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On the probable composition of 'Jamaican stone' aphrodisiac

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ABSTRACT

A dangerous aphrodisiac, commonly known as '*Jamaican stone*', banned by the U.S. Food and Drug Administration, has been studied by vibrational spectroscopy in order to solve the controversy on its composition. The results of the ATR-FTIR analysis revealed the presence of the α-pyrone ring, which is characteristic of bufadienolides from toad venom and bulbs of squill (*Drimia maritima* (L.) Stearn). This conclusion was reached after a comparative study with the spectra for phytochemicals derived from gambir and cat's claw, two *Uncaria* species also preconized as aphrodisiacs and deemed as possible constituents of the '*stone*'. Owing to their physiologic similarities to digoxin, bufadienolides have been shown to produce a toxic profile similar to that of digoxin, although the lack one of the side chains found on digoxin should allow the use of hemodialysis to treat '*Jamaican stone*' overdose.

1. Introduction

'*Jamaican stone*' (also referred to as '*Piedra china*', '*love stone*', '*black stone*' or '*China rock*') is a hard, dark brown drug, sold as a solid chunk (pills or dice). In the US, in spite of being banned by the Food and Drug Administration (FDA) and even when its importation and distribution are prosecuted, it can still be found in some adult stores and in neighborhood stores in some Hispanic districts. It is usually packaged in a clear plastic bag with some labeling and an information leaflet, warning that its use should be restricted to topical applications (Fig. 1).

The '*stone*' can cause serious heart problems or even death when ingested. Even when applied on the skin, which is its most frequent use, it can still be dangerous. Symptoms of poisoning include vomiting and chest and abdominal pain.

Although it has been used for years, there is still very little research done on the composition of the '*Jamaican stone*'. The manufacturer indications on its origin simply state that it is made from the concentrated sap of a tree which only grows in Asia and Jamaica and give elusive references to its anesthetics-like effects among the local people from where it is originated.

In 1967, a study by Das and Griffiths (1967) claimed that its main constituent would be *Uncaria gambir* Roxb. extract (gambier or gambir) and led to the identification of ethyl acetate as the chemical responsible for its bitter taste. Other plant species that have been suggested as components of the '*Jamaican Stone*' are the Caribbean cat's claw (*Uncaria tomentosa* (Willd. ex Schult.) DC), some species of seaweed (e.g., Irish moss seaweed, *Chondrus crispus* Stackh.) and squill (*Drimia maritima* (L.) Stearn; syn. *Urginea maritima* (L.) Baker).

Gambir is an astringent bark from a shrub growing in Borneo which has been traditionally used to handle the pain from tooth aches and as a chew when combined with nuts (for food). Gambir is mainly composed of cattechu-tanic acid (a tannin), (+)-catechin (see Fig. 2), (+)-epicatechin, dimeric proanthocyanidins, procyanidins B1 and B3, and gambiriins A1, A2, B1, B2 and C (Taniguchi et al., 2007), much of them 3′,4′,5,7-tetrahydroxysubstituted derivatives of 3,4-dihydro-2-phenyl-2H-1-benzopyran.

Gambir, in a similar fashion to cocoa and chocolate, has been reported to exert an effect on human sexuality, acting as an effective aphrodisiac, increasing sexual desire and improving sexual pleasure (Salonia et al., 2006). Cocoa products, apart from phenylethylamide (PEA), which has been reported stimulate the hypothalamus inducing pleasure sensations (Maxwell, 1996), also include (+)-catechin, (+)-epicatechin and procyanidins (Todorovic et al., 2015), which are present in gambir too. Thus, gambir's aphrodisiac properties may be referred to its flavonoid

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Fig. 1. Photographs of a commercial sample of '*Jamaican stone*'.

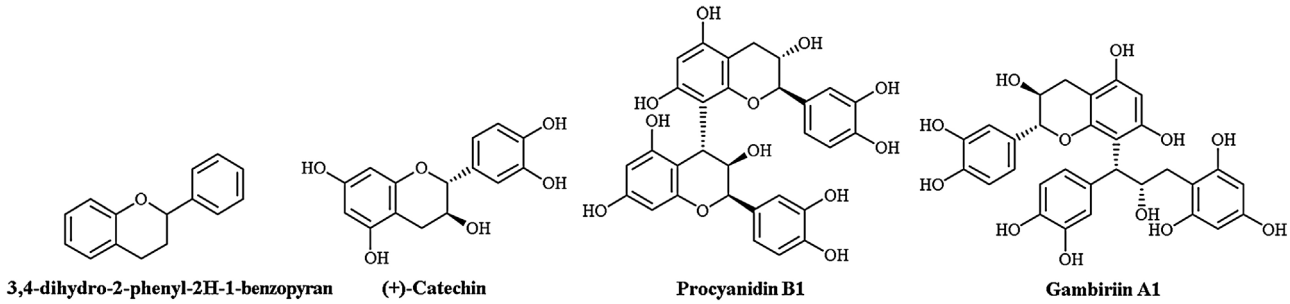

Fig. 2. Some constituents of gambir.

composition. It is worth noting that it has also enjoyed a spurt of popularity in a commercialized form (*Gambir Sarawak*) because it can be turned into a solution that is absorbed by the skin of the penis and delays the orgasm reflex.

Cat's claw is a plant whose bark contains quinovic acid glycosides, triterpenes, sterols and phenolic compounds and shares oxindole alkaloids with other *Uncaria* (Wahid et al., 2013) (Fig. 3). Nevertheless, at low doses, far from showing toxic effects, it has been reported to have anti-inflamatory and inmunostimulant properties (Quintela and Lock de Ugaz, 2003).

The fact that Borneo and Malaysian traders recommend a product (*Gambir Sarawak* or *tambah power*), which is different (and better) than the '*Jamaican stone*' (Lim et al., 2016), led us to consider an alternative composition: bufadienolides, suggested by the U.S. Food and Drug Administration on the basis of the arrhythmia problems reported by '*stone*' users (Sifferlin, 2015). Bufadienolides and their glycosides, which are compounds with steroid structure (Fig. 4), are derived from toad venom and bulbs of squill, and are cardiotonic steroids that cause symptoms similar to digoxin (CDC, 1995; Iizuka et al., 2001; Kamano et al., 1998; Meng et al., 2016). Specifically, they can cause an atrioventricular block, bradycardia, ventricular tachycardia, and possibly lethal cardiac arrest (CDC, 1995).

In the work presented herein, a rapid and accurate method for the fast and simultaneous qualitative and quantitative characterization of natural products and their constituents (Huck, 2015), namely Attenuated Total Reflectance Fourier-Transform Infrared (ATR-FTIR) spectroscopy, has been used to discriminate among flavan and diphenol rings (in gambir), oxindole alkaloids (in cat's claw) and α-pyrone ring (typical of bufadienolides) in order to ascertain the actual composition of the '*Jamaican stone*' (Fig. 5).

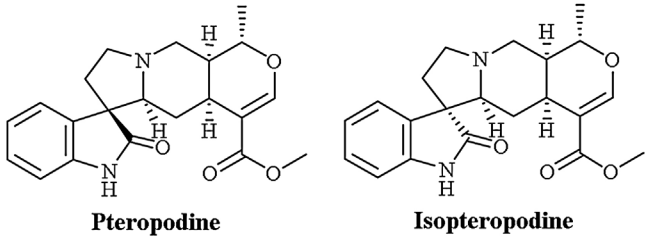

Fig. 3. Examples of oxindole alkaloid components of *Uncaria tomentosa* (Wahid et al., 2013).

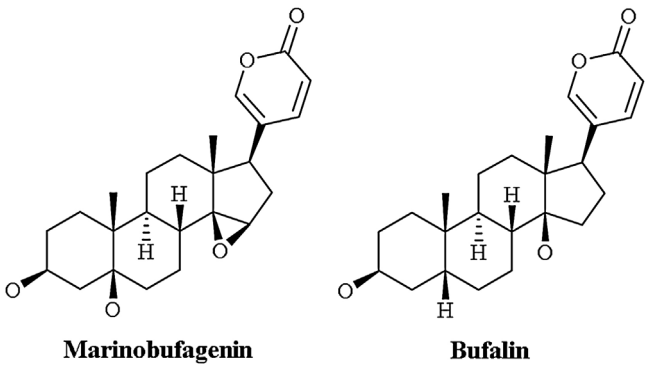

Fig. 4. Examples of bufadienolides (Miyashiro et al., 2008).

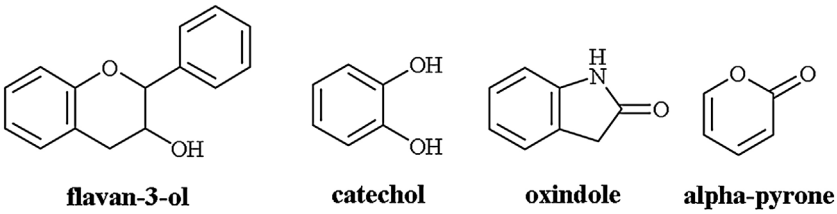

Fig. 5. flavan-3-ol, catechol, oxindole and alpha-pyrone.

2. Materials and methods

A dice of Jamaican stone was supplied, for research purposes, during a research stay at Columbia University. The sample was purchased at a neighborhood market at East Harlem (New York, NY, USA).

The vibrational spectra of the material in the 400–4000 cm^{-1} spectral range was measured using a Thermo Scientific (Waltham, MA, USA) Nicolet iS50 FT-IR Spectrometer, equipped with an in-built diamond attenuated total reflection (ATR) system.

3. Results and discussion

The presence of flavan-3-ol and catechol rings in the studied sample would be associated to three characteristic absorption bands: aromatic C—H group (νC—H group, in-plane δC—H and out-of-plane δC—H); aromatic C=C group (νC=C group at 1469 and 1619 cm^{-1}); and C—OH phenolic group (νO—H, in-plane δO—H at 1360 cm^{-1} and aromatic νC—O at 1279 and 1238 cm^{-1}) (Charlet, 2012).

A strong NH absorption peak would appear at 3368 cm^{-1} if oxindole alkaloids occurred instead (Wahid et al., 2013).

Alternatively, if pyrone structures (from bufotoxin and bufalin bufodienolides) were found in the '*Jamaican stone*', the enol ether atomic grouping (O—C=C) would absorb because of the C—H group, the olefinic C=C bond, and the ether C—O—C bond (Barroso-Bogeat et al., 2014). Moreover, if in particular bufotenine (a hallucinogenic congener of serotonin) intervened in the composition, the absorption bands of the indole ring would be observed.

The ATR-FTIR spectrum of the sample under consideration (Fig. 6) showed five bands that could be attributed to catechol: the one that appeared at 1156 cm^{-1} (provided that 5,7-dihydroxysubstituted flavonoids absorb at 1165 cm^{-1}) and four more (at 1521, 1507, 1419 and 1086 cm^{-1}), all of low intensity. Nevertheless, the sp^2 C—O stretching band at around 1280 cm^{-1}, typical of phenols; the C—O stretching band in phenolic compounds at 1620 cm^{-1}; and the =C—O—C groups stretching band at 1265 cm^{-1} were missing. Likewise, the strong NH absorption peak, which would appear at 3368 cm^{-1} if oxindole alkaloids occurred, was not present either. Other is the case of the α-pyrone (Py) ring, associated with at least half of the bands of higher absorbance in the spectrum, including those associated to ether atomic grouping O—C=C (see Table 1).

On the basis of the vibrational characterization, a composition rich in bufotoxin and bufalin bufodienolides appears to be the most probable. However, bufotenine (from bufo toad skin and glands), an active ingredient in West Indian *love stone* and in *chan su* Chinese medication, has not be identified: the expected absorption at 1064 cm^{-1} from the indole vibrations (νNC, δCH, νCC) does not appears in the spectrum.

Bufadienolides are usual components of aphrodisiacs, both in traditional Chinese medications (Bressman et al., 2016) and in Caribbean countries. Owing to their physiologic similarities to digoxin, bufadienolides have been shown to produce a toxic profile similar to that of digoxin, leading to multiple case reports of the use of these aphrodisiacs resulting in death. However, whereas digoxin is not dialyzable due to its size, bufadienolides lack one of the side chains found on digoxin, potentially allowing them to be dialyzed

Table 1
Assignments of the ATR-FTIR bands of the '*Jamaican stone*' aphrodisiac.

Wavenumber (cm^{-1})	Assignment	
3428	νO—H phenolic group	aliphatic and aromatic C—H, phenolic and alcoholic O—H stretching
2921	νCH and CH_2/OH involved in H bonding	
2851	νCH and CH_2	
1734	νC=O Py	
1700	νC=O	
1684	νC=O Py	
1652	νC=C Py	
1576	νC=C (1566 cm^{-1} in Py)	
1558		
1539	νC=C skeletal, aromatic ring	
1521	νC=C	
1507	νC=C	
1456	νC—C (CH_2 groups)	
1436	δC—H in the —CH_2—C=C atomic grouping	
1419	νC—C	
1156	δCHPh	
1086	νC—C/δ(CH),ν(NC) in indole/νC—O-C in cyclic ethers (Py)	
1023	νC—O-C Py/C—O in cyclic ethers	
929	γC—H Py	
851	γC—H	
759	γCHPh	
668	γPy	
577	γO—H	
525	δPh	
448	γPh	

υ: stretching; δ: in-plane deformation; γ: out-of-plane deformation; Py = pyrone ring; Ph = phenyl ring.

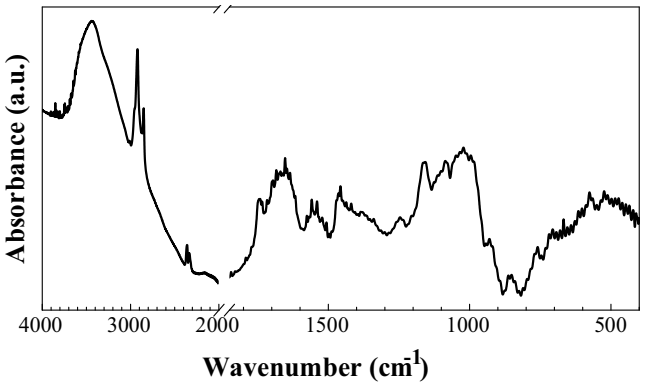

Fig. 6. ATR-FTIR spectrum of a sample of 'Jamaican stone' aphrodisiac.

(Bressman et al., 2016). Consequently, the use of hemodialysis could be a viable treatment for '*Jamaican stone*' overdose.

4. Conclusions

The ATR-FTIR characterization of the '*Jamaican stone*' aphrodisiac revealed the presence of different functional groups belonging to bufotoxin and bufalin (but not to bufotenine) bufodienolides. A comparative study of the spectrum with those of the phytochemical components of gambir and cat's claw, two *Uncaria* species also preconized as aphrodisiacs and suggested in the literature as probable ingredients of the '*stone*', showed that they were not amongst the constituents of the sample under study. Since bufadienolides can be dialyzed, the use of hemodialysis is tentatively proposed as a viable treatment for '*Jamaican stone*' poisoning.

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