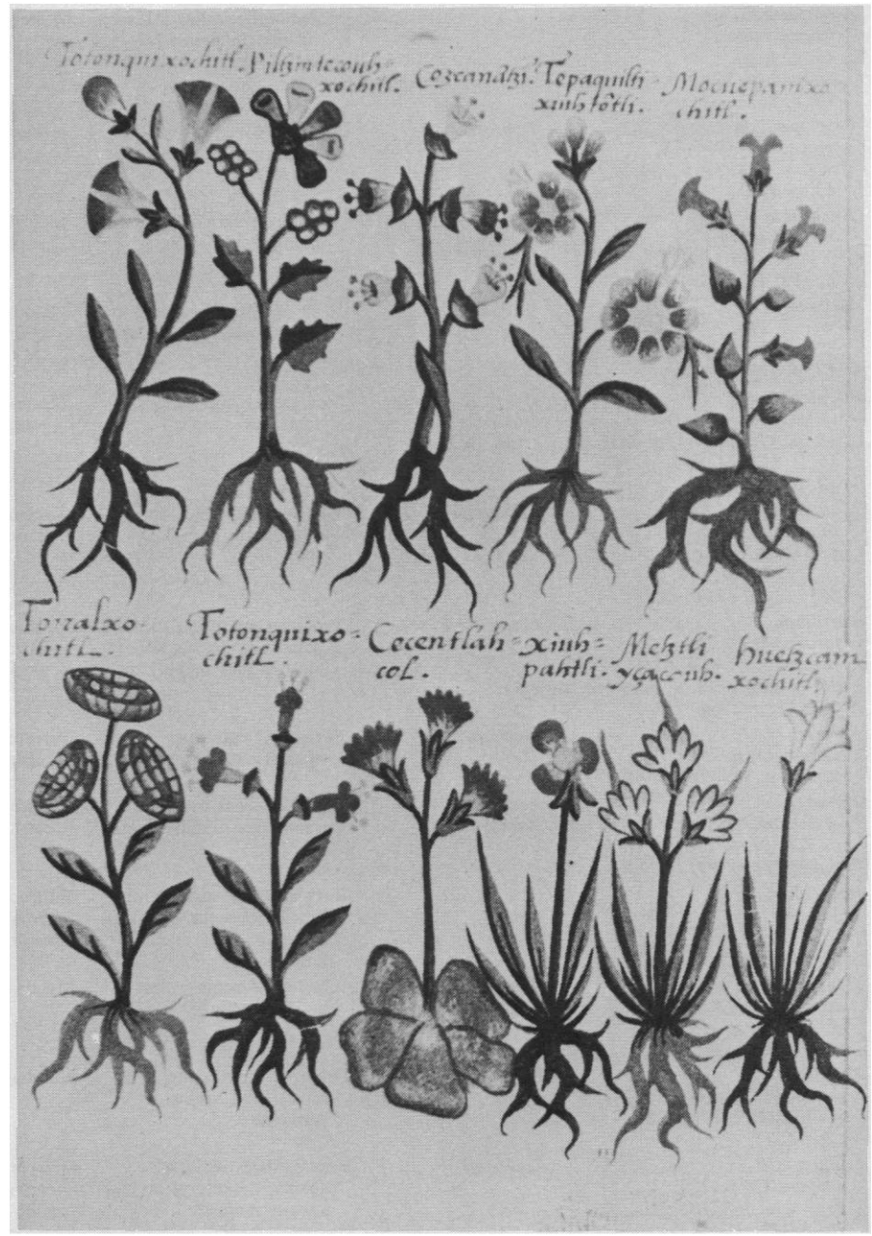

Fig. 2. Folio 38 recto of the *Badianus Codex*, an Aztec herbal of 1552.

Table 1. Some Aztec medicinal herbs.

Botanical name	Aztec name	Native uses	Relevant chemicals	Reference
Artemisia mexicana (*8*, p. 279; *9*, v. 4, p. 340; *10*,* p. 165; *11*, v. 1, p. 291; *12*, p. 169)	*Itztauhyatl*	Relieve weakness; against colic; reduce fever; against coughs	α,β,γ-santonin; thujone; thujyl alcohol; camphor; estafiatin; douglanin; arglanin	(*41*, pp. 127, 218, 764; *42*, p. 249; *43*)
Bocconia frutescens (*8*, p. 279; *9*, v. 4, p. 328; *10*, pp. 152, 153; *11*, v. 2, p. 611; *12*, p. 68)	*Cococxihuitl*	Against constipation; oil useful for abscesses, swelling	Chelerythrine; protopine; allocryptopine; dehydrosanguinarine	(*5*, p. 198; *44*)
Bromelia pinguin (*11*, v. 3, p. 1045; *12*, p. 218)	*Mexocotl*	Cures heat blisters in mouth	Pinguinain	(*23*, p. 835; *45*)
Carica papaya (*9*, v. 4, p. 334; *10*, p. 206; *11*, v. 2, p. 563)	*Chichihualxochitl*	Latex unripe fruit for rash, ulcer; ripe fruit digestive	Papain, carpaine, papase	(*5*, p. 243; *23*, p. 782)
Casimiroa edulis (*5*, p. 349; *46*, *47*)	*Cochiztzapotl*	Relaxes; makes sleepy; sedative burned and powdered seed on sores	*N*-Benzoyltyramine; *N,N*-dimethylhistamine; casimiroin; fagarine; casimiroidine	(*48*; *49*, p. 350)
Cassia occidentalis or *Cassia alata* (*9*, v. 4, p. 360; *10*, p. 150; *12*, p. 86)	*Totoncaxihuitl*	Astringent; purgative; anthelmintic; relieves fever; against inflammation of rashes	Chrysophanic acid; sitosterol; rhein	(*41*, pp. 503, 522, 855)
Chenopodium graveolens (*9*, v. 4, p. 334; *10*, p. 193; *12*, p. 122)	*Epazotl*	Against dysentery, anthelmintic; helps asthmatics breathe	Ascaridole; *p*-cymene; 1-limonene; menthadiene	(*23*, p. 757; *50*, p. 127)
Euphorbia calyculata (*9*, v. 4, p. 330; *11*, v. 1, p. 183; *12*, p. 36)	*Cuauhtepatli; chupiri*	Purgative; skin ailments, mange, skin sores	Salicylic acid; euphorbol; euphol; epoxylathrol	(*41*, pp. 354, 609, 835, 836; *51*)
Helianthus annuus (*10*, p. 220; *11*, v. 1, p. 100; *12*, p. 185)	*Chilamacatl*	Seed against fever; too much causes headache	Chlorogenic acid; scototenin; quercimeritrin	(*41*, pp. 294, 295, 395, 612, 1036)
Liquidambar styraciflua (*8*, p. 278; *9*, v. 4, p. 347; *10*, p. 112; *11*, v. 2, p. 360; *12*, p. 26)	*Ocotzotl; xochiocotzotl quauhxihuitl*	For rashes, toothache; tonic for stomach	Storenin; cinnamic acid esters; styrol	(*23*, p. 983)
Montanoa tomentosa (*8*, p. 274; *9*, v. 4, p. 327; *10*, p. 179; *11*, v. 3, p. 883; *12*, p. 151)	*Cihuapatli*	Diuretic; oxytocic; cures hydropesia	Tomentosin; zoapatlin; kaurene	(*32*, *52*)
Passiflora jorullensis (*8*, p. 258; *9*, v. 4, p. 326; *10*, p. 148; *11*, v. 2, p. 587; *12*, p. 236)	*Coanenepilli*	Produces sweating; diuretic; pain reliever; against poisons and snake bites	Harmol; harman; harmine; harmalol; harmaline; passicol	(*53*)
Perezia adnata (*5*, p. 258; *9*, v. 4, p. 349; *10*, p. 148)	*Pipitzahuac*	Purgative; cathartic; against cough, sore throat	Perezone; gallic acid and β-pipitzol	(*5*, p. 258; *41*, p. 481; *42*, p. 277)
Persea americana (*9*, v. 4, p. 323; *10*, p. 118; *11*, v. 1, p. 89; *12*, p. 59)	*Auacatl; ahuacaquahuitl*	Oil from seeds astringent, treat sores, remove scars	Unsaturated heptadecatriols	(*34*)
Pithecolobium dulce (*5*, p. 150; *11*, v. 3, p. 799; *12*, p. 65)	*Quamochitl*	Bark and root astringent; powdered seeds provoke sneezing; cures ulcers and sores	Pithecolombine; saponin from oleanolic acid; quercetin; kaempferol	(*23*, p. 841; *54*)
Plantago mexicana (*9*, v. 4, p. 319; *10*, p. 159; *11*, v. 1, p. 155)	*Acaxilotic*	Infusion of roots, vomit and cathartic	Mucilage, aucubin	(*41*, p. 1053; *50*, p. 52)
Plumbago pulchella (*9*, v. 4, p. 365; *11*, v. 1, p. 188; *12*, p. 77)	*Tlepatli; tletlemaitl; itzcuinpatli*	Diuretic; cures colic; leaves used against gangrene	Plumbagin	(*50*, p. 52; *55*)
Psidium guajava (*8*, p. 257; *9*, v. 4, p. 368; *10*, p. 119; *12*, p. 55)	*Xalxocotl*	Fruit is digestive; bark against dysentery; leaves against mange	Guijaverin; methyl benzoate; caryophyllene; crataegolic acid	(*41*, p. 812; *56*)

* References to the *Florentine Codex* (*10*) in this table are to Book 11.

Table 1 (continued).

Botanical name	Aztec name	Native uses	Relevant chemicals	Reference
Rhamnus serrata (*9*, v. 4, p. 362; *10*, p. 164; *11*, v. 1, p. 302; *12*, p. 186)	*Tlalcapulin*	Cures dysentery, stops bloody bowels	Rhamnetin; chrysophanic acid	(*41*, pp. 503, 509, 609)
Salix lasiopelis (*8*, p. 275; *9*, v. 4, p. 351; *10*, p. 169)	*Quetzalhuexotl*	Stops blood from rectum; cures fever; mixed with *cihuapatli* oxytocic	Salicin; picein; salipurposide	(*41*, pp. 104, 178; *49*, p. 343)
Schoenocaulon coulteri; Veratrum frigidum (*57*)	*Zozoyatic*	Sneeze producer; kills mice, lice (topically), flies	Cevadine; jervine; germine; cevine; veratridine	(*23*, pp. 226, 242, 488, 596, 925, 1104)
Smilax aristolochiaefolia (*5*, p. 355; *11*, v. 3, p. 760; *12*, p. 228)	*Mecapatli*	Sweat producer; diuretic; relieves pains in joints	Parillin; sarsapogenin; sitosterol; stigmasterol	(*5*, p. 356; *41*, pp. 854, 858, 865, 867; *58*)
Tagetes erecta (*9*, v. 4, p. 326; *10*, pp. 200, 214; *11*, v. 2, p. 650; *12*, p. 119)	*Cempohualxochitl*	Sweat producer; cathartic; cures dropsy	Quercetagitin; patuletin; tagetone; α-terthienyl	(*59*)
Talauma mexicana (*8*, p. 273; *9*, v. 4, p. 372; *12*, p. 11)	*Yolloxochitl*	Comforts heart; against sterility	Talaumine; aztequine; costunolide	(*5*, p. 343; *37*, *60*)
Theobroma cacao (*8*, p. 262; *9*, v. 4, p. 325; *10*, p. 119; *11*, v. 3, p. 913; *12*, p. 49)	*Cacahuaquahuitl*	Mixed with rubber stops excess diarrhea; excess produces dizziness	Theobromine; glycosides of cyanidin; esters and glycerides of many acids	(*41*, pp. 280, 291, 689, 693, 1056)

dine to slow down and regularize heartbeats. This combination of ingredients should possess hypnotic and sleep-producing properties (*29*).

Cassia occidentalis or Cassia alata (effective). Chrysophanic acid and its glycosides are cathartic, and the reduction product chrysarobin is used topically for psoriasis and other chronic skin diseases (*20*, p. 252; *27*, p. 1024).

Chenopodium graveolens (effective). Ascaridole is the main component of the anthelmintic oil of chenopodium. The oil is also a local intestinal tract irritant, which would be useful in dysentery. Volatile oil components would aid in restoring free breathing (*21*, p. 387).

Euphorbia calyculata (effective). Externally, salicylic acid is an exfoliative and a fungicide insecticide. The latex from *Euphorbia* is a strong purgative and vesicant. This would be expected to be an effective remedy for skin infections and sores (*20*, p. 1374; *22*, pp. 147, 509).

Helianthus annuus (not effective). It is not clear how the compounds found in sunflower seeds would relieve fever.

Liquidambar styraciflua (effective). The balsam storax obtained from *Liquidambar* is a stimulating expectorant and was used at one time for various catarrhs. Externally, as an ointment, it has been used as a parasiticide in scabies and other parasitic infections (*20*, p. 1160).

Montanoa tomentosa (possibly effective). This remedy, still used in folk medicine, is troublesome because the evidence is contradictory. There is wide agreement from native sources that *cihuapatli* is oxytocic, and there is wide agreement concerning its identity with *M. tomentosa* (*5*, p. 357; *30*). The reported constituents would not a priori be oxytocic, and there is conflicting literature concerning its effectiveness (*31*, *32*).

Passiflora jorullensis (not effective). Carboline alkaloids are potent monoamine oxidase inhibitors and muscular relaxants. They have been used as psychic sedatives and anodynes. Monoamine oxidase inhibitors have been used against Parkinson's disease (*23*, pp. 516, 517, 785; *27*, pp. 226, 234; *33*). Their usefulness as diuretics, diaphoretics, and remedies for poisons and snake bites is doubtful.

Perezia adnata (possibly effective). Gallic acid, being an astringent, might be useful in the treatment of sore throat by reducing inflammation of the membranes, but the other components do not explain the purgative and cathartic properties ascribed by native sources (*23*, p. 480).

Persea americana (effective). Unsaturated heptadecatriols and their acetate esters act as antibiotics against gram-negative bacteria. They would be effective emollients against scars and sores (*34*).

Pithecolobium dulce (not effective).

Plantago mexicana (effective). The *Plantago* seed is used as a cathartic. Polysaccharides are good bulk laxatives and cathartics (*22*, p. 286; *23*, p. 841; *27*, p. 1026).

Plumbago pulchella (effective). Plumbagin (methyljuglone) is active against bacteria, particularly staphylococcus, and thus might be effective against furuncles and acne. Since it is useful against urinary tract infections, it might be considered diuretic. It has a caustic effect externally (*20*, p. 932; *35*).

Psidium guajava (not effective).

Rhamnus serrata (effective). Chrysophanic acid is a cathartic, as mentioned above under *Cassia*.

Salix lasiopelis (effective). Hydrolysis of salicin yields salicylic acid. Salts have been used internally as a urinary antiseptic, analgesic, and antipyretic. The acid is used externally as a local antiseptic and is fungicidal for chronic eczemas (*20*, p. 1058; *22*, p. 509).

Schoenocaulon coulteri; Veratrum frigidum (effective). Veratrine is a mixture of cevadine, veratridine, cevadilline, and cevine. This mixture is extremely irritating to mucous membranes. Formerly it was used medicinally as a topical anodyne counterirritant. Cevine has been evaluated as an insecticide. These compounds are quite toxic and thus would be effective in killing mice. Extracts of *Schoenocaulon officinale* show a strong toxic action toward houseflies (*23*, pp. 226, 227, 1104; *36*). Since the alkaloids in *Schoenocaulon* and *Veratrum* match the various claims made for *zozoyatic*, the identification of this plant as *Stenanthium frigidum* or *Zygadenus* sp. is placed in doubt (*37*, *38*).

Smilax aristolochiaefolia (possibly effective). The effectiveness of sarsapa-

rilla is doubtful although it has been used formerly in chronic rheumatism, skin diseases, and syphilis (*20*, p. 1066; *23*, p. 934).

Tagetes erecta (not effective). Alpha-terthienyl is a nematicide, but otherwise the native predictions do not seem to be borne out (*39*).

Talauma mexicana (possibly effective). The compounds reported for this species would not a priori be active, but there are persistent clinical reports of digitalis-like activity (*40*).

Theobroma cacao (effective). Theobromine is a diuretic, stimulant, and smooth muscle dilator. Cacao butter is a mild cathartic and protects the gastrointestinal tract (*23*, p. 1033; *27*, p. 988).

Summary and Conclusions

If Aztec medicinal herbs are evaluated by standards which take the etiology of disease prevailing at the time into account, the results are favorable. Of the 25 plants dealt with in this article, 16 would produce most of the effects claimed in native sources, 4 may possibly be active, and 5 do not seem to possess the activity claimed by native informants. Thus, in this sample, a majority of the remedies were found to be effective. More work is needed to determine whether this proportion would be found for the remaining several hundred medicinal plants mentioned in native sources. It is clear that although magic and religion were quite important in the Aztec treatment of disease, there was a strong empirical underpinning which has not received the attention it merits.

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