Would you like some PTC with your coffee?

Priscilla Samayoa PID: 2723652

Group 2

**Introduction**:

In every human one can find the sense of taste. The basic sense of taste consists of sweet, sour, bitter, salt, and umami. Each sense has its own group of genes and receptors. It is believed that the ability to taste bitter substances came about so that humans could better avoid foods with toxins in it, since most of the chemical properties in toxins can be recognized by these receptors. The TAS2R family is a group of receptors that code for bitterness. Phenylthiocarbamide (PTC) is a bitter compound, similar to the bitter glucosinolates that can be found in brassica vegetables that cannot be tasted by everyone (Gorovic, 2011). Tasting PTC has been found to be a Mendilian marker meaning it can be passed down from parent to offspring. The ability to PTC is inherited as a Mendelian dominant trait while non-tasting is a Mendelian recessive trait. That is to say that if two individuals were to mate and both were homozygous dominant, they would not yield any non-tasters. The only way for non-tasters to show up in a population is as an offspring of two non-tasters (which would mean there would be no offspring who have the trait of PTC tasting) or as an offspring to heterozygous parents, who would have a copy of the dominant and recessive allele (Guo, 2001). The ability to taste this compound has found itself the source of genetic and anthropological research for over 70 years (Kim, 2005).

There are however, other factors that come into play when talking about the ability to taste PTC, such as environmental factors (Genick, 2011). Because the bitterness of PTC is similar to the bitterness found in some vegetables, it was expected that some correlation would be seen between vegetable intake and the ability to taste PTC. There was however, no correlation, supporting the idea that other external factors were in play (Gorovic, 2011). Studies have been conducted to test if the ability of PTC may have some cultural relation. In one specific study it was found that 30-40% of European and American Caucasians and a small portion of Japanese and American Indian populations are all non-tasters. There has also been some evidence to support the idea that there is a correlation between PTC tasting and gender (Hon, 2005)

There are those individuals, the non-tasters, who may not be able to respond to the bitter stimulus at low concentrations, but well past the threshold, at a higher concentration, they will be able to respond. The threshold for PTC tasting is bimodal (Genick, 2011). The ability to taste PTC has also been proven have certain relations with dietary preference among individuals (Kim, 2005). The ability to taste the bitterness of PTC may cause for a preference for less bitter food choices (Genick, 2011). There are many bitter substance found in specific foods. It has been found that the sensitivity of PTC tasting is related to the sensitivity of tasting caffeine and the ability to taste PTC can predict sensitivity to caffeine and other bitter substances. Caffeine can be found in coffee among other places (Hall, 1975). If there is a relationship between caffeine and the ability to taste PTC, it makes sense that one should be able to take things a step further and state that even if other substances mask the caffeine, it should still have a relationship to PTC. The possibility of such a relationship with small concentrations of caffeine may then be too small in coffee to reach a threshold for bitterness of non-tasters if masked. This possibility should then be further researched. Because of the dietary preference difference between tasters and non-tasters, we expect to find a correlation between the ability to taste PTC and the individual takes their coffee.

**Method**:

Six small sample cups and one large sample cup were obtained from the laboratory. Three different concentrations of PTC (10-4M, 10-3M, 10-2M) were added to three of the small sample cups and three different samples of coffee which remained unknown to the subjects (espresso, coffee and milk, or a Cuban colada, which is basically coffee with a lot of sugar), were added to the remaining small cups. The large cup was used for rinsing purposes. Each subject was asked to taste sample A and write down whether or not they found it to be too bitter, whether they found it to their liking, etc.

They then rinsed the taste out of their mouth using the large cup and then took up sample B and tasted it. After tasting sample B, the subjects were asked to repeat the procedures for sample A. They repeated the rinsing after sample B and did the same with sample C. After tasting all coffee samples, subjects were asked to rate the samples on a bitterness scale from 1-5 (5 being the most bitter) and write which sample was most to their liking.

Because of the very unpleasant taste there was little to no bias as to how bitter PTC is, so there was no need to continue with the blind test for PTC tasting. Twenty-two students were used as test subjects and given *Table-1, Table-2* and *Table-3* to fill out. The subjects were asked to rate the samples on bitterness (1-5, 5 being most bitter) if they were tasters, or to simply write down the least bitter PTC rating (which is 1) after trying any sample if they were non-tasters. If they were non-tasters, but can taste the sample with the highest concentration, they were asked to rate the sample(s) they can taste. Along with the table they were asked to answer the questions found below *Table-3*. Results were transferred to *Table-4, Table-5,* and *Table-6*, found in the results section to better organize data.

***Table-1: Enjoyment of coffee (1 being lowest, 5 being the highest)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Student**  **Number** | **Sample 1 of Coffee** | **Sample 2 of Coffee** | **Sample 3 of Coffee** |
| 1 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |

***Table-2: How bitter was the coffee?***

***(1 being the lowest, 5 being the highest)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Student**  **Number** | **Sample 1 of Coffee** | **Sample 2 of Coffee** | **Sample 3 of Coffee** |
| 1 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |

***Table-3: Bitterness of PTC (1 being the lowest, 5 being the highest)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Student**  **Number** | **Sample 1 of PTC** | **Sample 2 of PTC** | **Sample 3 of PTC** |
| 1 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |

Usual coffee preference [if any at all]: (coffee you normally would drink):

How often do you drink coffee (example- every morning, only when studying, etc.)?

What time do you usually drink coffee (circle one)?

Never Morning Afternoon Evening Throughout the day

Reason for enjoying coffee? (taste, caffeine, other): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Results**:

***Table-4: Class data for Enjoyment of coffee***

|  |  |  |  |
| --- | --- | --- | --- |
| **Student**  **Number** | **Sample 1 of Coffee** | **Sample 2 of Coffee** | **Sample 3 of Coffee** |
| 1 | 1 2 3 4 **5** | 1 2 **3** 4 5 | **1**  2 3 4 5 |
| 2 | 1 2 3 **4** 5 | 1 **2** 3 4 5 | **1**  2 3 4 5 |
| 3 | 1 2 3 4 **5** | 1 2 **3** 4 5 | **1**  2 3 4 5 |
| 4 | 1 2 3 4 **5** | 1 2 3 4 **5** | 1 2 **3**  4 5 |
| 5 | 1 2  **3** 4 5 | 1 2 3 **4** 5 | **1** 2 3 4 5 |
| 6 | 1 2 3 4  **5** | 1 2 3 4  **5** | **1**  2 3 4 5 |
| 7 | 1 2 **3** 4 5 | 1 **2** 3 4 5 | **1** 2 3 4 5 |
| 8 | 1 **2** 3 4 5 | 1 2 **3** 4 5 | 1 2 3 **4** 5 |
| 9 | 1 2 3 4 **5** | 1 2 **3** 4 5 | **1** 2 3 4 5 |
| 10 | 1 2 3 **4** 5 | 1 2 **3** 4 5 | 1 2 **3** 4 5 |
| 11 | 1 2 3 4 **5** | 1 2 3  **4** 5 | **1**  2 3 4 5 |
| 12 | 1 2 3 4 **5** | 1 2 3 **4**  5 | **1**  2 3 4 5 |
| 13 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 14 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 15 | 1 2 3 4 **5** | 1 2 3 **4**  5 | **1** 2 3 4 5 |
| 16 | 1 2 **3** 4 5 | 1 2  **3** 4 5 | 1 2 **3** 4 5 |
| 17 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 18 | 1 2 **3** 4 5 | **1** 2 3 4 5 | **1**  2 3 4 5 |
| 19 | 1 2 3 4 **5** | 1 2 3 4  **5** | **1**  2 3 4 5 |
| 20 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 21 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 22 | 1 2 3 4 **5** | 1 2 **3** 4 5 | 1 **2** 3 4 5 |

***Table-5: Class data for bitterness of samples***

|  |  |  |  |
| --- | --- | --- | --- |
| **Student**  **Number** | **Sample 1 of Coffee** | **Sample 2 of Coffee** | **Sample 3 of Coffee** |
| 1 | **1** 2 3 4 5 | 1 2 **3** 4 5 | 1 2 3 4 **5** |
| 2 | 1 **2**  3 4 5 | 1 2 3 **4** 5 | 1 2 3 4 **5** |
| 3 | 1 **2** 3 4 5 | 1 2 3 **4** 5 | 1 2 **3** 4 5 |
| 4 | **1** 2 3 4 5 | **1** 2 3 4 5 | 1  **2** 3 4 5 |
| 5 | **1**  2 3 4 5 | 1 **2** 3 4 5 | **1** 2 3 4 5 |
| 6 | **1**  2 3 4 5 | **1** 2 3 4 5 | 1 2 **3** 4 5 |
| 7 | 1 2 **3** 4 5 | 1 2 3 **4** 5 | 1 2 3 4 **5** |
| 8 | 1 **2** 3 4 5 | 1 2 **3** 4 5 | 1 2 3 4 **5** |
| 9 | **1** 2 3 4 5 | 1 2 **3** 4 5 | 1 2 3 4 **5** |
| 10 | 1 2 **3** 4 5 | 1 2 3 **4**  5 | 1 2 3 4 **5** |
| 11 | **1** 2 3 4 5 | 1 **2** 3 4 5 | 1 2 3 4 **5** |
| 12 | **1** 2 3 4 5 | 1 2  **3** 4 5 | 1 2 3 4 **5** |
| 13 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 14 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 15 | **1** 2 3 4 5 | 1 2 **3** 4 5 | 1 2 3 **4** 5 |
| 16 | 1 2 **3** 4 5 | **1** 2 3 4 5 | 1 **2** 3 4 5 |
| 17 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 18 | **1** 2 3 4 5 | 1 2 3  **4** 5 | 1 2 3 4 **5** |
| 19 | **1**  2 3 4 5 | **1** 2 3 4 5 | 1 2 3 **4** 5 |
| 20 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 21 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 22 | **1** 2 3 4 5 | 1 2 **3** 4 5 | 1 2 3 **4**  5 |

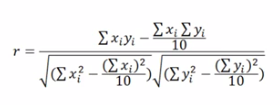
***Table-6: Class data for bitterness of PTC***

|  |  |  |  |
| --- | --- | --- | --- |
| **Student**  **Number** | **10-4M of PTC** | **10-3M of PTC** | **10-2M of PTC** |
| 1 | 1 2 **3** 4 5 | 1 2 3 4 **5** | 1 2 3 4 **5** |
| 2 | **1** 2 3 4 5 | **1** 2 3 4 5 | **1**  2 3 4 5 |
| 3 | 1 2 **3**  4 5 | 1 2 3 4 **5** | 1 2 3 4 **5** |
| 4 | **1** 2 3 4 5 | 1 **2** 3 4 5 | 1 2 **3** 4 5 |
| 5 | **1** 2 3 4 5 | 1 2 **3** 4 5 | 1 2 3 **4** 5 |
| 6 | **1** 2 3 4 5 | **1** 2 3 4 5 | **1** 2 3 4 5 |
| 7 | 1 2 **3** 4 5 | 1 2 3 **4**  5 | 1 2 3 4 **5** |
| 8 | 1 **2** 3 4 5 | 1 2 **3**  4 5 | 1 2 3 **4** 5 |
| 9 | **1** 2 3 4 5 | 1 2 3 **4** 5 | 1 2 3 4 **5** |
| 10 | 1 2 3 4 **5** | 1 2 3 4 **5** | 1 2 3 4 **5** |
| 11 | 1 2 3 4 **5** | 1 2 3 **4** 5 | 1 2 **3** 4 5 |
| 12 | **1** 2 3 4 5 | **1** 2 3 4 5 | 1 **2** 3 4 5 |
| 13 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 14 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 15 | 1 2 3 **4**  5 | 1 2 3 4 **5** | 1 2 3 4 **5** |
| 16 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 17 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 18 | 1 **2** 3 4 5 | 1 2 **3** 4 5 | 1 2 3 4 **5** |
| 19 | 1  **2** 3 4 5 | 1 2 3 4 **5** | 1 2 3 4 **5** |
| 20 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 21 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| 22 | **1**  2 3 4 5 | 1 **2** 3 4 5 | 1 2 3 **4** 5 |

The student 16 did not participate in the PTC tasting and thus 16’s information cannot be used since the whole purpose of this experiment has to do with Coffee and it’s correlation to PTC tasting.

The following equation to determine the correlation between PTC and Coffee samples:

***Equation 1:***



Instead of plugging in by hand, excel provided the following correlation coefficients to decrease error [gathered through the function =CORREL(array1,array2)]:

***Table-7: Correlation between PTC samples and favored coffee samples***

|  |  |
| --- | --- |
| *Correlation between favor of coffee sample 1 and 10-4M of PTC:* | 0.034284035 |
| *Correlation between favor of coffee sample 2 and 10-4M of PTC:* | -0.101035876 |
| *Correlation between favor of coffee sample 3 and 10-4M of PTC:* | 0.078731242 |
| *Correlation between favor of coffee sample 1 and 10-3M of PTC:* | -0.109557938 |
| *Correlation between favor of coffee sample 2 and 10-3M of PTC:* | -0.070873876 |
| *Correlation between favor of coffee sample 3 and 10-3M of PTC:* | -0.034188633 |
| *Correlation between favor of coffee sample 1 and 10-2M of PTC:* | -0.152445085 |
| *Correlation between favor of coffee sample 2 and 10-2M of PTC:* | -0.289522681 |
| *Correlation between favor of coffee sample 3 and 10-2M of PTC:* | 0.13892105 |

***Table-8: Correlation between PTC samples and bitterness of coffee samples***

|  |  |
| --- | --- |
| *Correlation between bitterness coffee sample 1 and 10-4M of PTC:* | 0.398434835 |
| *Correlation between bitterness coffee sample 2 and 10-4M of PTC:* | 0.282339674 |
| *Correlation between bitterness coffee sample 3 and 10-4M of PTC:* | 0.048001536 |
| *Correlation between bitterness coffee sample 1 and 10-3M of PTC:* | 0.227319371 |
| *Correlation between bitterness coffee sample 2 and 10-3M of PTC:* | 0.193163272 |
| *Correlation between bitterness coffee sample 3 and 10-3M of PTC:* | -0.067343503 |
| *Correlation between bitterness coffee sample 1 and 10-2M of PTC:* | 0.360326738 |
| *Correlation between bitterness coffee sample 2 and 10-2M of PTC:* | 0.524404424 |
| *Correlation between bitterness coffee sample 3 and 10-2M of PTC:* | 0.047431201 |

***Graph 1:***

***Graph 2:***

***Graph 3:***

***Graph 4:***

***Graph 5:***

***Graph 6:***

The histograms depict the relationship between each of the ratings given from *tables 1* through *table 3* for the subject’s as a whole, and how each subject’s ratings vary from one another from category to category. In this case they show that there is little to no correlation between the PTC ratings and the coffee bitterness ratings, as well as the fact that there is no correlation between PTC rating and coffee preference shown by these histograms. The correlation coefficient has proven to show that, even statistically, there is absolutely no correlation in the way that the PTC bitterness, the coffee bitterness, and the way each subject favors a specific coffee sample, vary from one another. Results are shown to be inconclusive.

**Discussion:**

The correlation coefficients show a strong correlation as the numbers approach 1. All the correlations between the favored coffee samples and the bitterness of PTC (*table-7*) were either negative or very low. The negative coefficients express an inverse relation, as the favor of one coffee sample increased, the PTC rating for bitterness would decrease. The rest of the values seen on *table-7* were close to 0, which means there is no real correlation to be found (McClave, 2008). This all suggests that there is an inverse relation between the two. Even in *graph 1-6* we see that rarely do any of the coffee samples match up with the PTC ratings that seem consistent among all test subjects. Without even taking into account at the correlation coefficients, by just glancing at the raw data, the lack of correlation is obvious. Our results do not allow for the rejection of the null hypothesis, that there is no correlation between PTC tasting and coffee preference.

The results prove contrary to the findings of previous research. People’s diets should change based on their ability to taste bitter substances, thus the bitter taste of caffeine should have been found bitter by those who can taste PTC and found barely bitter by those who can not taste PTC (Kim, 2005). Because of our previous research it is unexplainable why the relationship between the favored typed of coffee and the bitterness rating of PTC are shown to form inverse relationship.

There are, however, countless possibilities to explain any errors in this data. There could be human error, such as using the rating scale not as specified. It is possible that some of the test subjects did not really do the experiment as specified, some may have not rinsed between tastings, some may have taken a guess at the samples and this had a bias before even attempting the experiment. The fact that the experiment conducted by the test subjects happened without close monitoring allows all these things to be possible factors affecting the results. It is also possible that with a larger sample and more closely monitored experiment we would see results that reflect everything concluded in prior research.

The questionnaire part (found beneath *table-3*) of the research was not added because some of the test subjects did not complete it. Those who did gave few details and in those details the information was found to be inconclusive.

In the data there was even found to be a no correlation between the bitterness of each coffee sample and each of the PTC samples (*table-8*). That at least implies that the subjects were a not even consistent in their rating of bitterness. There still may have been similar errors in these results to those errors found in the results yielded by the correlation between the favored coffee samples and the PTC samples’ bitterness. In general the experiment must be re-examined and repeated after adjusting experimental procedures in order to yield more conclusive data.

Work Cited

Genick, U. K., Kutalik, Z., Ledda, M., Destito, M. C. S., Souza, M. M., Cirillo, C. A., . . . le Coutre, J. (2011). Sensitivity of genome-wide-association signals to phenotyping strategy: The PROP-TAS2R38 taste association as a benchmark. *PLoS One, 6*(11), Article.

Gorovic, N., Afzal, S., Tjonneland, A., Overvad, K., Vogel, U., Albrechtsen, C., & Poulsen, H. E. (2011). Genetic variation in the hTAS2R38 taste receptor and brassica vegetable intake. *Scandinavian Journal of Clinical and Laboratory Investigation, 71*(4), 274-279.

Guo, S., & Reed, D. R. (2001). The genetics of phenylthiocarbamide perception. *Annals of Human Biology, 28*(2), 111-142.

Hall, M. J. M., Bartoshuk, L. M. L., Cain, W. S. W., & Stevens, J. C. J. (1975). PTC taste blindness and the taste of caffeine.*Nature,253*(5491), 442-443.

Hong, J., Chung, J., Kim, Y., Chung, S., Lee, S., & Kho, H. (2005). The relationship between PTC taster status and taste thresholds in young adults. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics, 99*(6), 711-715.

Kim, U. K., & Drayna, D. (2005). Genetics of individual differences in bitter taste perception: Lessons from the PTC gene. *Clinical Genetics, 67*(4), 275-280.

McClave, J. (2008). *Statistics*. (11th ed.). Prentice Hall.