

It's Hot in Hawai'i: Capsaicin Content of Hawaii-grown Chili Peppers

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Introduction

Hot peppers (*Capsicum* spp.) are an important, high value commodity that are grown worldwide (Valenzuela, 2011). The three species of greatest importance are *C. annuum* (e.g. Jalapeno), *C. chinense* (e.g. Habanero) and *C. frutescens* (e.g. Tabasco). Pungency is the most notable characteristic of hot peppers, but other flavor characteristics as well as color and fruit shape are also important in consumer acceptance and marketing. Peppers are grouped by type based on these characteristics. Some common pepper types include:

- ▶ **Hawaiian:** This pepper is common in the backyards of Hawai'i. Plants are generally tall and long-lived, with small, bullet shaped fruits that ripen to a bright red and are very hot. Species: *C. frutescens*; also identified as *C. annuum* var. *glabriusculum*
- ▶ **Thai:** These peppers, also very popular in Hawai'i, are longer, thinner, and slightly less pungent than "Hawaiian" types, although they are still very hot. Frequently red, but ripe fruit may also be orange or yellow. Species: *C. annuum*.
- ▶ **Habañero/Scotch Bonnet:** This group of peppers represents some of the hottest available. In addition to being wickedly hot, they have a unique smoky floral aroma. "True" Habañeros are lantern shaped and orange in color, while "true" Scotch Bonnets are similar to habaños in color, but are flattened with a depressed base. However, the tremendous popularity of these peppers among gardeners and breeders has resulted in a plethora of shapes and colors. Species: *C. chinense*.
- ▶ **Other *C. Chinense*:** Often touted as the world's hottest, these peppers including 'Datil' and 'Ghost' are similar in flavor to Habañero, but the fruit have a distinctive elongated point or other variations in shape. Species: *C. chinense*.
- ▶ **Jalapeño:** Probably the best known pepper group, these chiles were named after the Mexican town of Jalapa. Jalapeños are broad shouldered fruits with blunt ends that ripen to red, but are normally consumed green and have mild to high heat, depending on the variety. Smoked, they are known as Chipotle. Species: *C. annuum*.
- ▶ **Serrano:** These peppers are the most widely used fresh chile in the Southwest U.S. and Mexico. These very hot chiles look like a slimmed-down version of Jalapeño. Species: *C. annuum*.



Diversity in *C. chinense*

- ▶ **Wax:** These chiles are most commonly used in the immature stage, when they are yellow. They are popular for pickling. Peppers in this group may be sweet to very pungent. Species: *C. annuum*.
- ▶ **Cayenne/Chili:** *C. annuum*. These elongated peppers may be slender or somewhat conical, are red when ripe and are commercially grown for powder. In Hawai'i, mild cayennes are consumed green and can be found in Asian markets.

The pungency of chile peppers is determined by the concentrations of capsaicin and similar compounds in the fruit. Capsaicin content is controlled by genetics and the environment. This means that cultivars can differ dramatically in "heat." It also means that pungency in the same cultivar can vary significantly from year to year and location to location. Some hot pepper cultivars have been selected for very low pungency, which has several benefits. For example mild habañero cultivars, such as those developed by Texas A&M, allows people sensitive to pungency to eat these uniquely flavored peppers. Mild peppers also allow salsa makers and other processors to tightly control pungency by adding pre-measured amounts of capsaicin to pepper products to create "Mild" "Medium" and "Hot" products consistently. Pepper pungency is often presented as "Scoville Heat Units" (SHU). In the Scoville method, pepper extract is diluted until the heat is no longer detectable by tasting. Although direct analysis of capsaicin content via high performance liquid chromatography (HPLC) is preferred, many people are more familiar with the Scoville scale, and it is still commonly used.

Measuring Pungency in Hawaii-grown Chili

In Hawaii, efforts to market locally grown fresh peppers and products derived from them are hindered by a lack of knowledge of the actual concentrations of capsaicin in the chili peppers grown here. In 2009, replicated trials (randomized complete block design, 3 reps) were established at UH Research Stations in Ho'olehua (Moloka'i) and Waimānalo (O'ahu) to improve our understanding of pungency in Hawai'i-grown peppers. A primary objective of this research was to measure the variation in capsaicin concentration among 14 commercial cultivars of chili peppers grown at two locations in Hawai'i (Table 1).



Waialua pepper

The focus was on 3 general types/groups of peppers:

1. Jalapeño
2. Habañero
3. Small-fruited peppers including Hawaiian and Thai types

Peppers were planted in June (O'ahu) and July (Moloka'i) of 2009. Plants were fertilized and irrigated as needed for optimal plant growth. Peppers were harvested at mature green stage

Table 1. Cultivars evaluated for pungency in Hawai'i in 2009.

Type	Species	Cultivar	Description	Estimated days to harvest	*Seed Source
Hawaiian	<i>C. frutescens</i>	'Hawaiian'	Classic Hawaiian type chili with relatively large fruit.	120	ADSC
		'Firecracker'	Very similar to 'Hawaiian', but with slightly smaller and more pointed fruits.	130	ECHO
Thai	<i>C. annuum</i>	'Orange Thai'	Thin, tapered fruits ripen to orange. Classic Thai type.	75	SSE
Other small fruited	<i>C. annuum</i>	'Super Chili'	Short, spreading plants, heavy yielder, peppers are larger and more conical than Hawaiian type.	60	JSS
		'Rooster Spur'	Well sized elongated fruits most resembles 'Hawaiian' among the small fruited peppers	65	SSE
		'Thai Hot'	Tiny bullet shaped fruit uncharacteristic of Thai types. Very ornamental.	60	SSE
		'Indian Hot'	Long Thai type. Good drying pepper, dark red.	75	TAMU
Jalapeno	<i>C. annuum</i>	TAM Jalapeño-2'	Hot, cylindrical green fruits ripen to red.	70	TAMU
		'Waialua'	Spicy, light green fruits, similar to jalapeno. Fruity aroma.	75	ADSC
		Mild Jalapeño-2'	Mild version of 'TAM Jalapeno-2.'	75	TAMU
Habanero	<i>C. chinense</i>	'Caribbean Red'	Very spicy. Lime green ripening to glossy red fruits.	90	SSE
		TAM Habañero'	Large, orange, slightly wrinkled fruits.	85	TAMU
		'Peto Orange'	Similar to TAM Habanero, smooth fruits, slightly later maturation.	90	TAMU
		Mild Habañero'	Yellow fruits. Strong Habanero flavor with low heat.	85	TAMU

*ADSC = University of Hawaii Seed Program www2.ctahr.edu/seed, 808-956-7890; JSS = Johnny's Selected Seeds, www.johnnyseeds.com, 877-564-6697; SSE = Seed Savers Exchange, www.seedsavers.org, 563-382-5990; TAMU = Texas A & M Pepper Breeding Program, k-crosby@tamu.edu.

for the Jalapeño cultivars and full color ripe for the remaining pepper cultivars. Peppers were oven dried and ground before being shipped to the Vegetable and Fruit Improvement Center, Texas A&M University. Total capsaicinoids were extracted in 100% methanol, then injected into an HPLC with a liquid phase of 45% acetonitrile, 0.5% phosphoric acid and distilled water (Collins, et al., 1995). Capsaicinoid concentrations were converted to Scoville units by multiplying by 16 (Collins, et al., 1995).

Some Like It Hot!

The pepper cultivars varied widely in their capsaicin content. Deer damage on Moloka'i prevented analysis of approximately half of the varieties. The 7 varieties analyzed from both locations were similar in pungency, with slightly but significantly higher values (7%)

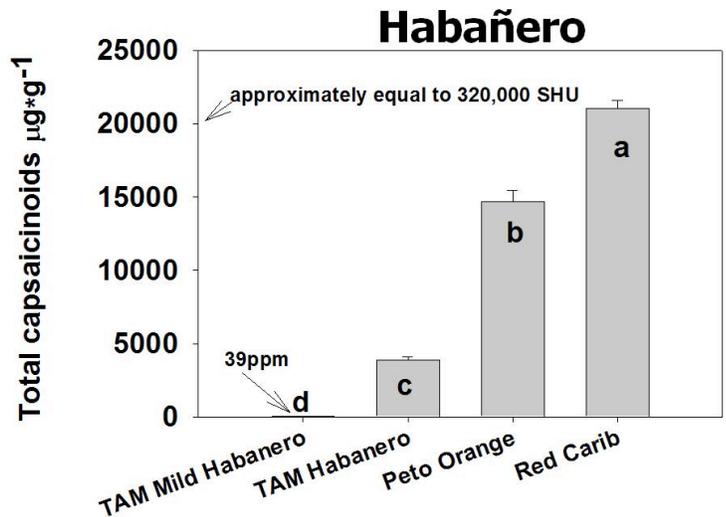
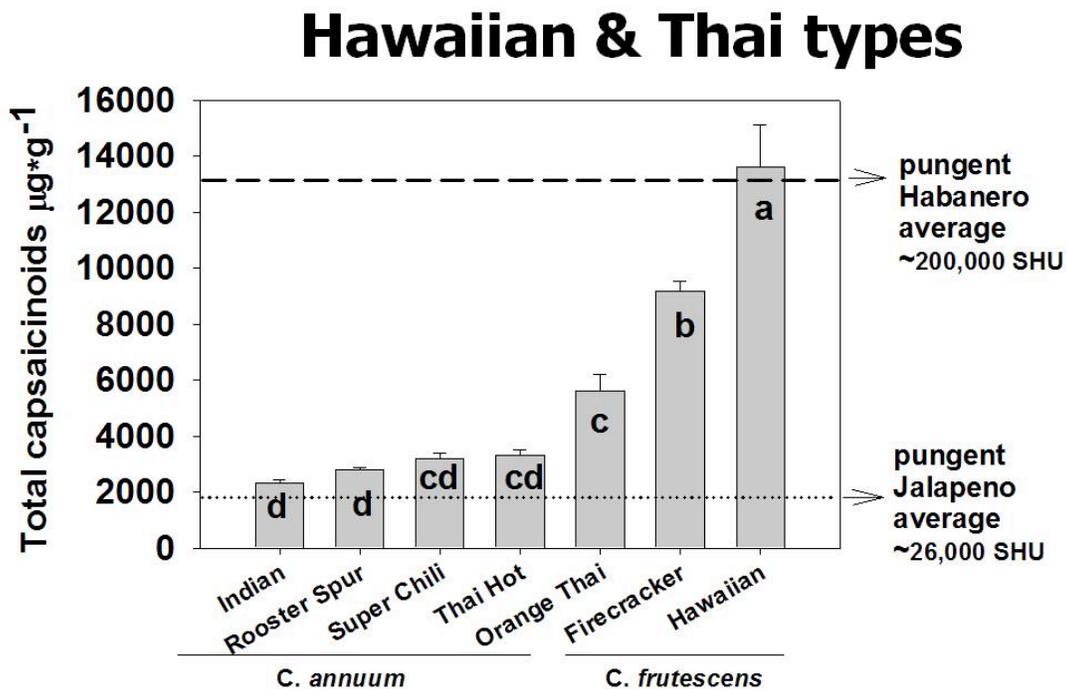


Figure 1. Capsaicinoid concentrations of Habanero (*C. chinense*) fruits grown in 2009 at the Waimanalo Research Station. SHU = Scoville heat units. Values are means of three analyses (10 fruit per analyses), bars represent standard errors. Means with the same letter are not different from each other (LSD, $\alpha = 0.05$).

Figure 2. Capsaicinoid concentrations of *C. annuum* and *C. frutescens* fruits in 2009 at the Waimānalo Research Station. SHU = Scoville heat units. Values are means of three analyses (10 fruit per analyses), bars represent standard errors. Means with the same letter are not different from each other (LSD, $\alpha = 0.05$).



measured in Waimānalo. The lack of large differences between the two sites is attributed to fairly mild climate conditions and ample irrigation that exceeded estimated crop needs at both locations. As expected, pungency was greater in the habañeros (~4,000-21,000 ppm, Figure 1) followed by the small fruited peppers (~2,000-14,000 ppm, Figure 2) and then the jalapeños (1,400-1,750 ppm, Figure 3). These ranges exclude the varieties developed for low pungency; pungency in the mild habañero was barely detectable (35 ppm, Fig. 1) and the mild jalapeño contained <500 ppm (Fig. 3). Of the small-fruited peppers, 'Hawaiian' 'Firecracker' and 'Orange Thai' distinguished themselves as the hottest. It is worth noting that 'Hawaiian' was as hot as the average habañero values, or ~200,00 Scoville Heat Units. The take home message is that opportunity exists to match capsaicinoid concentrations with agronomic and sensory traits to create and expand niche markets for small growers in Hawai'i and elsewhere.

References and Resources

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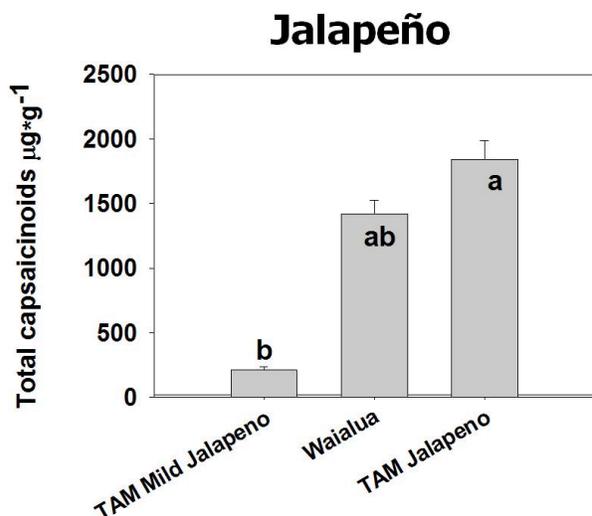


Figure 3. Capsaicinoid concentrations of Jalapeño type *C. annuum* fruits grown in 2009 at the Waimanalo Research Station. SHU = Scoville heat units. Values are means of three analyses (10 fruit per analyses), bars represent standard errors. Means with the same letter are not different from each other (LSD, $\alpha = 0.05$).



Traditional pepper sauces (top, arrow) are being commercialized (below) using imported peppers, and without adequate knowledge of pepper quality or consumer acceptance.

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