A New Taste for Bitters

Steve Byers

After studying with Maine herbalist Gail Faith Edwards, Steve Byers enrolled in David Winston's Centre for Herbal Studies. He is also currently studying at the Vermont Center for Integrative Herbalism. In the winter, he loves listening to AHG symposium recordings on the AHG website and looks forward to growing medicinal plants, gardening, and picking wild bitters in the spring. Steve currently lives in Montpelier, VT with his wife and daughter.

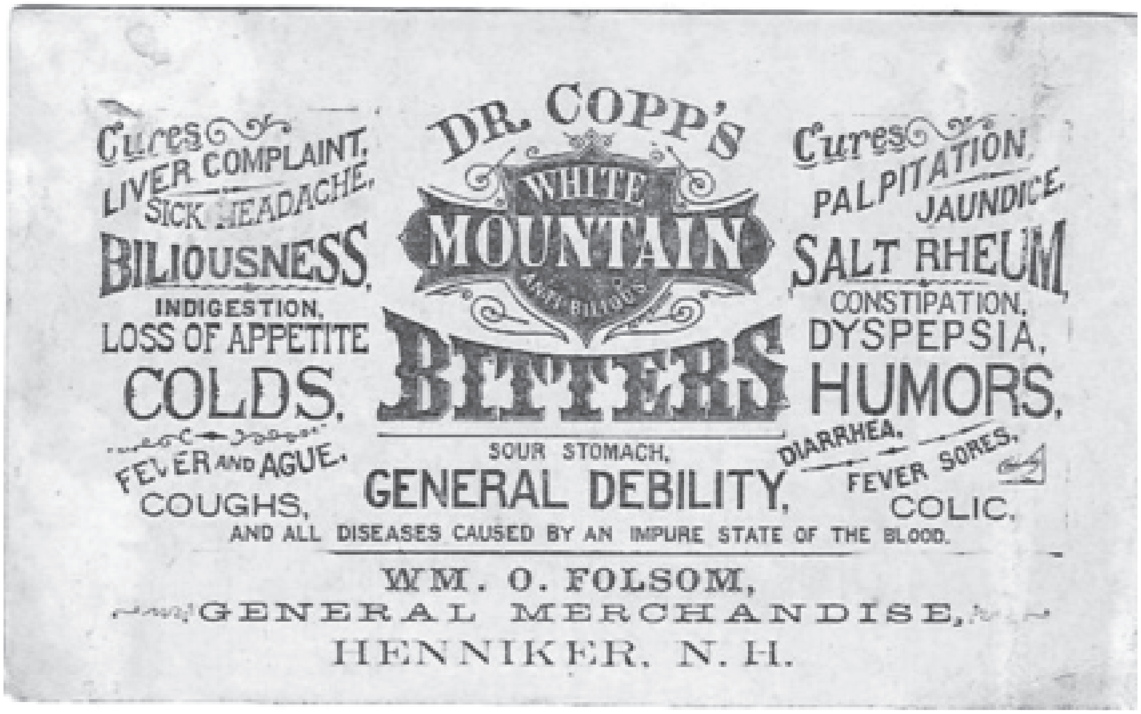
An exploration of the bitter taste has experienced great attention in the last decade as more people are rediscovering the essential role that this taste plays in human health. Herbalists have certainly placed a major role in reviving the use of bitter tasting foods, or "bitters", often in the form of pre-meal digestive tinctures or simple bitter greens like endives. Bitters are regaining popularity for their ability to bring relief to various gut-based health issues by helping restore normal digestive functioning, increase nutrient assimilation, and regulate the elimination of waste. In addition, exciting research is beginning to ask questions about how the tongue perceives bitterness, why bitter taste perception seems to vary from person to person, and what genetic factors are contributing to the bitter taste function.

Some of the popular bitter tasting plants used today include dandelion root *(Taraxacum officinale)*, gentian root *(Gentiana lutea)*, orange peel *(Citrus reticulata)*, and artichoke leaf *(Cynara scolymus)*, all of which stimulate a complex physiological response referred to as the "bitter reflex." The bitter reflex is activated the second the tongue tastes bitterness. Signals sent from nerves on the tongue to the vagus nerve running down from the brain and terminating close to the enteroendocrine cells lining the mucosa of the gastrointestinal tract prepare the body for digestion by increasing salivation, relaxing the esophagus, stimulating hydrochloric acid production in the stomach, initiating peristalsis, stimulating liver and gallbladder function, and even initiating enzyme production in the pancreas and small intestine. These enteroendocrine cells are responsible for the production of important peptides and hormones such as serotonin, gastrin, secretin, and cholecytstokinin (CCK) critical for regulating appetite, glucose homeostasis, peristalsis, and many other gastric functions. Some bitters such as gymnema *(Gymnema sylvestre)* and bitter melon *(Momordica charantia)* not only improve digestive function but also act as hypoglycemic agents to lower blood sugar levels in diabetics (Winston, 2011).

Research is showing that not everyone experiences the bitter taste the same way. Initial evidence from the 1930s (Fox, 1931), and now several studies in the last decade have begun to show that many of our bitter taste perceptions will vary based on factors ranging from our genetics to cultural food preferences, gender, and age. We can roughly evidence this ourselves by seeing how many children are repulsed by bitter tasting foods while adults are often less sensitive to bitterness. It is also worth considering how epigenetics may play a role in bitter taste perception where non-genetic factors over a lifetime can turn on or off different genes expressions. In order to engage a holistic view of this important taste it is necessary to consider the historical use of bitters, reflect on new research regarding bitter taste function and perception, and collectively utilize this information in the hope that it may better guide our understanding and use of bitters.

The changing world of bitters

Traditional diets of all cultures around the world include some sort of bitter flavored food before or during a meal. These foods are believed to help stimulate the appetite and prepare the stomach for healthy digestion to more effectively break down fats, increase nutrient absorption, and eliminate post meal bloating. Bitters have been known and used through the wisdom of necessity, nourishment, and survival as these traditions have been passed down through the generations. Many bitters historically used



were local weeds free for the taking.

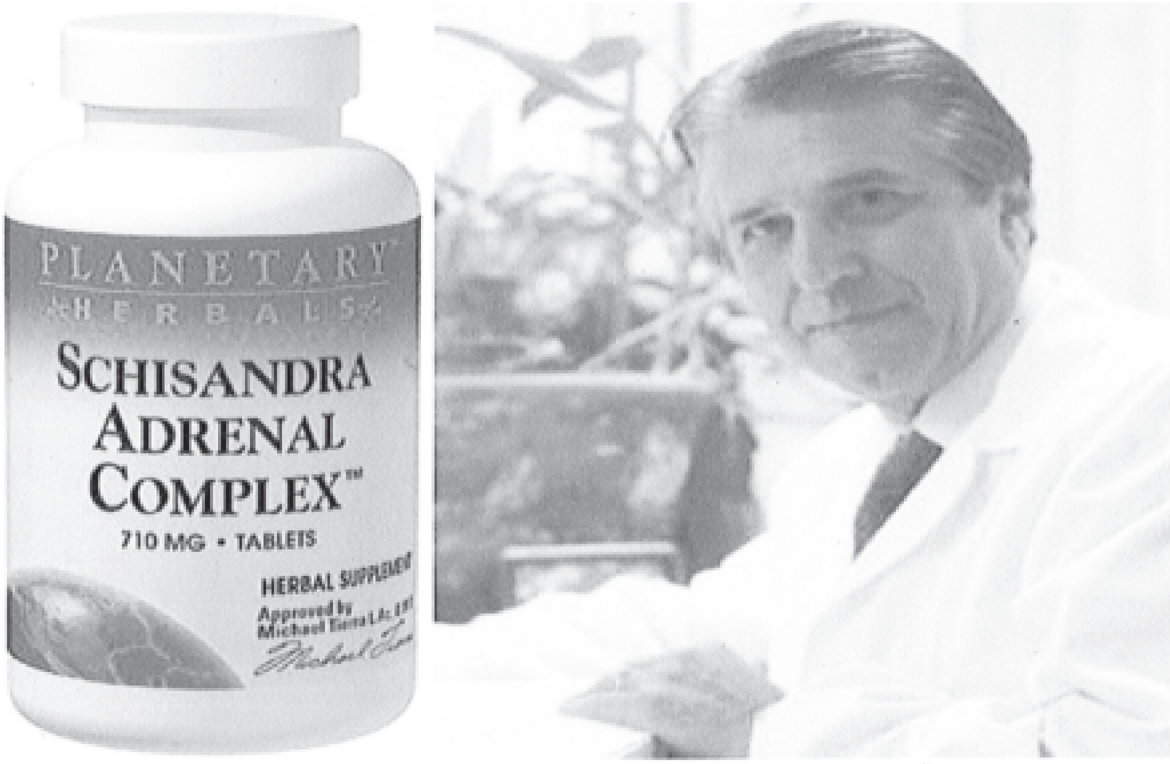
Europeans are still known today for their culture of bitter herbs. In the article *Bitters, Tonics and Digestion,* herbalist Christopher Hobbs writes that an estimated 20 million doses of bitters are taken every day in Germany. During a trip to Greece, Hobbs saw many people "picking wild greens and eating them with gusto," and that many would eat unripe plums -- which have a bitter, sour and astringent flavor -- at the table as a digestive tonic. Greeks are also known for traditionally eating a daily mixture of chicory and dandelion greens with olive oil, which they call *horta*.

Within Jewish tradition, bitter herbs are eaten at the Seder dinner before Passover to remind themselves of the bitterness of the slavery of their forefathers in Egypt. Fresh grated horseradish, parsley, romaine lettuce, and endives are common choices of bitters eaten with the Seder meal. In other parts of the Middle East, Arab Muslims and Christians eat bitter pickled vegetables prior to or during their meals. Asian cultures eat Kimchi, a lacto-fermented food with various sour, bitter, and pungent flavors that help stimulate digestion and also act as a probiotic to the intestinal flora, helping to grow the healthy gut bacteria critical to digestion and overall health.

In modern American history, we also have a strong cultural use of bitter plants and beverages including the creation of the once popular "Bitter Digestives". While these preparations were used for dozens of different ailments, they eventually fell out of favor and distribution. The main factor behind the reduced use of bitters in America was the growing popularity of bitter liquors in the late 1800s and early 1900s. Many "booze medicines" and bitter liquors, also know as "bracers", were produced under the auspice that they were medicinal beverages. One business succeeding in this booze medicine industry was The Hostetter Company whose Stomach Bitters were so popular that the Union Army bought thousands of cases during the Civil War and distributed it to the soldiers for their "stomach ailments" and as "a positive protective against the fatal maladies of the Southern swamps, and the poisonous tendency of the impure rivers and bayous" (Hostetter's United States Almanac, 1867).

In 1912 the American Medical Association (AMA) published a book, *Nostrums and Quakery*, that purported to identify the many bogus medicines infiltrating the medical profession. One account states that

> Hostetter's Stomach Bitters has for a good many years been recommended for malaria among numerous other conditions. The AMA chemists found small quantities of quinin and cinchonidin present. In order to get a daily dose of quinin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> equal to 15 grains, the minimum amount the Pharmacopeia recommends as antimalarial, it would be necessary to take 20 ounces of Hostetter's Bitters daily. This would necessitate swallowing an amount of alcohol equivalent to about 10 ounces of straight whiskey daily (pp 742-743).

It was no coincidence then that many booze medicine operations were curtailed in October 1912 by the Internal Revenue Services (IRS) when a lengthy list of about 200 liquor compound medicines on the market (including many bitter liquors) were exposed as fraudulent medicines, thus requiring a liquor dealer's license to permit their distribution.

The renewed use of bitters in America today is bringing new excitement and with it also some caution. For example, one GMP certified U.S. based company, Dr. Shen's Quality Chinese Herbs is self-regulating against phony industry claims about a popular formula called "Chinese Bitters" which contains the herbs gentian root and bupleurum root. On Dr. Shen's website they caution consumers about some of recent widespread claims about Chinese Bitters saying,

> In truth, this valuable formula can be of help only when these problems are caused by *Liver Qi Stagnation*, and *Heat or Dampness in the Liver or Gallbladder*. This condition underlies only a fraction of these complaints. Thus, the promise of success with Chinese Bitters must be viewed cautiously. For example, Chinese Bitters are actively promoted as a cure for infertility. In fact, there are many causes of infertility; and only some are related to *Liver Qi Stagnation*. Infertility can be caused by *Kidney Deficiency* (low batteries), *Blood Deficiency, Blood Stagnation, Damage to the Chong and Ren, Phlegm Obstruction*, etc. For these other conditions, Chinese Bitters have no effect.

False claims for cure-all treatments can hinder not only herb companies and the profession of herbal medicine, but most of all it can mislead clients in need of effective herbal therapies designed specifically for their condition.

As the herbal community develops its products and bitter formulas, it is important to keep in mind our history and the lessons we've learned. At the core, the age-old bitter food traditions remain the bedrock of dietary wisdom promoting general digestive health accessible to everyone, often in the form of wildly abundant roots and weeds. As we journey forward, we can enhance this wisdom by considering patterns found in new research on the bitter taste which is revealing that human taste is constantly evolving, demonstrating that while the need for the bitter taste is universal, one's perception of it is not.

New research on bitter taste perception

The human tongue has at least 25 human bitter taste receptors. (Meyerhof et al. 2010). Research has shown that our response to bitter compounds in foods and beverages is due partially to a group of genes called Taste 2 Receptors (TAS2Rs), which contain unusually high levels of allelic variation (mutations) from person to person indicating that individual taste perception is dependent on whether one has certain TAS2R gene mutations present or not (Pronin et al 2007). Currently, there are up to 19 forms of the TAS2R genes identified that have sensors for common compounds found in food and plants, such as glycosides, alkaloids, terpenoids, flavonoids, and other plant secondary metabolites (Meyerhof et al. 2010).

A synthetic chemical called 6-n-propylthiouracil (PROP) is currently one of the most common bitter substances (often administered in tests as a paper taste strip placed on the tongue) used to determine one's degree of bitter taste perception. As research continues to develop, taster status is being reflected through sensitivity to bitterness and other bitter tastants similar to PROP (e.g. pure caffeine, quinine, and other plant based materials) as well as other acuities such as somatosensation and retronasal olfaction (Hayes & Keast, 2011). One compound called goitrin, which naturally occurs in cruciferous vegetables like broccoli, is structurally similar to PROP and also elicits taste responses very similar to PROP (Wooding et al. 2010). This evidence helps bridge the gap between the synthetic and organic compounds used to study preference for bitter tasting foods.

Many studies using PROP have focused on the discovery that humans can generally be placed into three different taste status groups with varying abilities to taste bitters. The first group, referred to as "nontasters," shows an inability to taste the bitterness of PROP while "medium tasters" or "tasters" are able to detect the bitter taste of

PROP. The third group, "supertasters" are extra sensitive and are often revolted by the bitter taste of PROP. While this is only one simple method for describing the ability to taste bitterness, it does provide a framework for the information and insight we can gain through these taste studies.

Over the course of primate evolution, our taste receptors have been under complex pressure to adapt and change in order to enable survival (Wooding 2012). It is commonly believed that our nauseous aversion to bitterness is an evolutionary response that has protected humans from eating poisonous plants often characterized by their incredible bitter taste. Nausea has been shown to be a physiological response to bitter taste stimulation where the body anticipates the ingestion of potential toxins and induces a prophylactic aversive state (Peyrot Des Gachons et al. 2011). Some edible plants contain very bitter tasting chemicals like sesquiterpene lactones, which when tasted together (as they are naturally when eaten in a plant containing them) are able to synergistically inhibit certain bitter taste receptors making the edible plant taste less bitter and more palatable (Brockhoff et al. 2011). Researchers making this discovery suggest it is possible that during human evolution some of the pharmacological properties of our human taste receptors have been shaped and tuned by these edible bitter taste receptor agonists.

Taster status has also been shown to correlate with the dietary intake of fruits and vegetables: those who are more sensitive to the bitter taste often eat lower amounts of fruits and vegetables. In one study (Duffy et al. 2011) looking at the vegetable intake of college-aged adults, researchers measured bitter quinine sensitivity and counted fungiform papillae on the tongue of each participant. They reported that not only are nontasters more likely to eat vegetables but those nontasters with more fungiform papillae on their tongues ate more vegetables than the nontasters with fewer fungiform papillae. Another study by Yacknous & Guinard (2002) testing 183 college students found the distributions of papillae counts overlapped within PROP taster groups yet also noted that supertasters had higher counts of fungiform papillae on the anterior tongue. Additionally, it was concluded that PROP supertasters generally ate less green salad than tasters and nontasters. Also, PROP-tasting women consumed less fruit than nontasters and obtained a greater percentage of their dietary energy from fat. Finally, in a seven-week study of 252 Hispanic preschoolers (where 70% of them tested as PROP tasters), regular salad dressing served as a "dip" helped increase broccoli consumption and likeability by 80% in the bitter-sensitive group (Fisher et al. 2011).

Correlations between lower levels of bitter taste perception and issues such as obesity are starting to surface in the research. Findings show that while nontasters are more likely to eat fruits and vegetables when compared to medium tasters and supertasters, female nontasters actually have an increased incidence of higher body mass index (Feeney et al. 2011). Also in a study looking at obesity in boys, no supertasters were found to be obese. (Negri et al. 2011). A Turkish study (Oter et al. 2011) looking at caries (tooth decay) in school children showed that nontasters were "significantly more likely to have high caries risk" compared to PROP tasters. This raises an interesting question: Why are the kids who are more likely to eat vegetables, also more likely to be obese?

University of Florida professor Linda Bartoshuk, also a researcher at McKnight Brain Institute's Center for Smell and Taste, has suggested a link between childhood ear infections diagnosed as recurrent otitis media (ROM) and an increased risk of obesity later in life (Nelson et al. 2011). Data from three independent studies has helped confirm Bartoshuk's discovery that when the main sensory taste nerve, the chorda tympani nerve, which connects from the tongue through the middle ear to the brain, is damaged by ROM, it consequentially intensifies non-taste sensations from fatty foods and increases preference for foods that can lead to weight gain (Thompson, 2008). It appears that that our physiological ability to taste bitters can have an influence on our dietary choices and overall health.

University of Maryland researcher, Cedric Dotson, has assessed bitter taste perception through group samplings of the Amish Family Diabetes Study, a collection of ongoing research looking at the genetic trends contributing to diabetes, obesity, and cardiovascular issues in men and women within the Old Order Amish Community primarily in Lancaster County, PA. Dotson's research has linked functionally compromised bitter taste receptors with glucose dysregulation meaning that diabetics with poor blood glucose homeostasis may have a harder time tasting bitterness (Dotson et al. 2008). Another study found Amish women with a polymorphism in their TAS2R38 gene, considered to be non-tasters, had increased disinhibition in how they ate, meaning that they couldn't taste bitterness and had less control of eating (Dotson et al. 2010).

Some might wonder to what degree the "bitter reflex" varies between tasters and nontasters? In a small study in France, researchers separated 29 men into 2 groups based on their pre-tested overall taste sensitivity (hypo or hyper-sensitive) and tested them on their sensitivity to the bitter taste of caffeine by measuring and comparing their salivary proteome composition (Dsamou et al. 2012). The findings showed, "the saliva of hypersensitive subjects contained higher levels of amylase fragments, immunoglobulins, and serum albumin and/or serum albumin fragments. It also contained lower levels of cystatin SN, an inhibitor of protease." This suggests that higher taste sensitivity can actually elicit a stronger salivary reaction from caffeine and theoretically other bitter compounds as well. Considering the various research studies, perhaps those that are more sensitive to the bitter taste have stronger digestive reactions and functioning making the occurrence of obesity less likely. However, the digestive process is incredibly complex and conclusive evidence about the variation in the "bitter reflex" corresponding with taster status is far from complete.

Getting a new taste for bitters

For the first time in the history of herbal medicine, modern science and technological advances have provided many new perspectives that bring insight to older understandings of taste. There are many simple lessons we can all learn from this new research regarding our taste buds. For example, frustrated parents may benefit from remembering that children's taste perception is often more sensitive than adults. It is also possible for parents and children to genetically operate in two different sensory worlds, where the parent may be a nontaster and the child a supertaster. A study looking at the taste perceptions of 143 children and their mothers found that children with 1 or 2 bitter taste sensitivity alleles in their TAS2R genes (making them more sensitive to bitter) while also having mothers without these alleles, were viewed as being more emotional than other children who weren't as sensitive to the bitter taste (Manella et al. 2005).

What else can be learned from new research? It has recently become determined that the tongue isn't the only location for taste receptors -- the gut has them too! Another gene group called TAS1R's are known to detect the sweet taste, yet both TAS1R and TAS2R taste receptors are expressed on both the tongue and on subsets of cells in the gut on the enteroendocrine cells, which assist in nutrient assimilation and endocrine response (Rozengurt & Sternini, 2007). It is interesting to extrapolate and consider how a sweet and bitter tasting plant like American ginseng (*Panax Quinquefolius*) initiates some similar responses as described above (strengthening Stomach/Spleen Qi and enhancing endocrine function). Of further interest is a small taste testing study of 9 patients with therapy-resistant depression using vagus nerve stimulation (VNS), a therapy shown to have promising results for treating this condition (Sperling et al. 2011). Using VNS, the results showed an intensification of two tastes: sweet and bitter. Remembering that the "bitter reflex" also stimulates the vagus nerve, which communicates responses from the tongue to the gut, we can apply this information in consideration of herbs that may therapeutically benefit people with depression, especially gut-based depression.

In consideration of epigenetics, we know that different gene expressions found in different taster groups helps predict taster perception, dietary preference, and risk of obesity. As herbalists we know that diet, lifestyle, and herbal protocols can all have very beneficial and positive effects on one's health. While more research is needed to support this idea, my belief is that by reregulating digestive health with healthy lifestyle choices, diet, and herbs, especially bitters, it may be possible to turn on and off different gene expressions significant to a healthy wellbeing.

New research also gives us some tools to consider integrating in the clinical setting. What signs and clues can we gather from how strongly a person responds to a bitter cup of herbal tea? Can we notice any new patterns in papillae when using tongue diagnosis? How might one's bitter reflex and salivation differ from another person who is less sensitive to the bitter taste? While discussing dietary suggestions for a client, understanding taste sensitivity can help to more effectively customize their needs. On this point it is also worth reflecting on how the Tridosha system in Ayurvedic medicine provides a framework for Vata, Pitta, and Kapha balancing diets. Each diet suggests very specific ratios of sweet, sour, astringent, salty, pungent, and bitter foods and spices that are then adapted to a person's *prakruti*, or constitutional nature. At the

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same time, the taste ratios in the modern American diet are far out of balance and deserve some challenge, meaning more bitter tasting foods in the diet, in order to bring about balance.

As our culture and tongues continue to readjust and relearn this taste, we all might benefit from reading herbalist Jim McDonald's wonderful piece on bitters called *Blessed Bitters* (2010) which reminds us that, "Although initially an unfamiliar taste you may feel an aversion to, you'll probably find that the body quickly recognizes the essential nature of bitters. After using them a bit, the brain registers that the body is reacting to them in an 'Oh, finally' manner. Once we feel them satiate a craving we've long nursed and tried unsuccessfully to fill with something else, it clicks." May we all find balance as we journey together reclaiming these traditions. And if all else fails, don't forget about the dip.

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