

# Spicy In Means Spicy Out: Capsaicin-Associated Anal Burn (CAAB) in Three US Metropolitan Populations, a New Proposed Classification System

## Abstract

Capsaicin Associated Anal Burn (CAAB) haunts nearly 2/3 Americans 2-3 times annually. This results in considerable discomfort and public health burden, and is especially of importance in patients with irritable bowel syndrome, which may comprise up to 25% of the adult population. Traditionally, capsaicin levels of input foods are classified using the Scoville scale, whereby an organoleptic test was used to assess Scoville Units. However, with advances in technology, use of HPLC to identify the concentration of capsaicin in food is converted to Scoville Units as a function of dry mass. Specifically, 1 part per million (ppm) capsaicin translates to one American Spice Trade Association (ASTA) unit or about 15 Scoville Units. Although this evaluation is accurate for oral sensations, anal sensations have been documented to be quite different based on multiple factors, including stomach pH, overall nerve desensitization, height, weight, and salsa preference. This is important as anal burn has been shown to be considerably discomforting, causing serious morbidity in IBS patients, and affect consumer buying habits. Specifically, those over 30-40 years of age are significantly more likely to alter buying purchases to avoid anal burn. We used both biochemical assay and epidemiological data of oral surveys from over 1,500 consumers in three metropolitan areas representing a wide degree of spicy food consumption (New York City-spicy population; Indianapolis-weak population; and Seattle-intermediate population) to convert ASTA units to Fun Kee Units (FuKUs). We then utilized this algorithm to assign FuKU scores to three differently spiced versions of the same salsa and fed them to 11 undergraduates. Based on survey data, FuKUs directly correlated ( $R^2=0.987$ ) with anal burn sensation scores. In summary, our work trailblazes a classification structure for the underexplored area of anal burn evaluation, which has both clinical and economical importance.

**Keywords:** Capsaicin; Anal burn; Irritable bowel syndrome; Scoville units; Visceral hypersensitivity

**Abbreviations:** CAAB: Capsaicin Associated Anal Burn; ASTA: American Spice Trade Association; IBS: Irritable Bowel Syndrome

## Introduction

Irritable bowel syndrome (IBS) is one of the most diagnosed diseases by gastroenterologists worldwide, affecting potentially up to 25% of adults, causing increased morbidity and risk [1,2]. One of the significant pathophysiology of IBS is visceral hypersensitivity, which has been known to have both mechanical and chemical causes. Because postprandial gastrointestinal symptoms have been reported to develop in a significant number of patients following consumption of spicy food, Gonlachanvit et al. [2]. conducted a randomized, crossover study feeding subjects with and without IBS subjects and found that IBS patients were significantly more likely to exhibit hypersensitivity when chili, both in pill form and in food form, was consumed [2]. This observation has been further supported by recent mechanistic studies involving capsaicin, the active component of chilies. Akbar et al. [3] performed rectosigmoid biopsies of 23 IBS patients in addition to 22 controls and found a 3.5-fold increase in the median number of TRPV1-expressing (the capsaicin receptor) nerve fibers

in IBS patients compared to non-IBS controls. Although study has been done focusing on direct rectal application of capsaicin in IBS patients [4], a regularized system for understanding its effects of oral capsaicin consumption on visceral hypersensitivity, in both IBS and non-IBS patients, has not been performed.

Traditionally, the Scoville scale was developed based on an organoleptic test, which was prone to variation and issues with repeatability. The American Spice Trade Association (ASTA), then developed a scale based upon the Scoville unit scale that focused on strict chemical definition of units based on the parts per million of capsaicin present in a sample when analyzed by high performance liquid chromatography, called ASTA pungency units. However, both of these analyses focus on oral sensations related to capsaicin and not visceral. Therefore, the purpose of this study was to develop and propose a scale that converts the ASTA scale to capsaicin associated anal burn (CAAB) units employing both biochemical and epidemiological techniques. This new scale would be of significant importance to the gastroenterology and food science communities as it has both public health and economic implications.

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## Materials and Methods

### Subjects and sample data

We sent out surveys to nearly 3,000 people across three metropolitan areas with differing degrees of spicy food exposure: New York City (Burnin’ Hot), Seattle (Sweet N’ Spicy), and Indianapolis (Seriously man, those are just freakin’ BBQ Lays, why is your face red?!). Surveys contained questions related to demographics (sex, age, salsa preference, height, internet browser choice), food consumption (normal diet, how spicy food consumed is, how spicy common foods are perceived), and instances of CAAB resulting from consumption of foods. As the response rate for surveys is generally low, we hired Russian hackers to look at peoples’ Yelp search histories/reviews as well.

### Volunteer studies

Over 10ish undergraduate students doing poorly in FS 403: Food Analysis were told they could jump a whole grade by participating in the study, get free dinner, and are not allowed to tell anyone about it so that the author would not get scooped. Three different jars of the same brand of salsa were purchased and the ASTA pungency units measured for each using HPLC as previously described [5]. The salsas (mild, medium, and hot) were then provided as the students’ dinner and immediate oral burning sensation surveys were immediately completed, followed by homework surveys that were completed after passing the salsa. Sensations were rated on a 1 to 10 scale that was idiot-proof, and even had happy and sad faces in case the concept of numbers had still been too hazy for the volunteers.

### Data processing and statistical analysis

All completed survey and hacked data were manually put into Microsoft Excel by an indifferent summer student and surveys with inconsistent answers (i.e. not liking spicy food but then saying buffalo wings are their favorite food) were discarded. Analysis of Variance (ANOVA) with post-hoc Tukey test, linear

correlation, and graphics were performed and generated using JMP and Microsoft Excel/Paint, respectively.

## Results and Discussion

### Association between age and CAAB

Of those surveyed (Table 1), city significantly correlated ( $p < 0.05$ ) with consumption of spicy food. Age was significantly correlated ( $p < 0.05$ ) with frequent CAAB experience, as ages 30-100 were very significantly ( $p < 0.0001$ ) more likely to feel the anal burn. Ages < 30 years were more likely to seek capsaicin-associated foods and were chosen for feeding study because i.) There would be better sensitivity and distinction between oral and anal capsaicin-associated sensations, ii.) They were the easiest ones to get with me having to teach this frickin’ course this semester, and iii.) They would be cheaper to compensate (I mean, salsa as dinner? I remember those days. They didn’t call me ol’ ironsides for nothing’).

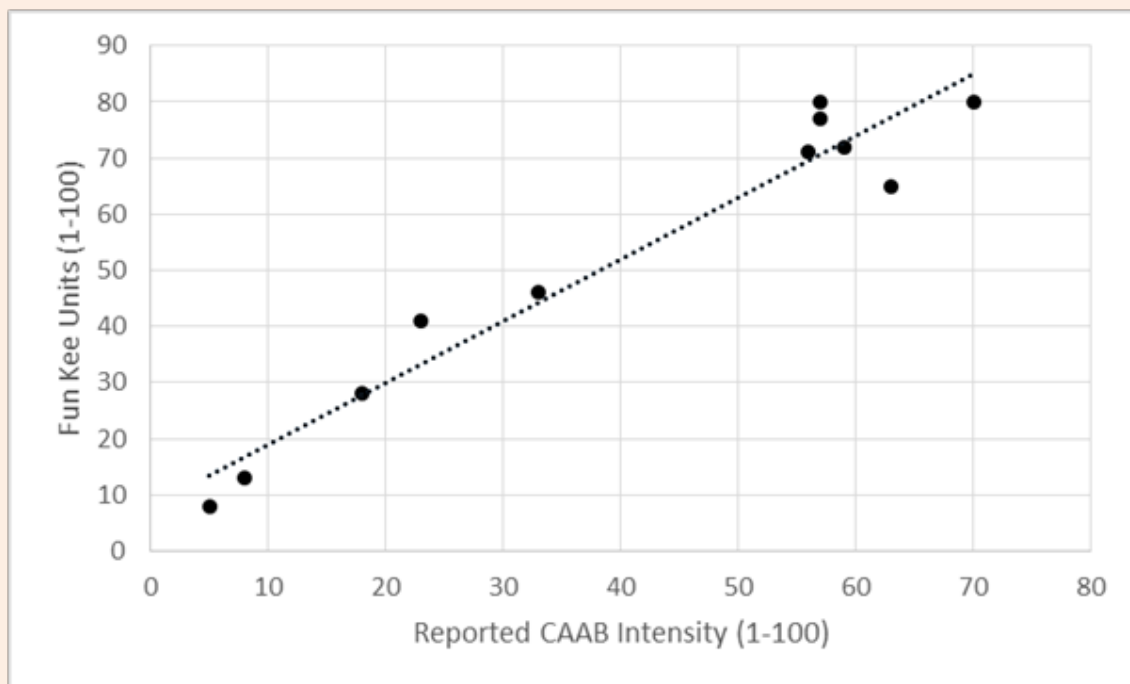
### Correlation of feeding study and creation of fun kee units

11 student volunteers participated, 6 of which were male and 5 of which were female. Input ASTA pungency units (5,000 for hot, 3,000 for medium, and 500 for mild) positively correlated with both oral burn ( $R^2=0.998$ ) and more loosely (no pun intended) with anal burn scores ( $R^2=0.765$ ). A new constant and equation based upon CAAB scores was then created and named after the author, these are too be called Fun Kee Units, or FuKUs (Figure 1). When correlation was then performed with the newly created FuKUs, a very positive association was observed ( $R^2=0.9987$ ). FuKUs also correlated when estimated FuKUs were overlaid with epidemiological correlation (data not shown). The conversion equation for calculating FuKUs is:

$$Y = 0.65x + 33; \text{ where } Y \text{ is the FuKU score and } x \text{ is the ASTA score.}$$

Table 1: Survey Response Demographics.

Subjects	Number NYC	Number Seattle	Number Indianapolis
Male	203	153	60
Female	170	142	78
Spicy Eaters	182	95	2
Moderate Eaters	125	139	85
No Spice Eaters	66	61	51
Frequent CAAB	70	63	41
18-30	126	114	37
30-50	113	105	29
50-75	82	45	69
75-100	52	31	3



**Figure 1:** Correlation of Generated Fun Kee Units to Reported CAAB intensity. Eleven volunteers were fed three salsas of differing capsaicin concentration and completed surveys regarding the degree of capsaicin-associated anal burn on a scale of 1-100, with 1 being no feeling and 100 being "butt rocket hot." The median CAAB score for each participant was then correlated with a developed Fun Kee Unit score based upon the equation  $Y=0.65x + 33$ .

In summary, the newly proposed system provides a means of classifying and bringing order to the wild world of capsaicin-associated anal burn. The next logical step would be to apply and test the correlation of FuKUs to the predominance of TRPV1-expressing nerve cells in the visceral tissue and further understand its behavior in patients with irritable bowel syndrome.

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