

UNIVERSITY OF KUOPIO

Faculty of Pharmacy

30 April 2001

To Whom This May Concern:

My name is J.C. Callaway, Ph.D. I am a fully accredited medical researcher in the Faculty of Pharmacy at the University of Kuopio, Finland. I hold a B.Sc. (1980) degree in Chemistry and a M.Sc. (1984) degree in Bio-organic Chemistry, both from Universities in the United States. In 1994, I received my Ph.D. in Medicinal Chemistry from the University of Kuopio after defending my doctoral dissertation, entitled 'Pinoline and other tryptamine derivatives: formations and functions', and in 1998 I was awarded the title 'Docent of Ethnopharmacology' from the University of Kuopio's Department of Pharmacology and Toxicology. I have also held medical research positions at the University of California at San Francisco and the University of Miami, Florida.

Since 1984, I have been investigating the topic of Ayahuasca at the University level, and I have published several articles on this and related topics in peer-reviewed, international scientific journals and reference books (a selected list of my publications on endogenous and exogenous tryptamines is included at the end of this letter). I have also published several other articles on my research in the areas of brain chemistry and substance misuse over the years.

Concerning Ayahuasca (also known as Hoasca, Daime, and many other names); this is a plant-derived beverage that always contains harmala alkaloids and often, but not always, contains N,N-dimethyltryptamine (DMT). Although DMT is proscribed by law in many countries, it is a natural component of many plants and animals throughout the world. In fact, DMT has been identified as a naturally occurring neurotransmitter in the normal human brain, and in the brains of all other mammals studied in scientific experiments, and this information can be found in the medical literature, particularly from the 1980s. It is not an exaggeration to say that DMT is everywhere.

I have read the Expert's Report submitted by Prof. F.A. de Wolff, Ph.D., and I do not think it is necessary to restate the general information already presented about DMT and its pharmacological mechanisms of action in regard to Ayahuasca. I would, however, like to emphasize that it is probably not reasonable to compare the results of injected DMT with Ayahuasca, and the results of our pharmacokinetic study on Ayahuasca (as 'Hoasca') did not show similar increases in blood pressure, body temperature, tachycardia, etc. This is the only clinical

study on Ayahuasca to date, and we found no acute or chronic pathology to be associated with the regular and long-term use of Ayahuasca in a religious setting. Extending an analogy offered by Prof. de Wolff; comparing injected DMT with the DMT in Ayahuasca would be much like comparing injected caffeine with the effects of caffeine in a few cups of coffee. In other words, such a comparison has serious limitations in practice. And while the temporary MAO inhibition by harmala alkaloids in Ayahuasca certainly do extend the action of DMT, this action is considerably attenuated when compared to the effects of injected DMT, both physically and psychologically.

Concerning contraindications; I have yet to hear of anyone complaining of subsequent problems between Ayahuasca and certain foods. While this is certainly true for certain antidepressant medications and foods that are rich in tyrosine, as correctly stated by Prof. de Wolff, this may not be true for the MAO inhibiting properties of the harmala alkaloids in Ayahuasca for the following reasons; these alkaloids are reversible inhibitors of MAO, whereas the antidepressant medications are typically not, and because the harmala alkaloids are specific for the isozyme MAO-A and tyrosine is metabolized by MAO-B. The older class of antidepressants, where this problem was first identified, irreversibly inhibits both MAO-A and MAO-B, and this contraindication does not generalize to Ayahuasca. However, one area of concern for public health would be in taking Ayahuasca after an established course of a serotonin re-uptake inhibitor (SSRI), such as Prozac, which would certainly result in a potentially lethal situation known as the serotonin syndrome. This syndrome is well described in the medical literature, although this same combination (SSRI + MAOI) is occasionally used in a hospital setting to treat intractable depression.

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It is my understanding that some members of the Santo Daime may use 'natural' Cannabis during their ritual, being distinct from the extremely potent forms of Cannabis that are produced under 'artificial' conditions of light, soil and fertilization (e.g. 'sinsemillia'). To the best of my knowledge, specimens of 'natural' Cannabis seldom exceed 3% THC, while specimens of sinsemillia tend to be at least 2-3 times more potent. Rather than speculate on this matter, I think it would be more useful to ask members of the Santo Daime how many years marijuana has been used in their rituals with Ayahuasca (i.e. 'Daime'), and if they have noticed any problems.

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Sincerely,

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Ayahuasca Articles

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Callaway JC and Grob CS (1998). Ayahuasca preparations and serotonin reuptake inhibitors: a potential combination for adverse interaction. *Journal of Psychoactive Drugs* 30(4):367-369.

McKenna DJ, Callaway JC, Grob CS (1998). The scientific investigation of ayahuasca: A review of past and current research. *The Heffter Review of Psychedelic Research* 1:6577.

Callaway JC (1999). Phytochemistry and Neuropharmacology of Ayahuasca. In *Ayahuasca: Consciousness and the Spirits of Nature*, Ralph Metzner (Ed.), Thunder's Mouth Press, pp. 250-275.

Callaway JC, Raymon LP, Hearn WIL, McKenna DJ, Grob CS, Brito GS, Mash DC (1996). Quantitation of NN-dimethyltryptamine and harmala alkaloids in human plasma after oral dosing with Ayahuasca. *Journal of Analytical Toxicology* 20:492-497.

Grob CS, McKenna DJ, Callaway JC, Brito GS, Neves ES, Oberlander G, Saide OL, Labigalini E, Tacla C, Miranda CT, Strassman RJ, Boone KB (1996). Human psychopharmacology of Hoasca, a plant hallucinogen used in ritual context in Brazil. *Journal of Nervous and Mental Disease* 184(2):86-94.

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Other articles of related interest

Tiihonen J, Virkkunen M, Räsänen P, Pennanen S, Saino E-L, Callaway J, Halonen P, Liesivuori J (2001). Free L-tryptophan plasma levels in impulsive violent offenders. *Psychopharmacology* (in press).

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Pâhkala R, Rago L, Callaway JC, Airaksinen MM (1997). Binding of pinoline on the 5hydroxytryptamine transporter: competitive interaction with [³H]citalopram. *Pharmacology and Toxicology* 80:122-126.

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Callaway JC, Airaksinen MM & Gynther J (1995). Endogenous 3-Carbolines and other Indole Alkaloids in Mammals. *Integration-Journal of Mind Moving Plants and Culture* 5:1933.

Callaway JC, Gynther J, Poso A, Vepsäläinen J & Airaksinen MM (1994) The Pictet-Spengler Reaction and Biogenic Tryptamines: Formation of

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P.O.Box 1627, FIN-70211 Kuopio, Finland
tel. +358-17-162440, fax +358-17-162456

• Department of Pharmacology and Toxicology
P.O.Box 1627, FIN-70211 Kuopio, Finland
tel. +358-17-162402, fax +358-17-162424

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