

Capsaicin: History and Use of a Natural Deterrent

Ilídio R. S. Martins, Ph.D
Aversion Technologies, Inc.

Capsaicin is a naturally occurring substance that is responsible for the burning, pungent sensation associated with the ingestion of hot peppers from the *Capsicum* genus. The effect elicited by these peppers is at the origin of the name *Capsicum*, which derives from the Greek *kapto*, meaning “to bite”.

Hot peppers are a native plant from the American tropics and their use can be traced back to the Aztec and Inca civilizations. The Aztecs named them “chilies” and used them for culinary purposes. After discovery of the New World, chili pods were introduced in Europe and their cultivation expanded to other parts of the globe. Nowadays, hot peppers are found in nearly every country and are an important part of the culinary tradition of many different cultures.

The active component of chili peppers was initially isolated by J. C. Thresh in 1846. The compound was named “capsaicin” and its chemical structure was later determined by E. K. Nelson in 1919. The complete chemical synthesis of 8-methyl-N-vanillyl-6-nonenamide (capsaicin’s IUPAC* name) was reported in 1930 by Spath & Darling. In the 1960’s, Japanese investigators identified additional substances from *Capsicum* extracts with similar chemical and pharmacological properties that were termed “capsaicinoids”. Currently, this family of chemical analogues includes both natural (homodihydrocapsaicin, dihydrocapsaicin, nordihydrocapsaicin, homocapsaicin and capsaicin) and synthetic (nonivamide) members.

The association between capsaicin and the irritant properties of chili peppers was initially recognized in the 1870s by the pharmacologist Rudolf Buchheim and the doctor Endre Hőgyes who noted that capsicol (partially purified capsaicin) caused a burning feeling when in contact with mucous membranes and increased secretion of gastric juice. The pungency of peppers is related to their capsaicin content and can be measured using the Organoleptic Test designed by Wilbur Scoville in 1912. The test is performed by tasting different dilutions of alcoholic extracts from peppers in order to find the dilution at which the pungent flavor is absent. The hottest pepper is the Mexican *habanero* with 350,000 Scoville Units. The Scoville scale remains today the standard measure of chili pepper pungency and the test is used in many laboratories to detect capsaicin-like substances. There are currently methods that enable a more direct and less subjective measurement of the capsaicin content, namely by using high-performance liquid chromatography.

In addition to the culinary use in the pepper form, capsaicin is employed in many other applications. Animal deterrence is thought to be one of the main natural functions of capsaicin and this property has been adapted to several commercial uses. Capsaicin in chili peppers acts as a mammal repellent, which prevents animals from chewing, and thus destroying, the *Capsicum* seeds with their molars. Birds, in

contrast, are insensitive to capsaicin and do not destroy the germinative potential of pepper seeds. This selective deterrence property is important for efficient dispersion of chilli pepper seeds in a natural context and has been commercially applied to produce, for example, squirrel-free bird food. In addition to mammal repellence, capsaicin is also used against insects and mites. Due to its biological origin and mechanism of action, this molecule is labeled as a “biochemical” by the U.S. Environmental Protection Agency and was first registered for pesticide usage in 1962. Capsaicin is one of the few natural substances currently available for broad pest deterrence in organic farming.

Due to its low toxicity profile, capsaicin can also be employed in applications that target human subjects (for example, as a non-lethal force agent). In the aerosol form, capsaicin can contact the human skin, eyes, and respiratory airways where it provokes pain and irritation. Aerosolized capsaicin was popularized by the so-called “pepper sprays” for self-defense and law enforcement, an application that is reminiscent of the use by the Incas of burned chili peppers to temporarily blind the invading Spaniards.

Current medical applications of capsaicin also find roots in practices with centuries of history. Native Americans rubbed their gums with peppers to relieve toothaches, a custom quickly adopted by the Europeans. Today, capsaicin is the active ingredient in creams, ointments, and dermal patches used to relieve pain and reduce itching and inflammation.

In summary, capsaicin is a substance that is naturally available and that is well characterized at the chemical level. Historically, humans have included capsaicin in their diet and used it to relieve pain and to deter other humans or animals.

* The International Union of Pure and Applied Chemistry

References:

United States Department of Agriculture. Capsicum L. Germplasm Resources Information Network 2009 [cited 2010 2 June]; Available from: <http://www.ars-grin.gov/cgi-bin/npgs/html/genus.pl?2056>

Maga JA, Todd PH. Capsicum. Critical Reviews in Food Science and Nutrition. 1975; 6(2): 177-99.

Quattrocchi U. CRC world dictionary of plant names: common names, scientific names, eponyms, synonyms, and etymology: CRC; 1999.

Irish HC. A Revision of the Genus Capsicum: With Especial Reference to Garden Varieties: Spellman Pr; 2008.

Naj A. Peppers. A Story of Hot Pursuits. New York; 1992.

Szallasi A, Blumberg PM. Vanilloid (capsaicin) receptors and mechanisms. Pharmacological reviews. 1999; 51(2): 159.

Scoville W. Note on capsicum. J Am Pharm Assoc. 1912; 1: 453.

Reregistration Eligibility Decision (RED) Capsaicin. In: U.S. Environmental Protection Agency OoP, Pesticides and Toxic Substances, Office of Pesticide Programs, editor. Case 4018. Washington, DC: U.S. Government Printing Office; 1992.

National Pesticide Information Center. Capsaicin: technical fact sheet. [cited 2010 June 2]; Available from: <http://npic.orst.edu/factsheets/Capsaicintech.pdf>

Copping LG. The Manual of Biocontrol Agents (of The BioPesticide Manual). BCPC, Alton, Hants. 2004.