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Chocolate, Theobromine, Dogs, and Other Great Stuff.

Chocolate is now considered a health food, according to many news reports. It provides a goodly dose of antioxidants, prolongs the lives of Dutch men, contains compounds that chemically echo tetrahydocannabinoid and encourage feelings of love, and it even "may halve the risk of dying," according to a recent headline in the *New Scientist*.

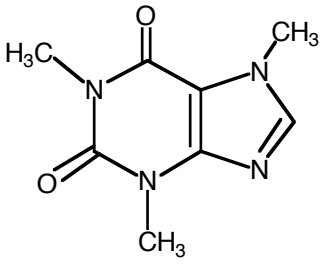
On the other hand, if chocolate is included in the diet in therapeutic doses, it will also most assuredly lead to obesity. Furthermore, the amounts of anandamide (the THC mimic) and phenylethylamine (the so-called "love" compound) are present in chocolate in very, very low amounts. And finally, we all have a 100% chance of dying at some time, so a headline that talks about cutting our chance of dying in half makes no sense.

Nevertheless, chocolate is great stuff. It comes in many varieties. One end of the spectrum is bitter baking chocolate; adding sugar provides chocolate of various degrees of sweetness. Adding milk finally brings us to milk chocolate, which many people consider barely makes it over the line into chocolate. White chocolate is only cocoa butter fat, and really isn't chocolate at all.

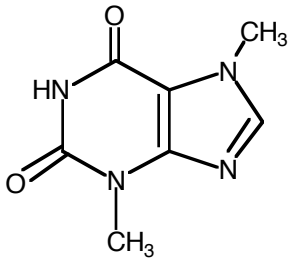
Over 600 different molecules contribute to the taste of chocolate. Many people talk about the caffeine in chocolate, but there is relatively very little caffeine in chocolate; the compound that particularly characterizes chocolate is theobromine, a very close relative of caffeine. There is six to ten times more theobromine in chocolate than caffeine. No matter how much organic chemistry you have (or don't have) it is easy to see that caffeine and theobromine are very closely related when looking at the chemical structures.

Structures of caffeine and theobromine:

Caffeine



Theobromine



Amount of theobromine in

unsweetened chocolate	~ 400 mg/oz
milk chocolate	~ 44 mg/oz
white chocolate	0
hot chocolate	~ 13mg/oz *or* ~ 104 mg/8 oz cup

Theobromine is a mild stimulant for people, but it is particularly toxic for dogs. The literature and the web are littered with approximations and disclaimers about just how toxic it really is. It is very difficult to assess the lethal dose of chocolate or theobromine for dogs for the obvious reason that no one is going to do a controlled study on dogs that will end up with half of them dead. Some reports in the media lead the reader to believe that when a dog steals one Oreo or a single chocolate chip, it will die. Dogs are variable in their susceptibility to theobromine poisoning and, in addition, toxicity is dependent on dose. Large dogs can handle more than peewees, unless, of course, the behemoth is one of those acutely susceptible dogs. That said, *never* take a dog that has snarfed some chocolate casually.

Allowing for appropriate leeway, the toxic doses for dogs are shown in the next table. The half-life of theobromine in dogs is said to be 17 – 18 hours (it is 6 – 10 for people). If you think your dog has eaten a questionable amount of chocolate or if it is having a reaction, head off to the vet pronto. Presumably my 80 pound dogs could eat several pounds of milk chocolate, but why let them develop a taste for it? A previous 90 pound dog of ours ate a whole chocolate cake *and* its fudge frosting with impunity (this happened before chocolate toxicity awareness so I didn't know enough to worry); we, and he, were very lucky as he was probably right on the edge of the toxicity guidelines.

Type of chocolate	**Estimated dangerous dose per weight of dog**	
Milk chocolate	1 oz	per 1 pound of dog
Semisweet chocolate	1 oz (1 square)	per 3 pounds of dog
baking chocolate	1 oz (1 square)	per 9 pounds of dog

Note: Slightly different values are listed in different sources.

A few extra chocolate factoids:

Chocolate comes from the seed of a small tree, *Theobroma cacao*. The chemical theobromine (which contains no bromine) comes from the genus name, which means food of the gods, from the Greek *theo* (god) and *broma* (food).

Chocolate comes from the cacao tree which originated in the rainforest understory of the Amazon/Orinoco regions. Cocoa cultivation originated among the Mayans and was later appropriated by the Aztecs. Chocolate was consumed by the elite, who combined it with native spices such as peppers. Cocoa beans were valuable and used as currency and to pay taxes. Columbus came upon cocoa beans during one of his later voyages but he had no inkling of its value or potential as a wildly popular substance and passed it up. Several years later Cortez was intrigued by it, took it back to Europe, and, as they say, the rest is history.

Harold McGee. *On Food and Cooking: The Science and Lore of the Kitchen.* Scribner (2004)
T. P. Coultate. *Food: The Chemistry of its Components.* The Royal Society of London (2002)
http://chemistry.about.com/library/weekly/aa090301a.htm
http://vetmedicine.about.com/cs/nutritiondogs/a/chocolatetoxici.htm
http://netpet.batw.net/articles/choc.tox.html