

Commentary

The Methyltetrahydro- β -Carbolines in Maca (*Lepidium meyenii*)

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Maca, a plant native to the Peruvian highlands, contains (1R,3S)-1-methyl-1,2,3,4-tetrahydro- β -carboline-3-carboxylic acid (MTCA). The family of the tetrahydro- β -carbolines has been associated with both biologically helpful and harmful compounds. We present evidence that MTCA is a natural constituent of Maca, and on consumption no toxicity is found. This suggests that, when consumed as multi-component, MTCA may lose its adversity as drug action.

Keywords: *Lepidium meyenii* – Maca – methyltetrahydro- β -carbolines – polyphenols

Maca (*Lepidium meyenii*) is a cruciferous herb, usually found above 3300m in the Peruvian Andes. It is traditionally used for nutritional and fertility-enhancing properties (1). Among other compounds, hypocotyls of Maca contain (1R,3S)-1-methyl-1,2,3,4-tetrahydro- β -carboline-3-carboxylic acid (MTCA) in the butanolic fraction (2). This compound, a member of the family tetrahydro- β -carbolines, has been suggested to be an inhibitor of the monoamine oxidase (MAO) enzyme, and that it is co-mutagenic or is a precursor to mutagenic compounds. These mutagens can cause neuronal death *in vitro* or they can be bioactivated, giving rise to endotoxins. It is also mentioned that tetrahydro- β -carbolines may play an essential role in craving associated with addictions (2).

The mutagenic effect of MTCA on *Salmonella typhimurium* TA100 in the absence of S9 has been described in Japanese soy sauce treated with exogenous nitrites (7). However, MTCA is not mutagenic on *S. typhimurium* TA100 in the absence of the nitrites, with or without S9 (3).

These results have motivated the French Agency for Sanitary Security (AFFSA) to issue an alert about health risks associated with the consumption of pulverized Maca (4). The alert describes an alkaloid derived

from MTCA that inhibits MAO and can produce neuronal death.

Conflicting observations necessitate research to determine the true actions of MTCA in the human body. MTCA naturally occurs in fruits like oranges, grapefruits, and other fruit juices (5). These are frequently consumed because of their favorable health properties. Recently, MTCA has been described in a fermented garlic extract (6,7). Its concentration increases with time and this in turn increases anti-oxidant activity. Herraiz (personal communication) has detected MTCA in several foods, some showing concentrations greater than that naturally found in Maca.

MTCA accumulates in mammalian tissues and fluids and, in presence of nitrites, is a mutagenic compound precursor (3). Our research demonstrates the absence of mutagenic effects of Maca to the *S. typhimurium* TA100 in absence or presence of S9 (L. Villegas et al., unpublished observations). Recently, it has been demonstrated that MTCA can inhibit the production of nitrites induced by LPS (7), preventing the conversion of the MTCA to other non-beneficial metabolites.

Manabe et al. (8) suggested that high-MTCA levels correlate with the development of cataracts. However, subsequent studies have demonstrated that MTCA has anti-oxidant capacity greater than that of Vitamin E, and offers significant protection against ultraviolet radiation (9). Recent rat models show an aqueous extract of Maca,

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obtained after following a traditional boiling process, protected epidermal cells from the damaging effects of ultraviolet radiation (10).

Polyphenols can inhibit MTCA mutagenicity in presence of nitrites (11). Research shows that polyphenols are important constituents of Maca and they can be related to beneficial effects (10).

In relation to the suggestion that MTCA found in Maca can inhibit MAO activity and alter neuronal function (2), our laboratory recently demonstrated that MTCAs do not affect MAO activity in brain (12). This outcome contrasts with the effects of other β -carbolines (13). Research shows MTCA in Maca is not neurotoxic, rather it improves memory and learning in mice (12,14). Having a favorable effect on the experimental mouse model for Alzheimer (12), Maca constitutes a potential treatment for this pathology. Results of recent MTCA–Maca research, taken in conjunction with the fact that Maca contains several beneficial compounds, some of which has anti-carcinogenic properties (1,15), leads us to conclude that Maca consumed as a whole plant must not generate undue health concerns. As mentioned in the French alert (4), our conclusion incorporates the lack of reported toxicity where Maca is consumed after a traditional boiling process.

MTCA is natural constituent of many plants and no toxicity is found on consumption of such whole plants. This suggests that as multi-component, MTCA may loose adverse drug action.

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