Appetite 117 (2017) 186–190

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Sensory properties of chile pepper heat – and its importance to food quality and cultural preference

Ivette Guzmán*, Paul W. Bosland

Chile Pepper Institute, Department of Plant & Environmental Sciences, College of Agricultural, Consumer, and Environmental Sciences, New Mexico State University, 945 College Drive, Las Cruces, 88003, NM, USA

ARTICLE INFO

Article history:
Received 30 December 2016
Received in revised form
29 May 2017
Accepted 25 June 2017
Available online 27 June 2017

Keywords:
Capsicum
Chile pepper
Capsaicinoids
Descriptive terminology
Heat attributes

ABSTRACT

Chile peppers are one of the most important vegetable and spice crops in the world. They contain capsaicinoids that are responsible for the characteristic burning (pungency) sensation. Currently, there are 22 known naturally occurring capsaicinoids that can cause the heat sensation when consumed. Each produces a different heat sensation effect in the mouth. A need exists for a standard and new terminology to describe the complex heat sensation one feels when eating a chile pepper.

A comprehensive set of descriptors to describe the sensory characteristics of chile pepper heat was developed. It was validated with trained panelists tasting samples representing the five domesticated species and 14 pod-types within these species. Five key attributes that define and reference a lexicon for describing the heat sensation of chile peppers were determined to describe the heat sensation in any product, and importantly, can be used in the food industry worldwide.

1. Introduction

Chile peppers (*Capsicum* species) are one of the first crops domesticated in the Western Hemisphere about 10,000 BCE (Perry et al., 2007). In fact, the *Capsicum* genus was so important to mammals (humans) that when they came into contact with it, five different *Capsicum* species in separate regions of the Americas were independently domesticated (Bosland & Votava, 2012). One possible reason for such an early domestication is chile peppers were used as medicinal plants by indigenous peoples (Cichewicz & Thorpe, 1996). In 2014, a review by Omolo et al. found that chile pepper extracts exhibit anti-microbial properties. Capsaicinoids, naturally occurring alkaloids found only in *Capsicum* species, are the most probable reason for the early adoption as a medicinal plant and have been traditionally used to relieve pain. Recently, a review compiled research indicating that daily capsaicinoid consumption could influence weight management and may be used as natural weight-loss aids (Whiting & Derbyshire, 2014). In addition, some chile pepper varieties have high amounts of provitamin A, vitamin C, and folate, which may influence overall health and perhaps increase longevity (Chopin & Littenberg, 2017; Kantar et al., 2016).

Capsaicinoids give the sensation of hotness or heat when consumed by humans. Due to their heat characteristics, chile peppers are a food ingredient that is popular in Latin American, African, and Asian cuisines, while becoming increasingly important to the U.S. and European food industries. In fact, Asian culture has considered the heat sensation produced by chile peppers as one of the six main taste sensations, along with bitter, sweet, sour, salty, and umami (McQuaid, 2015). Sensations from capsaicinoids are important in our appreciation of ethnic cuisines as a whole. It is well known that some cuisines call for the use of specific chile peppers to season a dish to acquire an authentic taste (Zewdie & Bosland, 2001). The diversity of chile heat profiles goes beyond a "prickle and burn" sensation, and are reflected in unique traditional recipes developed over time on every continent. The spice trade greatly influenced what chile peppers would become predominate within a region.

Even though chile pepper heat is well known in general, a more organized and detailed vocabulary is needed to describe the complex nature of this sensory experience. A multifaceted terminology for the chile pepper heat sensation allows for a more systematic and qualitative approach to characterizing sensory attributes of capsaicinoids. The descriptors also establish a consistent way to describe a chile pepper's heat attributes. Such information is invaluable to food manufacturers contemplating using chile peppers as an ingredient in their products, and targeting a specific

* Corresponding author.
E-mail address: ivguzman@nmsu.edu (I. Guzmán).

http://dx.doi.org/10.1016/j.appet.2017.06.026

ethnic food. This new tool of descriptors provides a basis for understanding the differences in unique heat sensations among species and varieties of chile peppers.

Capsaicinoids give the sensation of hotness or heat when consumed by mammals (humans). The heat level of a chile pepper can be determined using chemical, instrumental, or sensorial methods (Wall & Bosland, 1998, pp. 347–373). The Scoville Organoleptic Heat test is a subjective measure of chile pepper heat using human tasters (Scoville, 1912). Today, the most reliable, rapid, and efficient method to identify and quantify capsaicinoids is high-performance liquid chromatography (HPLC); the results of which can be converted to Scoville Heat Units by multiplying the parts-per-million by 16. (Collins, Wasmund, & Bosland, 1995). However, it is not only the quantity of capsaicinoids, but the assemblage of the capsaicinoid mixtures that define a chile peppers quality in a cultural setting, and subsequently its use in a food product.

Capsaicinoids are not sensed by our taste buds per se. Heat sensation from capsaicinoids results from irritation of the transient receptor potential channel TRPV1, which contains a vanilloid binding site capable of interacting with capsaicinoids (Julius, 2013). TRPV1 are heat and pain receptors most commonly located in the mouth and throat and are positioned on the peripheral terminals of nociceptive neurons. However, TRPV1 receptors can also be found in the human stomach (Holzer, 2011). Receptor occupancy triggers cation influx, action potential firing, and the consequent burning sensation associated with chile peppers (Caterina et al., 2000). Even at dilutions down to 6 parts-per-million, a sensation of warmth can be detected (Jurenitsch, 1981).

It has been shown organoleptically that humans not only note intensity of heat level, but perceive each capsaicinoid differently (Krajewska & Powers, 1988). The investigations of Krajewska and Powers (1988) revealed that nordihydrocapsaicin was the "least irritating," and the burning was located in the front of the mouth and palate. It caused a "mellow warming effect." The heat sensation developed immediately after swallowing and receded rapidly. In comparison, capsaicin and dihydrocapsaicin were more "irritating," and were described as having a "typical" heat sensation. Both compounds produced the heat in the mid-mouth and mid-palate as well as the throat and the back of the tongue. In contrast, homodihydrocapsaicin was very "irritating, harsh and very sharp." The heat did not develop immediately and it affected the throat, back of the tongue, and the palate for a prolonged period. The heat sensation can last up to 12 h after ingestion (personal observation). Studies have measured burn magnitude of various capsaicin concentrations, indicating an increase and a plateau in burn sensation measured in minutes (McBurney, Balaban, Christopher, & Harvey, 1997; McBurney, Balaban, Popp, & Rosenkranz, 2001). Different combinations of these capsaicinoids produce the different heat characteristics of individual chile pepper varieties known as a heat profile (CPI, 2011).

Even though chile pepper heat is well known, it is mostly known only as a burn whose magnitude and intensity are measured (Cliff & Heymann, 1992). No descriptive vocabulary or lexicon exists to describe the complex nature of this sensory experience. A standardized vocabulary that objectively describes the sensory properties of a consumer product and facilitate communication across diverse audiences is useful. Examples of published descriptive vocabularies exist for apple juice, honey, pomegranate juice, French cheese to name a few (Cliff, Wall, Edwards, & King, 2000; Galán-Soldevilla, Ruiz-Peréz-Cacho, Serrano Jimenéz, Jodral Villarejo, & Bentabol Manzanares, 2005; Koppel & Chambers, 2010; Rétiveau, Chambers, & Esteve, 2005).

The heat sensory lexicon described here will be welcomed by food scientists in product development and plant breeders developing new cultivars. In addition, the need for a descriptive vocabulary for the complex chile pepper heat is needed because many cultures demand a specific heat profile for the chile pepper product to be considered a "quality" product according to their culinary preferences. Studies have shown that personality and cultural factors may affect the liking of the burn intensity in spicy foods (Byrnes & Hayes, 2013; Nolden & Hayes, 2017). Published data indicates that taste perception and eating habits are related to population, genetics and culture (Risso et al., 2017). Therefore, according to personal or cultural preference, alternative heat profiles may be considered to be associated with an inferior product. For example, Asian consumers prefer a "sharp" heat in their chile peppers, while the New Mexican pod-type, a favorite chile pepper for the southwestern U.S., has mostly a "flat" heat.

The popularity of chile peppers necessitates a specific vocabulary to describe the heat sensation. It is evident that a complex sensory sensation like chile pepper heat needs a specific descriptive language to provide more information about how different chile peppers produce their heat response when consumed. The purpose of this paper is to describe a set of terminologies for the heat sensory properties of specific types of chile peppers when consumed.

2. Material and methods

2.1. Chile pepper samples

A total of 41 varieties of chile peppers were harvested in 2014 from the Chile Pepper Institute Teaching Garden that is located at the Fabian Garcia Science Center in Las Cruces, NM, and has been an integral part of the Institute's teaching program for 25 years. All seeds were sourced from the Chile Pepper Institute at New Mexico State University in Las Cruces, NM. The Chile Pepper Institute Teaching Garden grows more than 150 different varieties of chile peppers, including all the domesticated species of *Capsicum*, i.e., *C. annuum*, *C. baccatum*, *C. chinense*, *C. frutescens*, and *C. pubescens*. Fruit samples were prepared from all five domesticated species, and from 14 different pod-types within the species (Fig. 1). A pod-type is a cultivated variety that is distinguishable mostly by a characteristic pod shape, but can also be differentiated by culinary use. These subspecific categories are used by the chile pepper industry to aid in supplying the correct chile pepper for the proper product. From an industry and a plant breeder's point of view the differences in heat profiles among the pod types has great significance.

2.2. Sensory analysis

All of the fruit samples were served at room temperature. A random sample of six fruits from different plants of each variety were harvested at the maturity stage associated with consumption. For example, *C. annuum* jalapeno fruits were harvested at the green mature stage, while *C. pubescens* (manzano) fruits were harvested at the red ripe stage. Fruits were diced into small pieces. Each panelist used a 3-inch lightweight plastic taster spoon to sample the diced fruits. Only one chile pepper variety was evaluated during each session in order to reduce the carryover effect of the capsaicinoids. All samples were evaluated at least three times on different days. Multiple servings of the sample could be served during the tasting period. Additional tastes were available if the panelists requested it. Once the panelist had determined the heat profile, it was recorded.

The descriptive terminology for this lexicon was developed over 15 years. A consensus profile method developed the lexicon because new attributes could be easily added, defined, and referenced when they arose in the chile pepper tasting. After a