ABILITY OF STUDENTS IN FOOD AND NUTRITION RELATED FIELDS TO PERCEIVE PHENYLTHIOCARBAMIDE (PTC)

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To the Associate Vice President for Research and Dean of the Graduate School:

I am submitting herewith a thesis written by Monica Coulter entitled "Ability of Students in Food and Nutrition Related Fields to Perceive Phenylthiocarbamide (PTC)." I have examined this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science with a major in Nutrition.

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Dedication

To Kevin Walker for all his support and encouragement.

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Ability of Students in Food Related Fields
to Perceive Phenylthiocarbamide (PTC)

Monica Lee Coulter

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ABSTRACT

This study investigated the ability of students in food related fields to perceive bitterness in phenylthiocarbamide (PTC). The relationships between PTC taster status and related food preferences, participant's major, and the decision process when making food choices were also examined. The information was gathered by questionnaire.

Nutrition students were found to taste PTC at a level lower than the general population while the other majors found to taste at higher levels than would be expected.

The Mann Whitney U test, and Pearson's Product Moment Correlation Coefficients were performed. No PTC taster related hereditary predispositions toward liking or disliking of foods were found. Most students with high food preferences scores were PTC tasters. PTC tasters and non-tasters ranked taste significantly higher than nutrition in making food choice decisions.

PTC taster status played a less significant role than education and exposure in shaping the food preferences of these individual's.

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CHAPTER I

Introduction

What to some is food to others may be sharp poison." Lucretius, the Roman poet and philosopher may have died in 55 BC, but his sentiments hold true even today.

Individual food preferences depend upon variety of different factors. Perhaps most significant are the culturally determined attitudes and beliefs that include ethnicity, religion and availability of particular food items. Even within the same culture there is great diversity among individuals. There are complex interactions between factors – exposure, social valuation, income and education all play a role in food preferences. (Rozin & Vollmecke 1986).

Added to this increasingly involved scenario are biological differences that effectively relegate us to live in our own separate worlds of taste. (Bartoshuk 1980)

The chance discovery of phenylthiocarbamide (PTC) by Dr. A. L. Fox in 1931 was the start of what was to become the most thoroughly studied genetic trait involving taste. (Merrell 1975)

Extensive testing has determined that the population is bimodally distributed into tasters and non-tasters of bitter compounds such as PTC that contain the chemical structure Nitrogen-Carbon=Sulfur. While non-tasters is the popular term used in the literature, most individuals can actually taste these compounds, the difference is their much higher taste thresholds. (Blakeslee 1932; Reed 1995)

Taste thresholds tend to vary with gender, age and ethnicity. More individuals with European backgrounds are non-tasters. Relatively few people of Asians and African ancestry are non-tasters. Smoking tends to decrease sensitivity to bitterness. (Reed 1995)

Perception of taste is considered to have served an evolutionary purpose. Sweetness indicates a food high in calories. Salt signals the presence of necessary minerals. Sourness is thought to point out under-ripe fruit or potentially harmful acids and bitterness cautions on the presence of potential poisons.

Foods are generally made of complex mixtures of these different tastes, with few foods contributing only one single pure taste. Even the compounds that contribute the tastes are themselves varied. Numerous compounds contribute bitterness to foods. The PTC related compounds represent one specific type of bitterness.

A variety of commonly disliked foods, such as the cruciferous vegetables, contain PTC related bitter components. Taking this into account, research has been done to determine if perception of these particular compounds play a role in food preferences. Since these vegetables also happen to exhibit antithyroid properties, some believe that PTC taster status perhaps played a protective role in helping to determine what foods are accepted or rejected. (Drewnowski 1995; Anliker 1991)

Various studies have been conducted on the food preferences of PTC tasters and non-tasters. Subjects have included young children, monozygotic and dizygotic twins and family members. (Anliker et al 1991; Falciglia et al 1994; Glanville & Kaplan 1965)

Students planning careers in food and nutrition related fields will play influential roles in what foods the general population consumes. No studies are available on the ability of these students to perceive phenylthiocarbamide.

Purpose of the study

The purpose of this study was to investigate the ability of individuals seeking degrees in food and nutrition related fields (MS in nutrition, MS in food science, BA in hospitality management and AOS in the culinary arts) to perceive bitterness in phenylthiocarbamide (PTC). The research question is "What is the PTC taster status of students in food and nutrition related fields?"

The specific objectives of the study were:

1. What was the PTC taster status of the participants?
2. What was (were) the relationships between PTC taster status and food preferences of the participants for bitter, hot and other selected food substances?
3. Were there any relationships between PTC taster status and the participant's major?
4. Were there any relationships between PTC taster status and importance of nutritional properties and taste qualities when making food choices for the participants?

CHAPTER II

Literature Review

Food Preferences

The American Institute of Wine and Food's project, Resetting the American Table: Creating a New Alliance of Taste & Health declared as a core value that, "Taste is the first determinant of consumer food choices in America" (Callaway 1992). But what exactly determines what tastes good to Americans or to any one else?

Role of evolution

Evolution in part determines what tastes good to us. Four basic tastes allow us to perceive sweet, sour, salty and bitter. We are born with an innate preference for sweet tastes, which is an advantage in a natural environment where sweetness predicts nutritious foods. Our perception of sourness probably evolved to help us avoid under-ripe fruit or potentially harmful acids. The taste for salt was to direct us toward necessary minerals while the ability to detect bitterness helped us avoid poisons (Freedman 1993). Some would include a fifth, "umami" or savory taste as a guide to determine foods high in protein but there is no general consensus on this (Hahn 1996).

Importance of exposure

Humans are omnivores. Being able to eat a wide variety of foods has distinct advantages. Humans are able to survive and even thrive under diverse conditions. While we do have a few innate taste preferences, we largely decide what foods to consume on a trial and error basis. Before that experimental process can begin however, there has to be an opportunity for exposure. And indeed, the overwhelming determinant of our acceptance of a food source is our exposure to that food (Rozin 1990).

The forum for that presentation and familiarization is the society in which we live. Agricultural and economic availability, religious and philosophical beliefs, technological advancements, education, even occupational considerations play an immense role in food preferences. Indeed if only one question were allowed in determining as much as possible about a person's food preferences, "What is your culture or ethnic group?" would be the most telling (Rozin & Vollmecke 1986).

Individual differences

Even within the same society, there are individual differences. Experience, gender, health, age, social status, genetic makeup and even a thrill-seeking temperament help determine individual likes and dislikes (Rozin & Vollmecke 1986).

Aside from individual differences, the mechanism for determining food preferences, our sense of taste, works basically same in everyone.

Perception of flavor

Taste and flavor are used interchangeably from a culinary perspective but physiologically there are subtle differences between the two. The perception of flavor is a result of the combined perceptions of taste, smell and the trigeminal senses. While taste and smell are more familiar, the trigeminal senses may be less understood. These senses respond to the touch, temperature and pain sensations such as found in the crunch of celery, the cool, smoothness of premium vanilla ice cream and the heat from a jalapeno pepper. Even though these perceptions are not strictly sensations of taste, they do make a large impact on the overall impression of a food's flavor and in turn on our acceptance or rejection of particular foods.

Chemical senses

The senses of smell and taste are referred to as the chemical senses (chemosensory) since they allow us to interact directly on a molecular basis with our surroundings. Of these two senses, our sense of smell is far more acute than the sense of taste. Humans are thought to be capable of recognizing at least 10,000 distinct odors compared to only four or five different tastes. Most of what we perceive as the flavor of food is actually it's aroma (Freedman, 1993).

This information may make the sense of taste seem inferior to smell but rather they simply serve different (though intimately related) purposes. Smell conveys the all complexities, the numerous subtleties needed to give a rich and detailed portrait of a food. The sense of taste comes directly to the point – sweet, sour, salty, bitter – with all the subtlety of a security guard checking for identification.

Perception of taste

The organ for perceiving taste is primarily the tongue. Tiny bumps or papillae on the surface of the tongue, the oral cavity and the epiglottis contain gustatory or taste pores which open into onion-shaped taste buds.

Each papilla may have up to fifteen individual taste buds. Within each taste bud are 80 to 100 taste cells. Some of the taste cells stretch up out of the opening of the taste bud. The exposed tips of these cells channel saliva containing dissolved food molecules down into the taste bud.

Receptors embedded in these taste cells interact with food molecules to trigger a nerve impulse which is interpreted in the brain as a particular taste. The whole process takes about 200 to 500 milliseconds (IFIC 1995).

Salty and sour

Perception of saltiness and acidity (sour taste) are caused by the dissolution of electrolytes. An interaction between the cation and anion with the receptor sites triggers a message that is then sent for interpretation by the brain (Fennema 1996).

Sweet and bitter

Sweet and bitter tend to be more complex taste stimuli. They often come packaged together in nature which is why artificial sweeteners may taste bitter and intensely sweet to PTC tasters (Bartoshuk 1979; Bartoshuk 1990). Often relatively minor changes in the electronic configuration of a single atom can change sweet into bitter. Replacing the sulfur in phenylthiocarbamide (PTC) with an oxygen results in an intensely sweet compound, dulcin. α-D-Mannose is sweet, β-D Mannose is bitter. This indicates that the stereochemical configurations determine specific tastes, but the exact nature is not fully understood (Shallenberger 1993).

Taste thresholds

A taste threshold is the lowest concentration of a solution which can be distinguished from water (Glanville & Kaplan 1965). Sweet, sour, salty and bitter thresholds vary among individuals. There is a 3-fold variation in recognition of sweetness and an 80-fold variation in saltiness from sodium chloride. Hydrochloric acid sourness and quinine bitterness both have a 200-fold variation (Shallenberger 1993).

These differences in acuity may certainly play a role in the development of food preferences.

Genetics

History of Phenylthiocarbamice (PTC)

Another possible explanation for some individual differences in food preferences is the genetically determined ability to taste phenylthiocarbamide (PTC) and related compounds such as 6-*n*-propylthiouracil (PROP) that contain the chemical structure H-N-C=S. This genetic difference was discovered in 1931 by Dr. Arthur L. Fox, working in E. I. duPont deNemours laboratories in Wilmington, Delaware. Dr. Fox accidentally spilled a powdered thiourea compound while working in the lab. Dust particles floating in the air found their way into the mouths of some of his colleagues. Dr. Fox reported they found powder "bitter enough to make them go round sticking out their tongues and making wry faces for an hour" – while others exposed to the same thiourea crystals found them to be tasteless (Fox 1931).

Genotype

Moody (1975) declared that "it (PTC taster status) is probably the most easily demonstrated case of simple Mendelian inheritance we have in human genetics." More recent work suggests that the traditional theory of a single locus, two-allele model of PTC sensitivity does not provide the best fit with available data.

In one study based on 120 families with a total of 1152 members, a two-locus model in which one locus controlled PTC taste perception and another locus controlled more general taste acuity appeared to better coincide with study results (Drewnowski & Rock 1995). Bartoshuk (1993) even suggests that as many as five to ten bitter genes are at work to help us cope with the variety of chemicals that taste bitter.

While explanation of the exact nature of the genotype (genetic constitution) is still waiting to be resolved, much work has been done on the tangible properties (phenotype) associated with this genetic trait.

PTC tasters and non-tasters

Tasters and non-tasters of PTC related compounds differ quantitatively rather than absolutely in their abilities

(Fuller 1981). Shallenberger (1993) reports that the range in threshold for the PTC related compounds is 9000-fold. Thresholds for PTC tasters of 6-*n*-propylthiouracil are 1.0 x 10^{-4} mol/L and the non-taster's threshold was > 2.0 x 10^{-4} mol/L (Bartoshuk 1979). Pia (1981) explained the wide variation as the interaction of the genes in question with other genes that modify their expression. Non-tasters can be divided into two categories, one group with high thresholds for PTC compounds and another group with low sensitivity to a wide range of taste stimuli (Drewnowski & Rock 1995). Even for PTC tasters, thresholds are lower in childhood and rise with age. Sex hormones seem to be involved in some way as well. Women tend to have lower thresholds than men, and young women that are PTC tasters reach maturation an average of 3.8 months earlier than non-tasters (Fuller, 1981; Dresnowski & Rock 1995).

Racial differences

Population studies show that there is a wide racial variation in ability to taste PTC. Individuals with European ancestry are 25 to 35% non-tasters. The percentage of non-tasters is much lower (less than 15%) in those of

African or Asian descent (Moody 1975). Overall distribution is considered to be 25% non-tasters and 50% PTC tasters. The remaining 25% comprise a group of individuals that are unusually responsive to the compounds and are classified as PTC super-tasters (Bartoshuk 1993).

Increased sensitivity of PTC tasters

There are physiological differences in PTC super-tasters. They have been found to have about four times as many taste buds as non-tasters so the opportunity for their taste receptors sites to interact with taste molecules is greatly improved. The trigeminal senses are also associated with taste buds making PTC super-tasters more responsive to the oral burn of spices (Bartoshuk 1993).

Both PTC tasters and super-tasters show more sensitivity to a variety of compounds. These tasters perceive more bitterness from compounds that do not contain the PTC related compound with the structure of H-N-C=S. Caffeine, (Hall et al. 1975), potassium chloride (Bartoshuk et al. 1980) and saccharin are examples. Saccharin is also sweeter to PTC tasters (Bartoshuk 1979).

PTC and food preference

A number of common foods contain PTC related compounds. Turnips, spinach, broccoli, cauliflower and cabbage are examples (McKee 1990). Survey studies have shown that vegetables, particularly cruciferous vegetables are among the most disliked of all foods (Drewnowski & Rock 1995).

Numerous studies have been conducted investigating the genetic influence on food preferences. Drewnowski and Rock (1995) found that there was a significant correlation between high sensitivity to PROP and a preference for mild-tasting foods. Anliker et al. (1991) tested 34 children between the ages of five and seven. In acceptance of cheese, (calcium content is known to contribute bitterness), PTC tasters ranked cheese significantly lower in preference tests than non-tasters did. Falciglia and Norton (1994) detected a greater similarity in food preference between monozygotic twins than dizygotic twins which led them to conclude that there is an important role for genetics in accounting for individual food preferences. Studies by Glanville and Kaplan (1965) and Fisher et al. (1961) found that subjects with lower thresholds for PROP (higher sensitivity) tended to have more food aversions than those with higher thresholds.

Evolutionary advantage

The existence of genetic sensitivity to PTC related compounds was thought to provide an evolutionary advantage in the avoidance of bitter poisons. According to Garcia and Hankins (1975), one of the cardinal rules for survival in an unfamiliar or threatening environment is to avoid eating anything that tastes bitter. Even protozoan will reject food that has been treated to taste of quinine (Garcia & Hanks 1975).

PTC related compounds are found in cruciferous vegetables and while they are not exactly poisonous, they do have antithyroid properties. These compounds are also perceived as more bitter by PTC tasters. Interestingly, the incidence of adenomatous (benign tumor) goiter is higher among non-tasters than PTC tasters (Brown 1990). However, no supporting evidence indicates that the taster status mediates the development of goiter by influencing food selection (Mattes & Labov 1989).

Use of PTC and related compounds

A number of different methods have been used in studies to determine PTC taster status. Both PTC and PROP are frequently used, each having pros and cons.

The Harris and Kalmmus (1949) procedure is routinely used for determining detection thresholds. In a series of taste tests, subjects were asked to discriminate between plain water and solutions containing varying amounts of PTC or PROP (Lawless 1980). A number of variations of this basic test have been used but all are relatively time consuming and may involve ingesting as much as 200 mg of the compound. This method is less suitable for field work and there is some concern over toxicity when using PTC, despite over forty years of testing without a reported mishap. The lethal dose of PTC for rats (single, oral) is 40 mg/kg. The lethal dose of PROP for rats is 90 mg/kg administered subcutaneously and repeated over six weeks. Although since rats may be comparatively sensitive to thiourea-related compounds, the toxicity may be significantly lower in humans (Lawless 1980).

Filter paper impregnated with PTC or PROP is a method that is widely used in anthropological studies and in field work due to its relative ease. However this method may produce a high rate of false negatives and concentration levels may be not be consistent (Lawless 1980).

PROP is not considered as effective as PTC in determining taster status, but since it is used in the treatment of hypothyroidism, more is known about possible adverse reactions (Lawless 1980).

Propylthiouracil (PROP) is one of the most popular antithyroid drugs. The usual dosage is 50 to 100 mg three or four times a day (Goth 1981). Its half life is 1½ to 2 hours and it is excreted mainly through the urine. The drug works by "preventing the transformation of iodide to iodine and hence, blocks the incorporation of iodine into the precursors of thyroid hormones." The effects of the drugs can take up to two weeks to begin since the hormones are stored in the thyroid. Side effects can include, rash, nausea and diarrhea (Mutschler et al. 1995).

CHAPTER III

Methods

Subjects

One hundred and eighteen students in food related fields were given a questionnaire including PTC taste papers to determine their PTC taster status. The students were enrolled in Texas Woman's University in Denton and Houston, Texas; the University of North Texas in Denton, Texas; and The Culinary Institute of America in Hyde Park, New York during the spring of 1997. The questionnaires were given during scheduled classroom or laboratory activities by the regular instructors.

Questionnaire Overview

Questionnaire Package

The questionnaires were shipped via United Parcel Services to each of the participating instructors. Each package included a posted, addressed envelope for returning the questionnaires, an administration instruction sheet, the questionnaires (Appendix A), PTC information sheets for the students, and candy to alleviate any unpleasant bitter sensation remaining after tasting the PTC filter papers.

The administration instruction sheet (Appendix B) emphasized the need to insure the students that the exercise was completely voluntary and their choice to participate or not would in no way affect their grade. Step by step directions for administering the questionnaire were also included.

Format

The questionnaire was presented in a booklet format. Two sheets of 8½ by 11 inch paper were folded in half and stapled twice down the center to form a booklet measuring 4¼ by 5½ inches. The eight pages that resulted were printed both on front and back. This format prevents the possible loss of the last page of the questionnaire and encourages the respondents to look on the back of each page for questions, (Sudman & Bradburn 1983).

Cover letter and title

The back cover page of the booklet contained a letter introducing the purpose of the questionnaire. This cover letter also reiterated the voluntary nature of participation, requested that anyone on thyroid medication refrain from answering the questions or taking the PTC taste detection test and thanking the respondents in advance (Salant & Dillman 1994). The statement: "I understand that the return of my completed questionnaire constitutes my informed consent to act as a subject in this research." was also included.

The administration instruction sheet asked that the booklets be distributed to the students with this back page face up. The students were also instructed to read through the cover letter, then turn the booklet over to the front.

The back and front covers of the booklet were illustrated with appropriate line drawings of food (Gaber 1982) in an effort to capture the interest of the students. The illustrations also were intended to help alleviate any negative feelings that may contribute to test anxiety. The overall tone of the instrument was conversational using personal pronouns in an effort to establish a level of comfort and engender a willingness to participate fully, (Salant & Dillman 1994).

The title on the front cover was *Food Preferences of Nutrition, Food Science, Hospitality Management and Culinary*

Arts Students: Influence of Genetically Determined Threshold for Phenylthiocarbamide (PTC).

The specific majors were included in the title rather than the generic "food related fields" to foster a sense of connection with the students. Food preferences were mentioned first in the title to engage the interest of the students before possibly alienating them with the unfamiliar scientific term, phenylthiocarbamide.

A blue, 3/4 inch round, self adhesive label sealed each booklet until the student was ready to begin. This was in an effort to maintain the sanitary condition of the PTC and control taste papers.

Questionnaire Content

Food preference questions were asked first, next the taste detection test, then the demographics section and finally questions concerning attitudes toward nutrition and taste when making food choices. This order was chosen in an effort to establish a level of comfort for the respondents with the instrument before asking the more intrusive questions on taste detection, demographics and attitudes.

Each section was introduced by directions or a transitional phrase to prepare the respondents for what was expected, (Salant & Dillman 1994).

Choice of foods included

A list of the following twenty foods for preference ranking was developed based upon previous tests with tasters of PTC or related compounds:

Anchovies
Beer
Black Coffee
Broccoli
Brussels sprouts
Buttermilk
Cabbage
Cheddar cheese
Cottage cheese
Diet soft drinks
Grapefruit juice
Green beans
Horseradish
Jalapeno peppers
Kale
Salami
Spinach
Strawberries
Turnips
Wheat bread

Foods were also chosen with attention given to creating a varied list including commonly available, widely recognized foods and beverages. An assortment of food groups were selected so that the focus was not solely on foods associated with a bitter taste.

Hedonic scale

The foods were listed in alphabetical order in bold print. A box labeled "never tried" was included to the right of each food listing. Printed below each food item was a nine point hedonic scale and beneath that the endpoints of the scale were the labels "dislike extremely" (1) and "like extremely" (9). The midpoint was labeled "neither like nor dislike", (Peryam & Pilgrim 1957). Students were instructed to circle the number that best indicated how well they liked or disliked the foods.

Genetic taste detection test

The genetic taste detection test was located on page 5 of the booklet. For taste papers, the test used strips of filter papers approximately ¼ inch wide and 2 inches long. The filter papers were either impregnated with phenylthiocarbamide (PTC) or were left plain to serve as a control. The PTC taste papers were purchased from Southern Biological Supply Company in McKenzie, Tennessee. According to their product specifications, each paper contains approximately 0.3 mg of PTC.

The taste papers were fastened to the booklet with red or yellow 3/4 inch, round, self adhesive labels called "dots" in the instructions. Each pair of taste papers (PTC and control) was fastened with the same color dot and the pairs were randomly assigned to one of the two colors. (Master sheet for randomization is found in Appendix C)

Randomization of test

Two, three-digit sample codes were assigned to each type of taste paper. The sample codes were written on the colored "dots" fastening the taste papers to the booklet. The PTC taste papers were given the code 562 or 914. The control taste papers were either 237 or 480. The placement of the taste papers was varied so that the PTC and the control taste papers were presented first to an equal number of students.

Student instructions

The following instructions were given to the students: "Lift off the dot holding the filter paper for the first sample and test by placing the filter paper on your tongue. You may close your mouth to help taste the paper but please do not swallow it. After you have tasted the first paper, please respond to the questions on taste and intensity before repeating the process for the second sample. Gum or candy will be provided to prevent any after taste from lingering. Keep the dots to learn the test results."

Questions on perception and intensity

Each filter paper was accompanied by two written requests. The first asked the student to circle the response that best indicated their taste perception of the sample. The responses were tasteless, sweet, sour, salty or bitter, in that order.

The second question on perceived intensity had responses numbered from 1 to 9. These were labeled: extremely weak (1) and extremely strong (9). The intensity rating was used to gain insight into the perceived intensity of the PTC taste experience.

Statistical Analysis

Food preference, genetic taste test and demographics data were analyzed using the SAS software program 6.12, (SAS Institute Inc., Cary N.C.).

The Mann Whitney U (Wilcoxon Rank Sum) nonparameteric t-test was used to determine if PTC tasters differed from non-tasters in the mean Hedonic score given for each food.

Pearson's product-moment correlation coefficients were calculated to examine the relationship between perceived intensity of PTC test papers and the mean Hedonic score given for each food.

Significance was set at the α level of $P \leq 0.05$.

CHAPTER IV

Results and Discussion

Completed Questionnaires

Of the 175 questionnaires generated, 143 were distributed to instructors. A package containing thirty-two of the questionnaires was misrouted during shipment and not distributed. One hundred eighteen questionaires were completed by students.

Demographics

Major

More than 97% answered the question on major. Thirty seven percent of those responding were culinary students. Approximately 30% of the students majored in nutrition, while 24% majored in hospitality. Food science was selected as their area of study for 10% of the students (Figure 1).

Gender

Of the 118 completed questionnaires, 116 responded to the question on gender and 59.5% of the students were female (Figure 2).

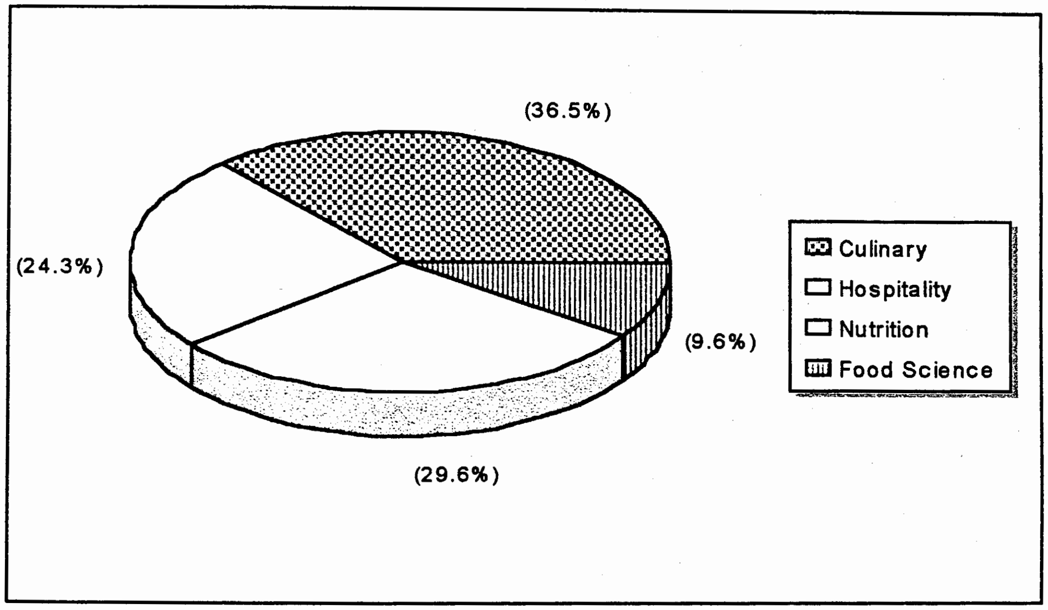


Figure 1. Percentage of students reporting by major.

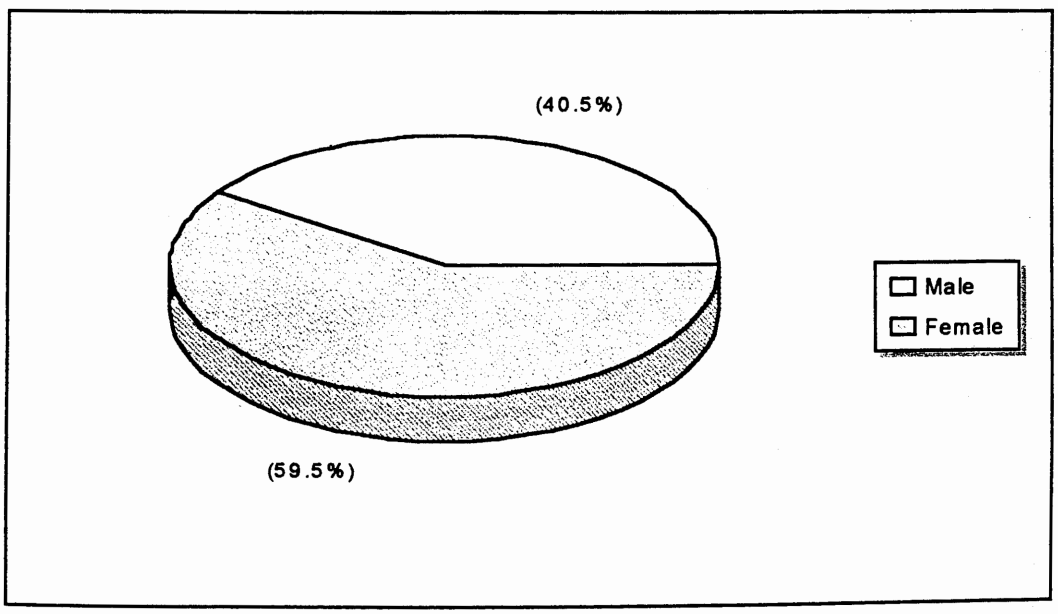


Figure 2. Gender of student participants.

Age Range

The 20 to 29 age range was the most frequently reported (approximately 59%) as would probably be expected when surveying college students. There were, however, students in every category except 60 or over. (Figure 3)

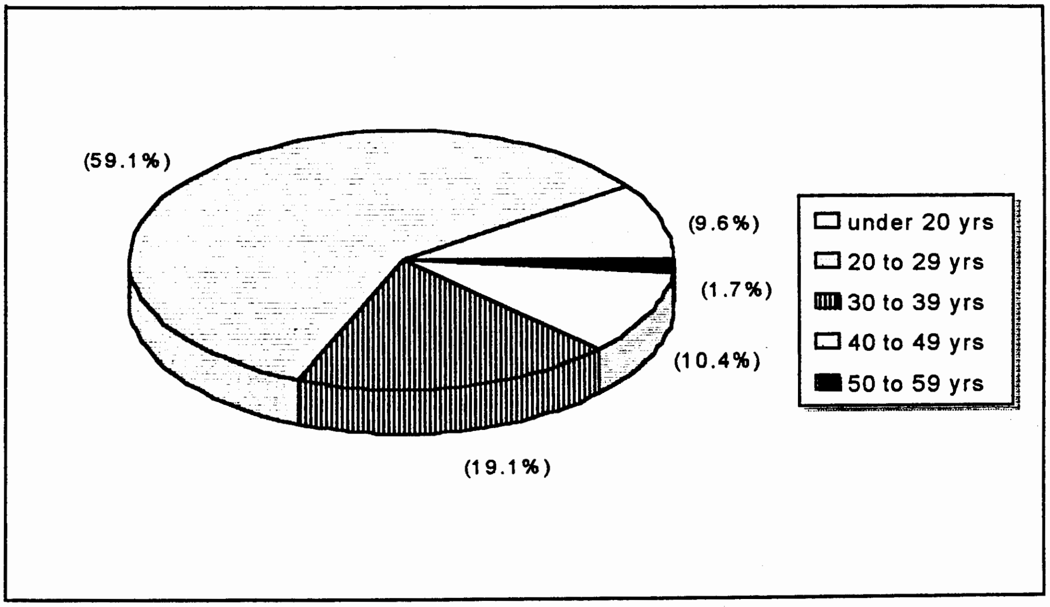


Figure 3. Age range of student participants.

Smokers

Of the 116 students responding to the question on smoking, more than one in five reported in the affirmative when asked "Do you smoke cigarettes?" (Figure 4).

Ethnic Heritage

More than 95% (113) of the students answered the question on ethnic heritage. The overwhelming majority, (83%) of the students were Caucasian although there were students in each ethnic group. Seven Asian and five Hispanic students were represented. Three students circled Multiracial and two each defined themselves as Native American or African American (Figure 5).

Taste Test

Determination of PTC Taster Status

PTC taster status was determined by students response to the taste detection test. Students responding that the PTC taste paper was bitter and the control was tasteless were categorized as "PTC tasters". A response of tasteless for both taste papers resulted in the students being designated as "non-taster". Students with any other combination of responses were termed "undetermined PTC taster status."

Results of PTC Taste Detection Test

PTC taster status was determined for 84 students. Sixty-nine students (58.5%) were identified as PTC tasters

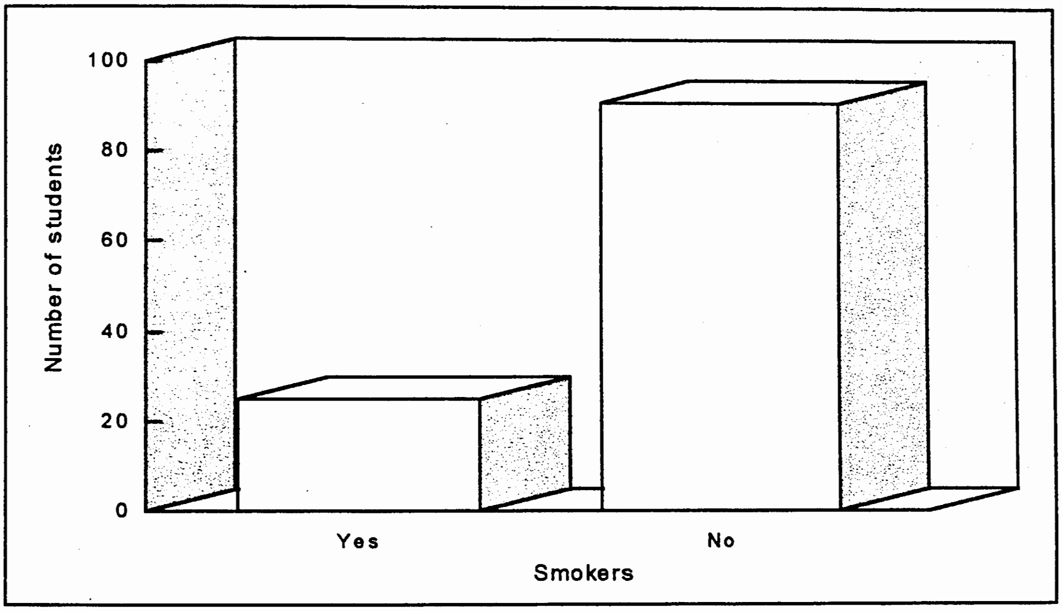


Figure 4. Number of smokers participating.

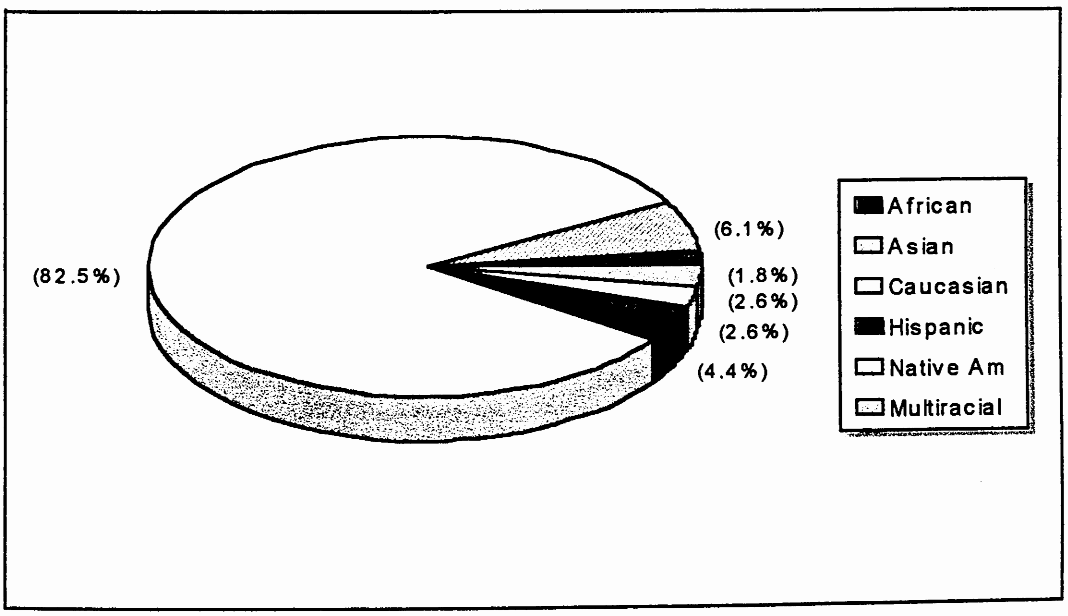


Figure 5. Ethnic heritage of student participants.

and fifteen (12.7%) were identified as non-tasters. The remaining 34 (28.8%) were grouped as "undetermined" (Figure 6).

The sequence in tasting taste papers may have influenced the relatively high number of students grouped as undetermined. Since some students tasted the PTC paper first, it is possible that a lingering bitter after taste caused the control paper to also have a bitter taste.

Of the 84 students whose taster status was determined, 82.1% were PTC tasters and 17.9% were classified as non-tasters. According to Blakeslee (1931) and Pai (1981), the general population consists of about 75% PTC tasters and 25% non-tasters. This follows the expected genetic pattern for the ability to taste PTC as the dominant characteristic Figure 7) (Blakeslee 1931) (Pai 1981).

Intensity of Perception

A question on intensity of perception for both the control and the PTC taste paper was asked. While it was necessary to ask this question for both papers, the intent was to gain information on the perception of the PTC taste papers.

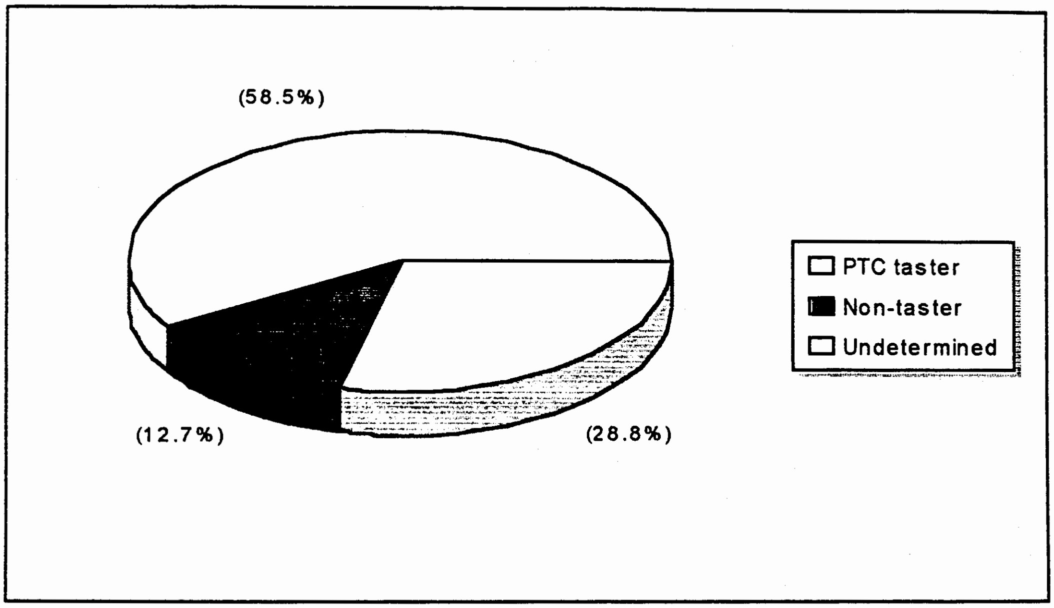
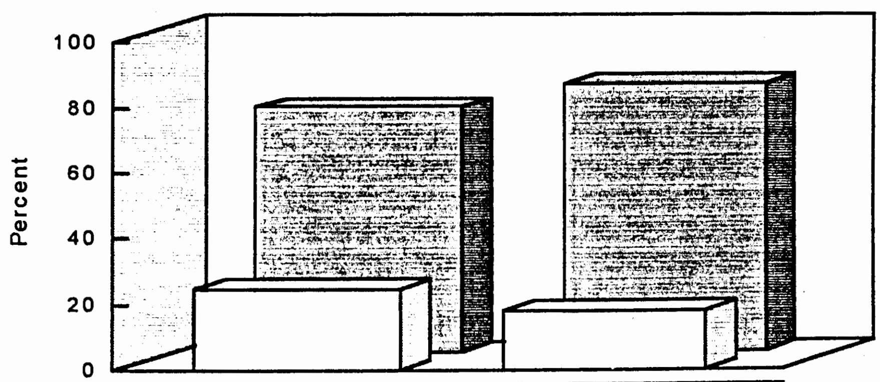


Figure 6. Results of PTC taste detection test in percents.

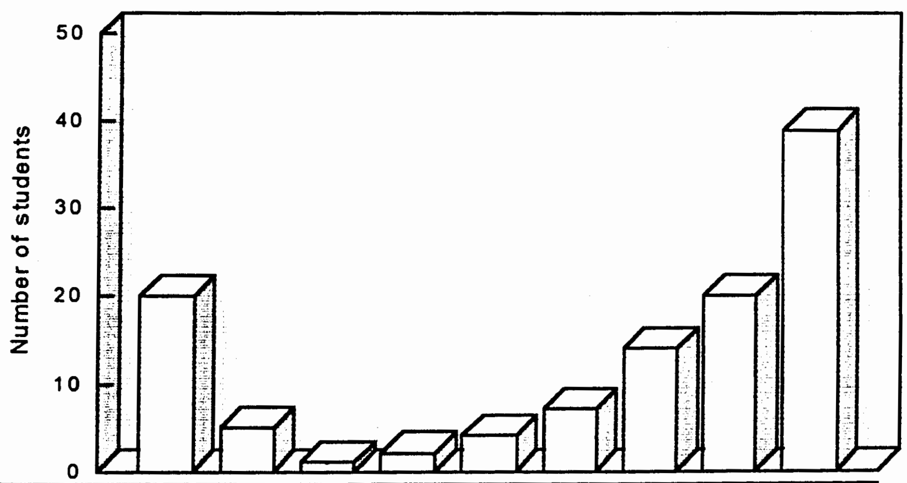


Status	General population	Study
Non-taster	25	18
PTC taster	75	82

Figure 7. Comparison of the study students to the general population on the proportion of PTC tasters and non-tasters.

Intensity of PTC

Response to the intensity of PTC taste papers was heavily weighted toward strong (Figure 8). The most frequent response, 34.82%, was 9 (extremely strong) with the cumulative frequency for 7, 8 and 9 at more than 65%. Only 11.61% of the students were in the middle at 4, 5 or 6 in their reaction to PTC. At the other end of the scale, 23.21% found the PTC taste papers to merit a 1, 2 or 3. Interestingly, 17.86% of the students declared the intensity of PTC taste papers to be extremely weak which confirms the earlier finding that 17.9% of the students were non-tasters of PTC.



Hedonic Scale	One	Two	Three	Four	Five	Six	Seven	Eight	Nine
☐ Results	20	5	1	2	4	7	14	20	39

Figure 8. Frequency of response to perceived intensity of PTC taste papers.

Intensity of control

As perhaps would be expectd, nearly three quarters of the students held the opinion that the intensity of the control papers was extremely weak. The other 25% were scattered over the rest of the Hedonic scale (Figure 9).

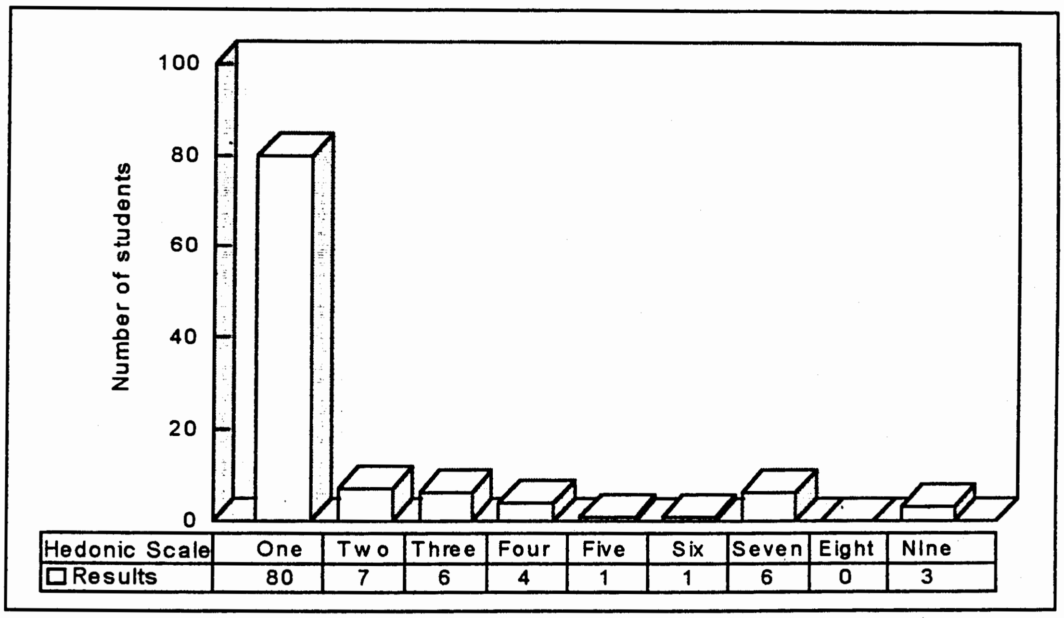


Figure 9. Frequency of response to perceived intensity of control papers.

PTC Taster status and Demographics

PTC taste status and major

One of the main purposes of this study was the investigation of the PTC taster status of students in food related fields. Figure 10 shows the number of students in each major whose status could not be determined.

Figure 11 details the PTC taster status according to declared major. The percentages of students that were PTC tasters in three majors were very close for (culinary - 87.5%, hospitality 86.7% and food science 88.9). The taste percent (70.4) of PTC tasters than the other majors. detection test for the nutrition students showed a lower percent of PTC tasters than the other majors.

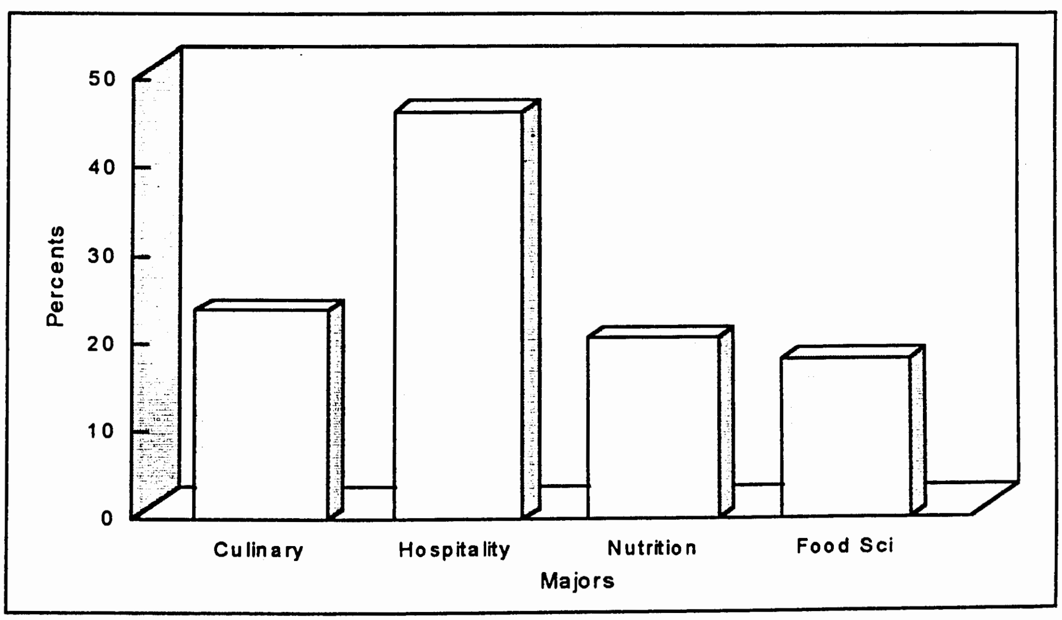
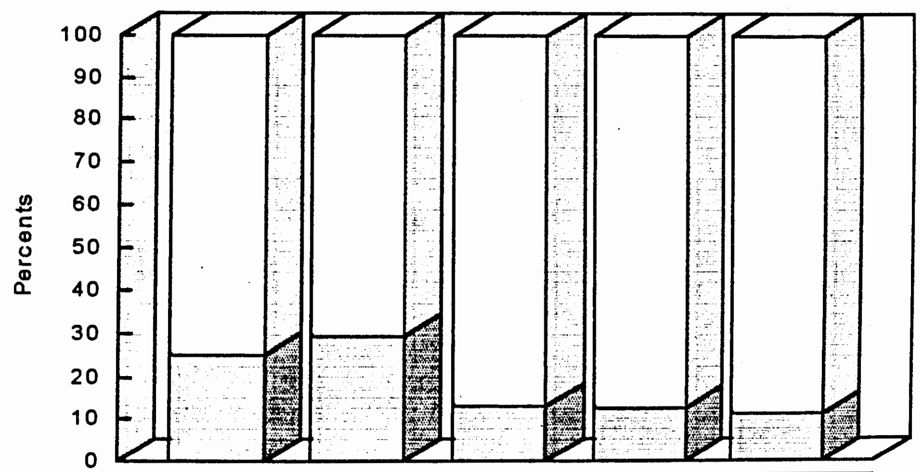


Figure 10. Percent of study students by major whose PTC taster status could not be determined.

The percentage of non-taster status for food science, culinary and hospitality major students is roughly half of that is found in the general population. However in nutrition majors there is an almost 5% greater incidence of non-taster status than one would expect from the general population.



	Population	Nutrition	Hospitality	Culinary	Food Sci
non-taster	25	29.6	13.3	12.5	11.1
PTC taster	75	70.4	86.7	87.5	88.9

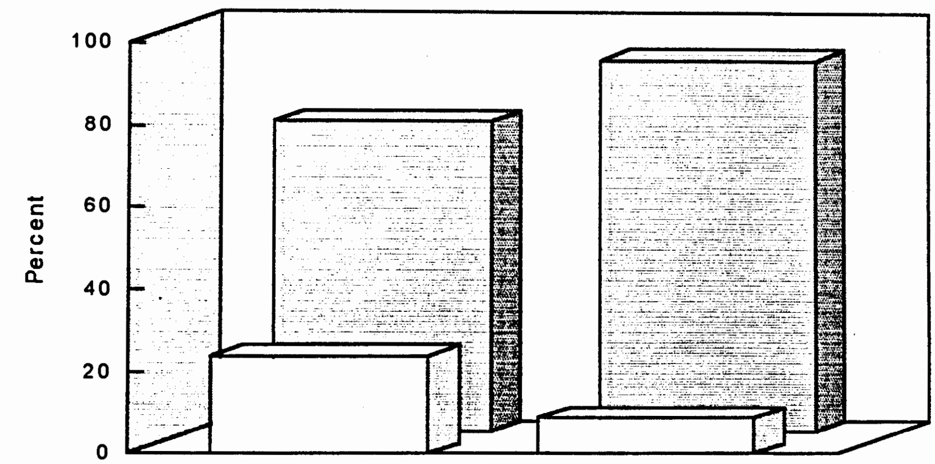
Figure 11. PTC taster status of general population and study students by major.

PTC taster status and gender

Seveny-six percent of the females and 91% of the males were PTC tasters (Figure 12).

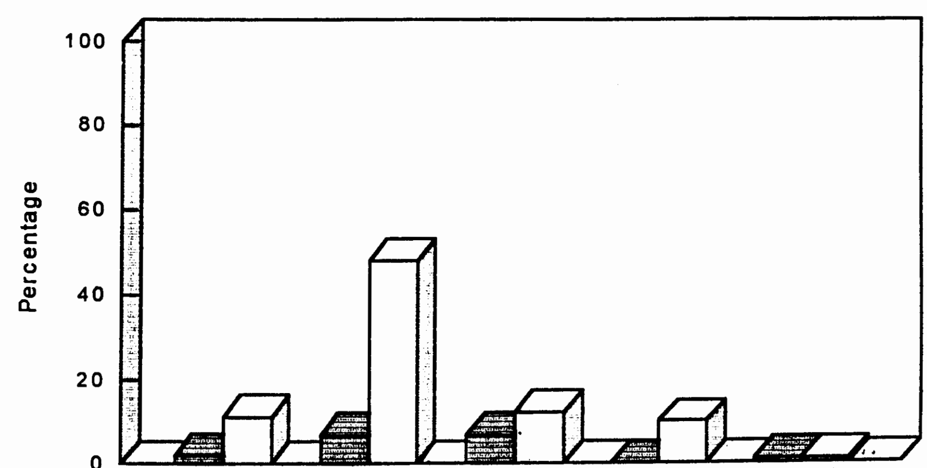
PTC taster status and age range

The majority of the PTC non-tasters and tasters fall into the age range of 20 to 40 years (Figure 13).



Gender	Female	Male
Non-taster	24	9
PTC taster	76	91

Figure 12. Percent of PTC taster status by gender.

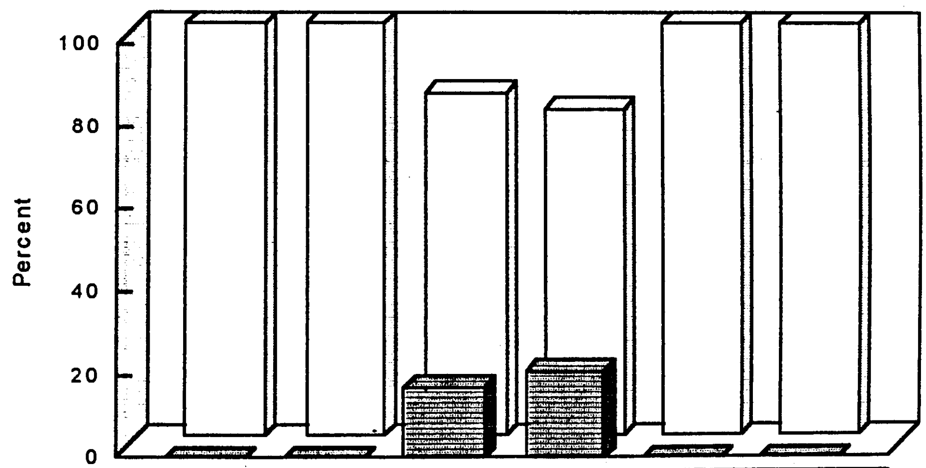


Age ranges	under 20	20 to 29	30 to 39	40 to 49	50 to 59
Non-taster	2	7	7	0	1
PTC taster	11	48	12	10	1

Figure 13. Percentage of PTC taster status by age.

PTC taster status and ethnicity

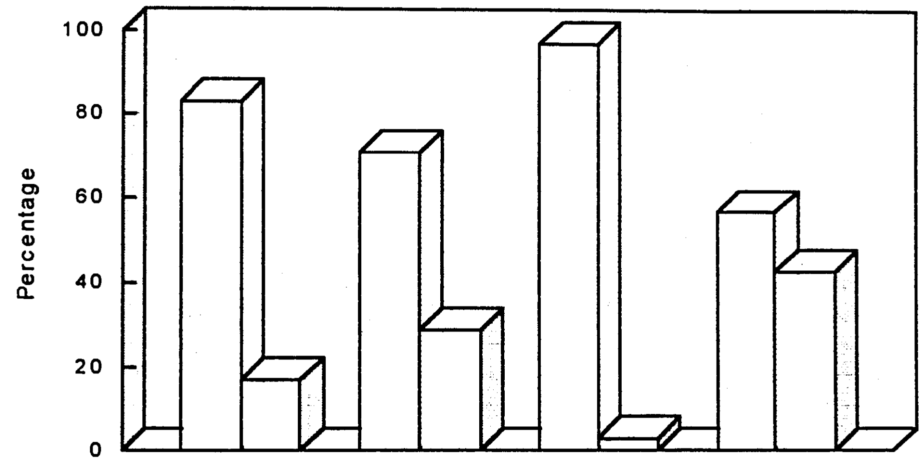
About 80% of the Caucasian participants are PTC tasters (Figure 14). Only 19 individuals of the entire study subjects were of any other ethnic group. Five participant's ethnicity was undetermined.



Ethnicity	Native Am	African	Asian	Caucasian	Hispanic	Multiracial
Non-taster	0	0	17	21	0	0
PTC taster	100	100	83	79	100	100

Figure 14. Percent of PTC taster status by ethnicity.

The nutrition majors were the least ethnically diverse of participants with 97% being Caucasians (Figure 15).



Majors	Culinary	Hospitality	Nutrition	Food Sci
Caucasian	83	71	97	57
Other Ethnic	17	29	3	43

Figure 15. Percent of ethnicity by major.

Food Preference

Highest Means and Hedonic Ratings

The five foods which received the highest mean Hedonic ratings as preferred foods are: strawberries, wheat bread, cheddar cheese, green beans and broccoli (Figure 16). These five foods were also ranked "like extremely" with the most frequency (Figure 17).

Strawberries lead in both categories with a mean Hedonic score of 8.4 and the highest ranking given by over 65% of the participants.

Hedonic Rating of 5 and 1

Diet soft drinks, buttermilk, turnips, Brussels sprouts, jalapeno peppers and cottage cheese were the most frequently rated 5, for "neither like nor dislike" on the Hedonic scale (Figure 18). Diet soft drinks and buttermilk not only held the distinction of being the most ambivalently regarded foods, they also appeared as two of the five foods marked, 1, for "dislike extremely" most frequently (Figure 19). Anchovies, black coffee and horseradish also generated strong negative feelings.

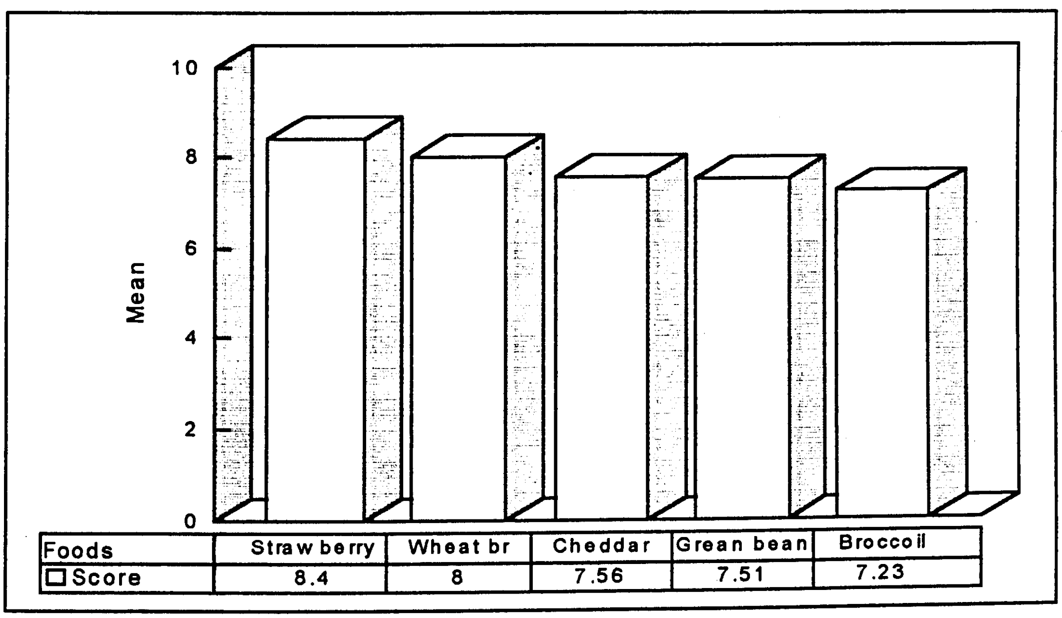
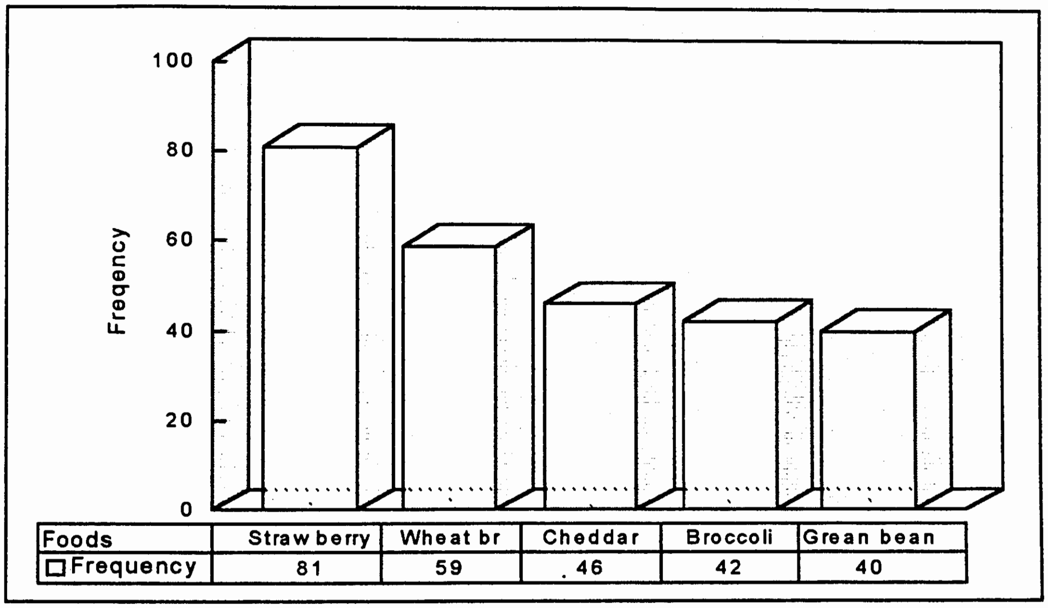
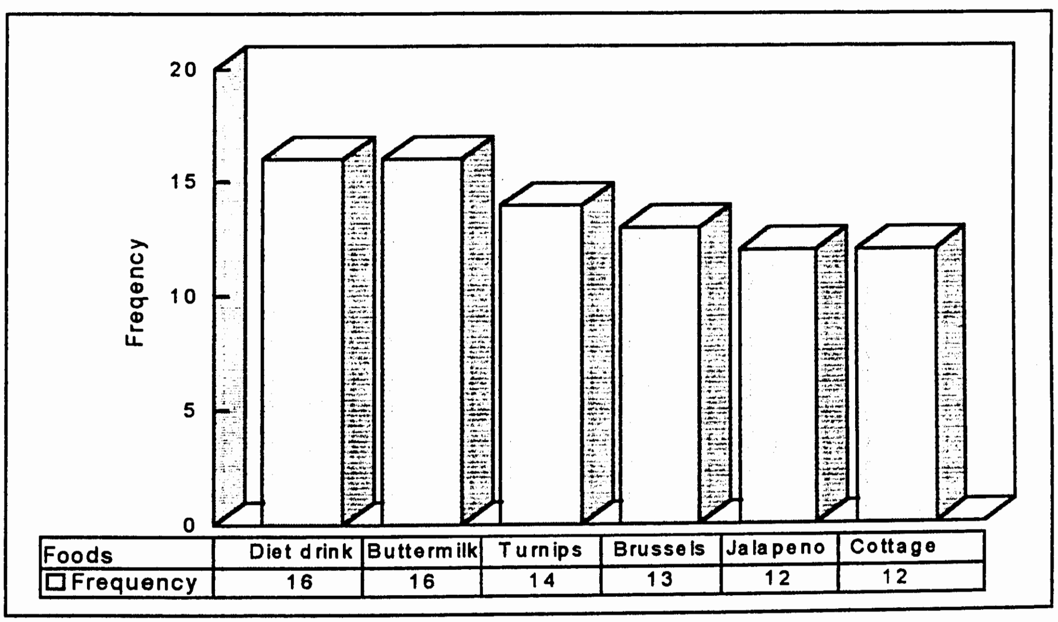


Figure 16. Foods with the highest mean Hedonic score in the food preference list.



<u>Figure 17.</u> Foods most frequently rated a "9" on the Hedonic scale.



<u>Figure 18.</u> Foods most frequently rated a "5" on the Hedonic scale.

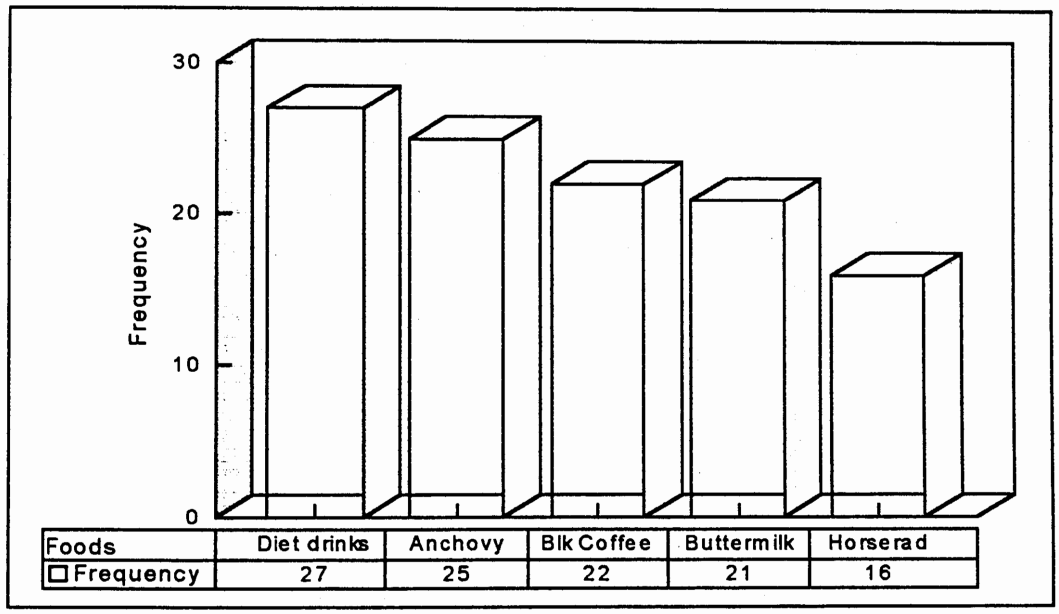


Figure 19. Foods most frequently rated a "1" on the Hedonic scale.

Greatest Standard Deviation

Turnips, kale, Brussels sprouts, horseradish and black coffee in that order, had the greatest standard deviations. (Figure 20)

"Never Tried Foods"

Every student in the survey had tried broccoli, diet soft drinks, green beans and wheat bread. Kale stood out as the least tasted food with more than 45% of students checking the "never tried" box. Anchovies were a distant second in that classification with almost one third of the students reporting not having eaten them. (Figures 21a & b)

Hedonic ratings

Frequency histograms of the Hedonic ratings for all foods surveyed in the preference test are found in Figures 22 through 41.

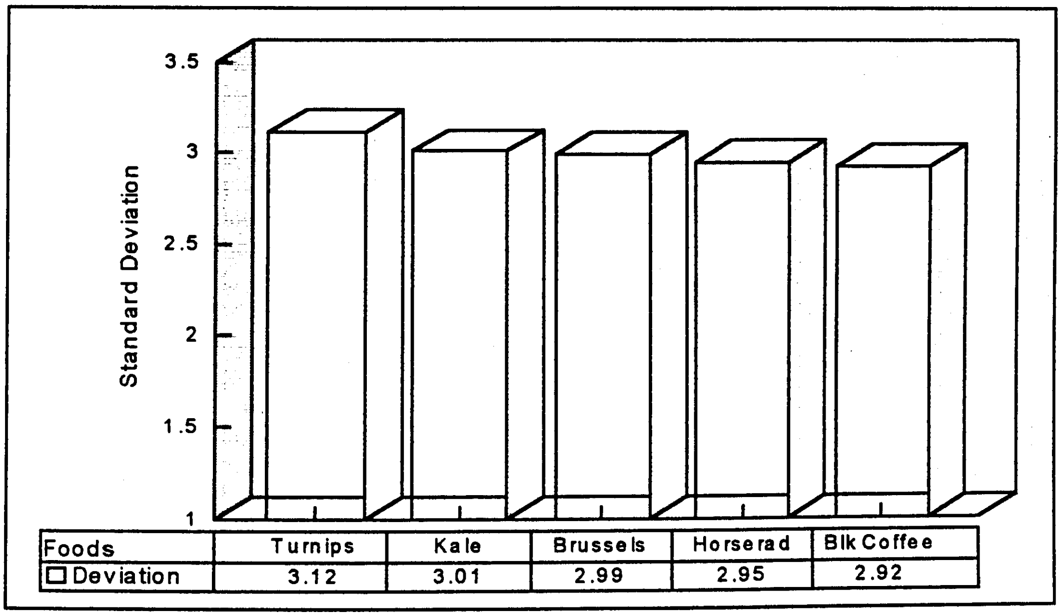
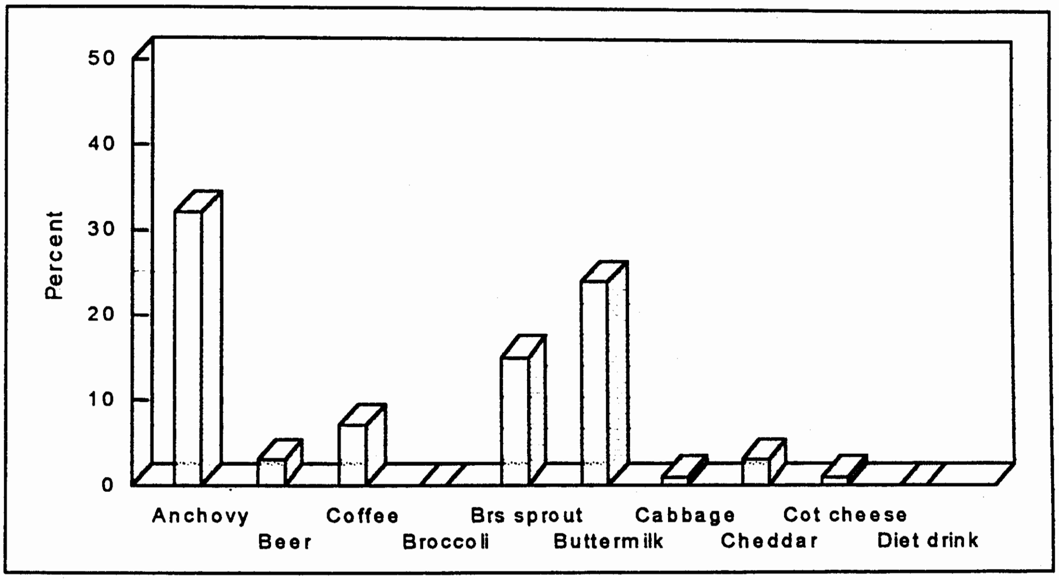
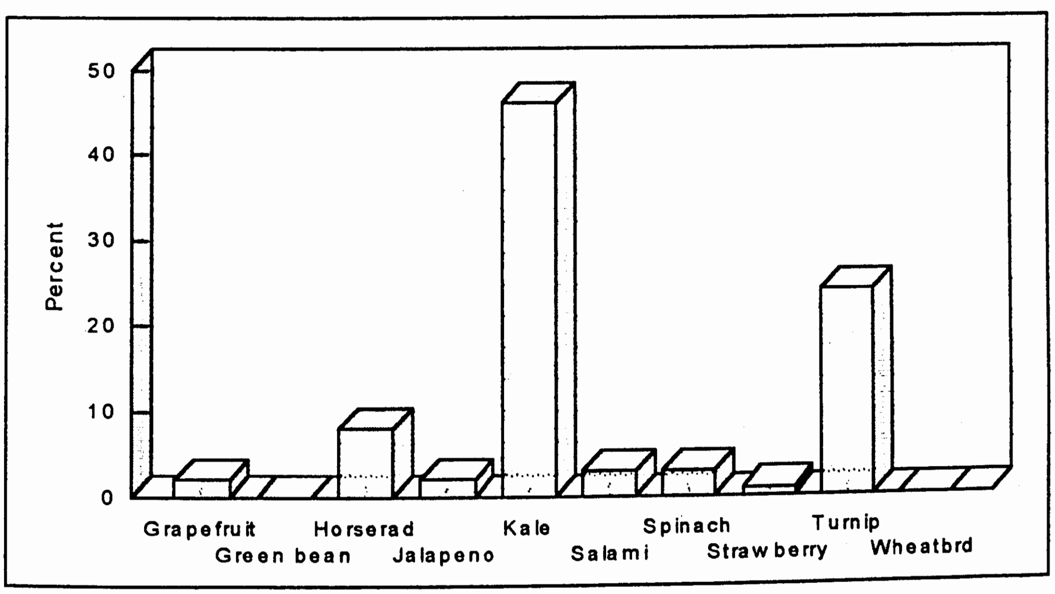


Figure 20. Foods with the greatest standard deviation.



<u>Figure 21a.</u> Frequency of foods marked "Never Tried", anchovy through diet drink.



<u>Figure 21b.</u> Frequency of foods marked "Never Tried", grapefruit through wheatbread.

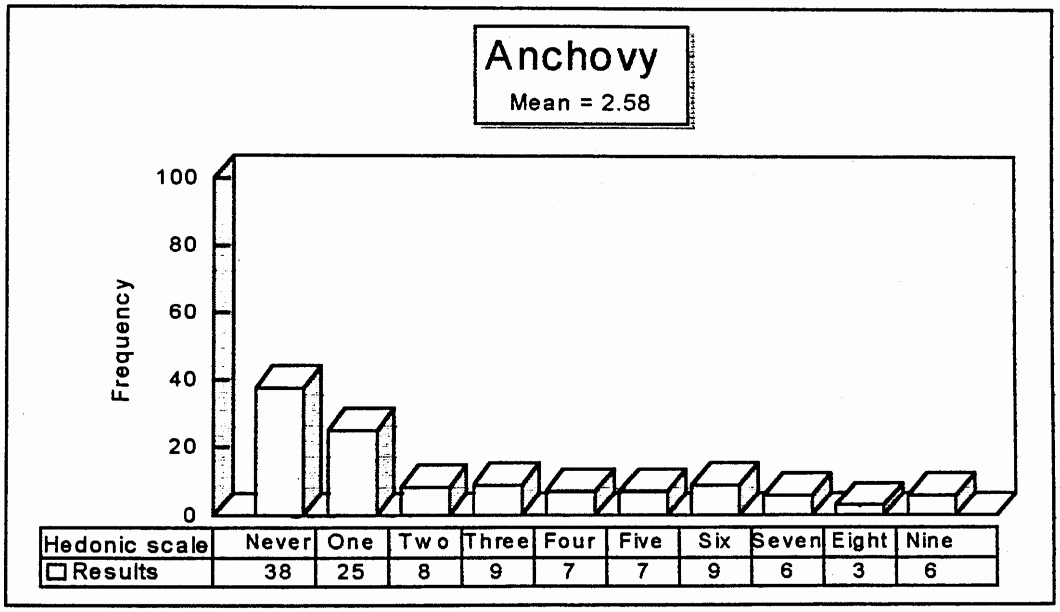


Figure 22. Hedonic rating for anchovies.

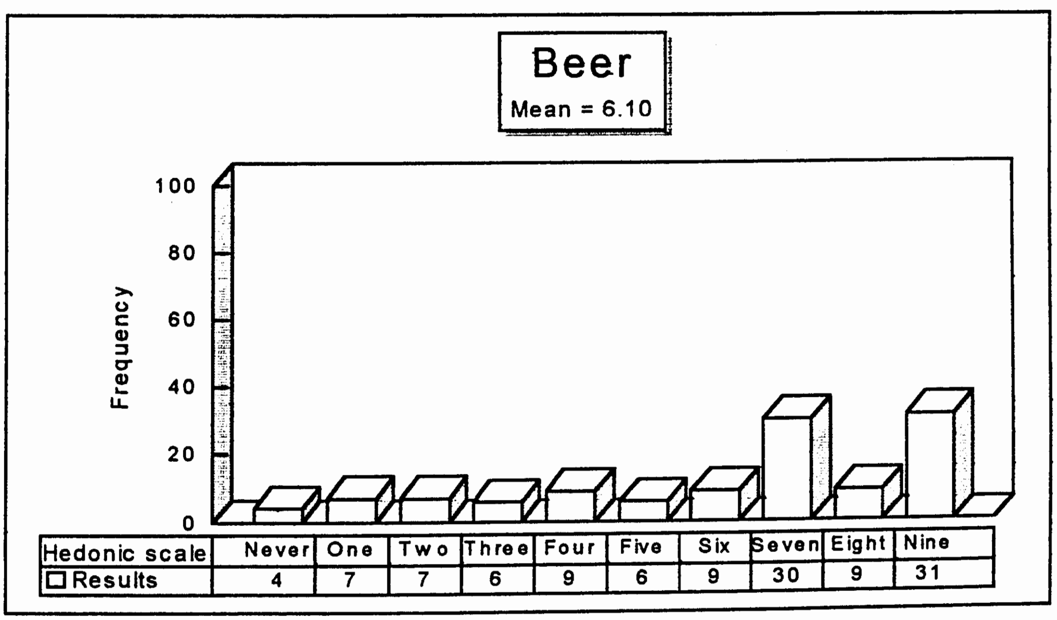


Figure 23. Hedonic rating for beer.

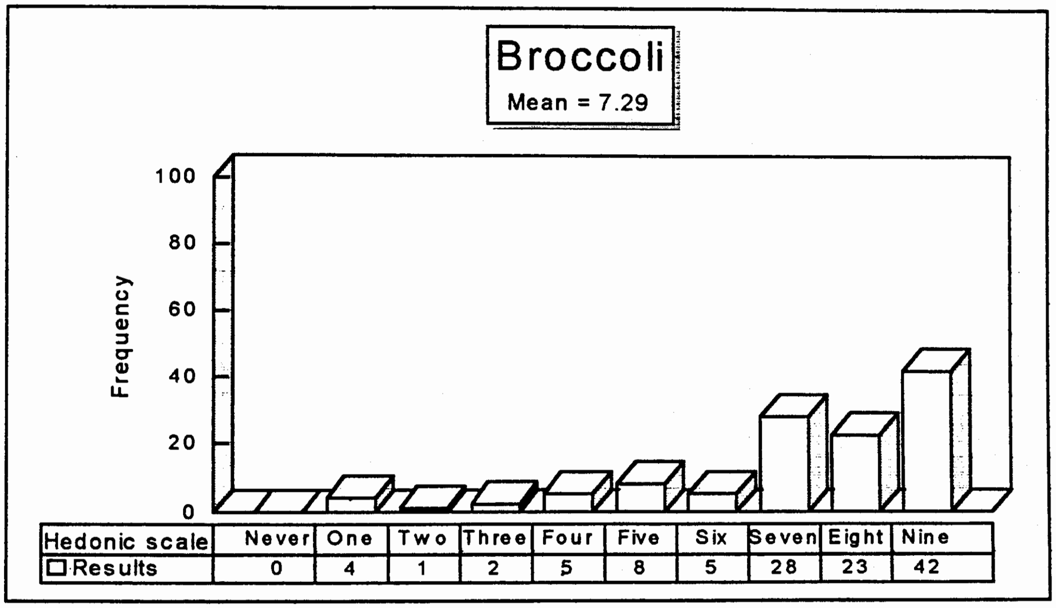


Figure 24. Hedonic rating for broccoli.

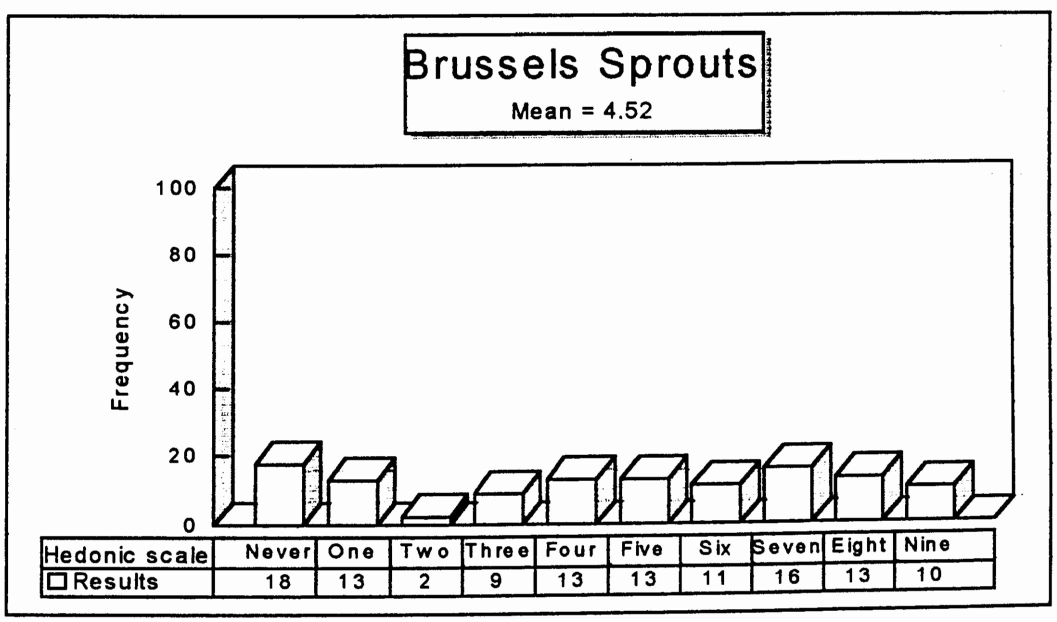


Figure 25. Hedonic rating for Brussels sprouts.

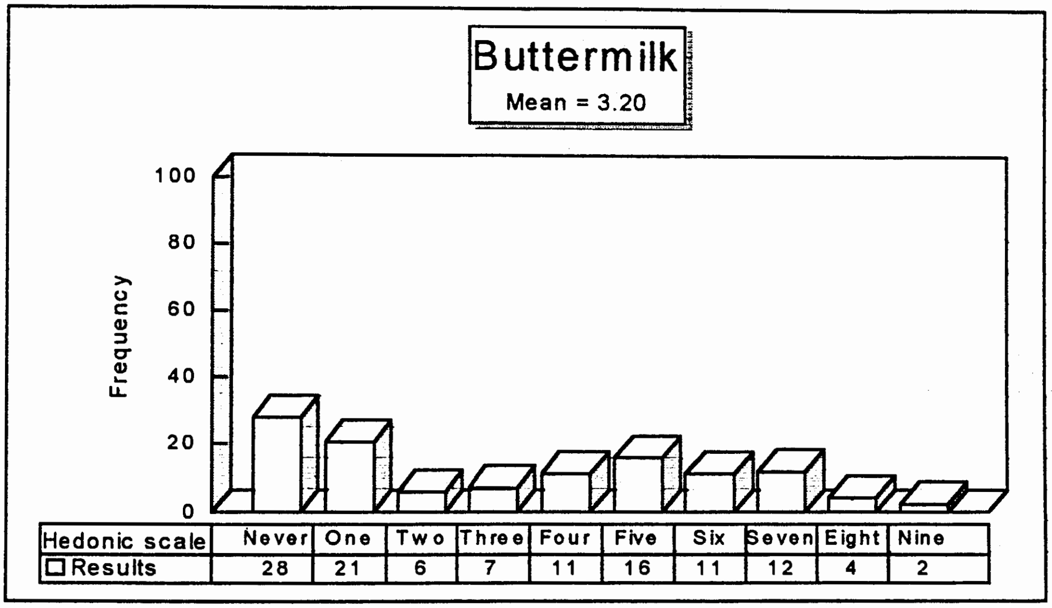


Figure 26. Hedonic rating for buttermilk.

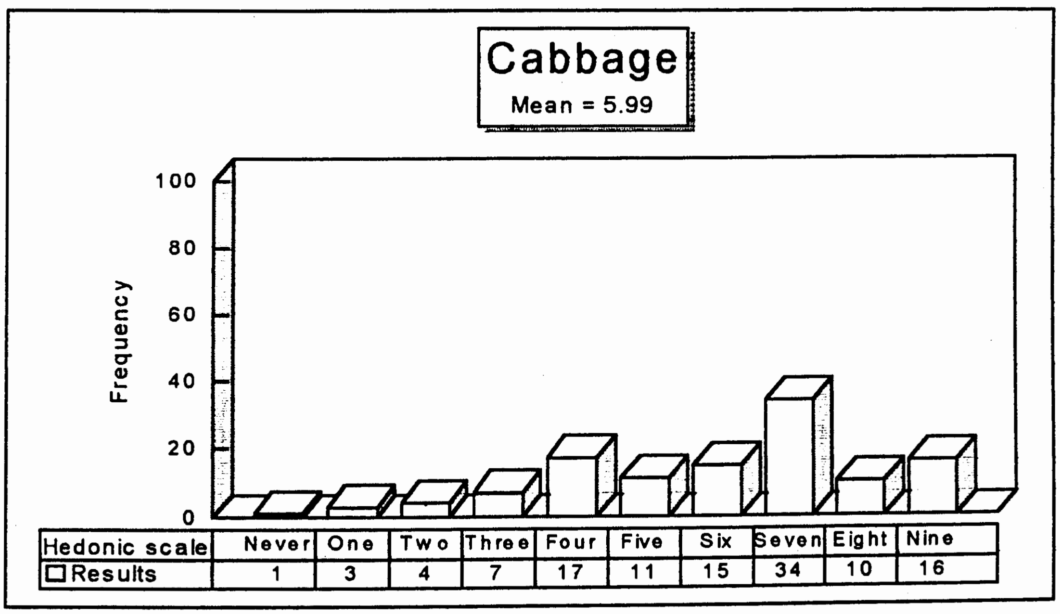
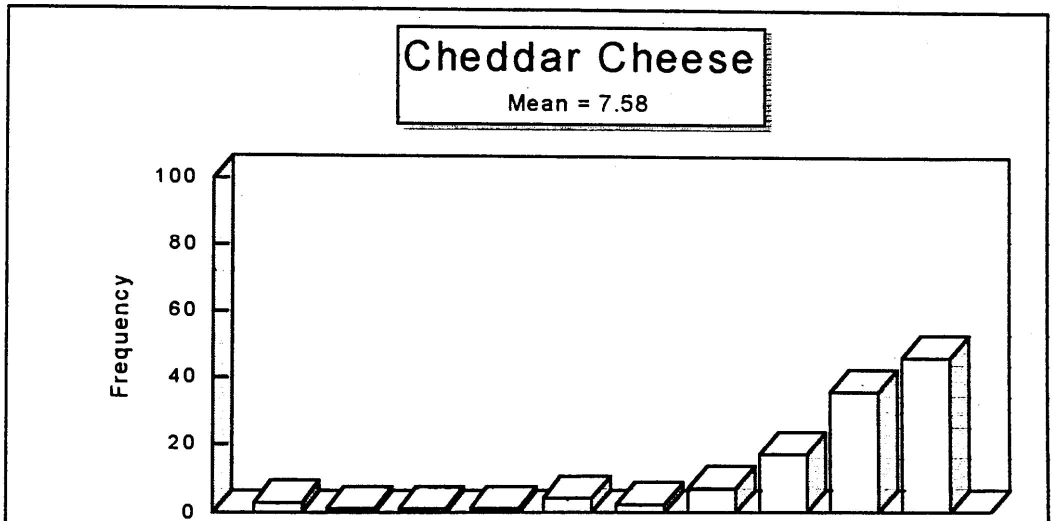
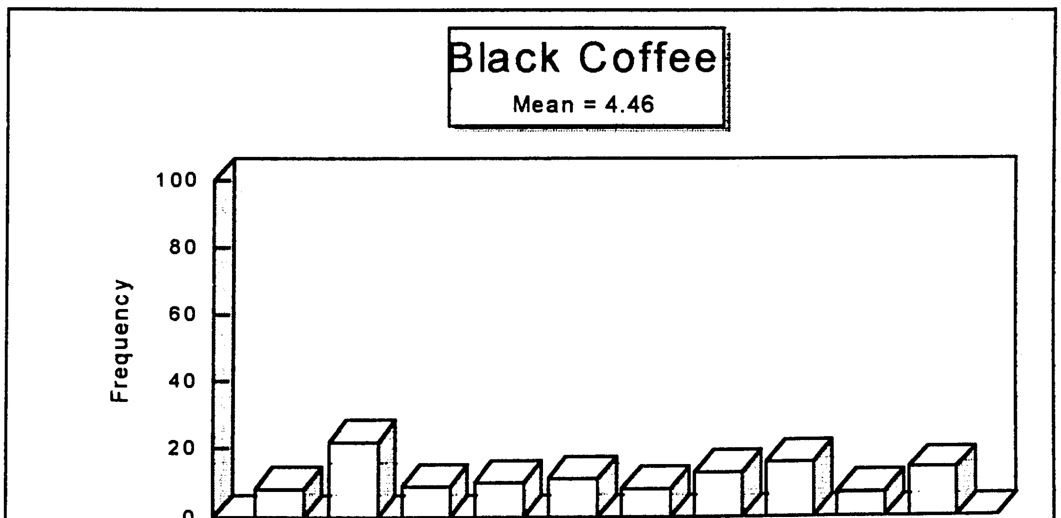


Figure 27. Hedonic rating for cabbage.



Hedonic scale	Never	One	Two	Three	Four	Five	Six	Seven	Eight	Nine
☐ Results	3	1	1	1	4	2	7	17	36	46

Figure 28. Hedonic rating for cheddar cheese.



Hedonic scale	Never	One	Two	Three	Four	Five	Six	Seven	Eight	Nine
☐ Results	8	22	9	10	11	8	13	16	7	14

Figure 29. Hedonic rating for black coffee.

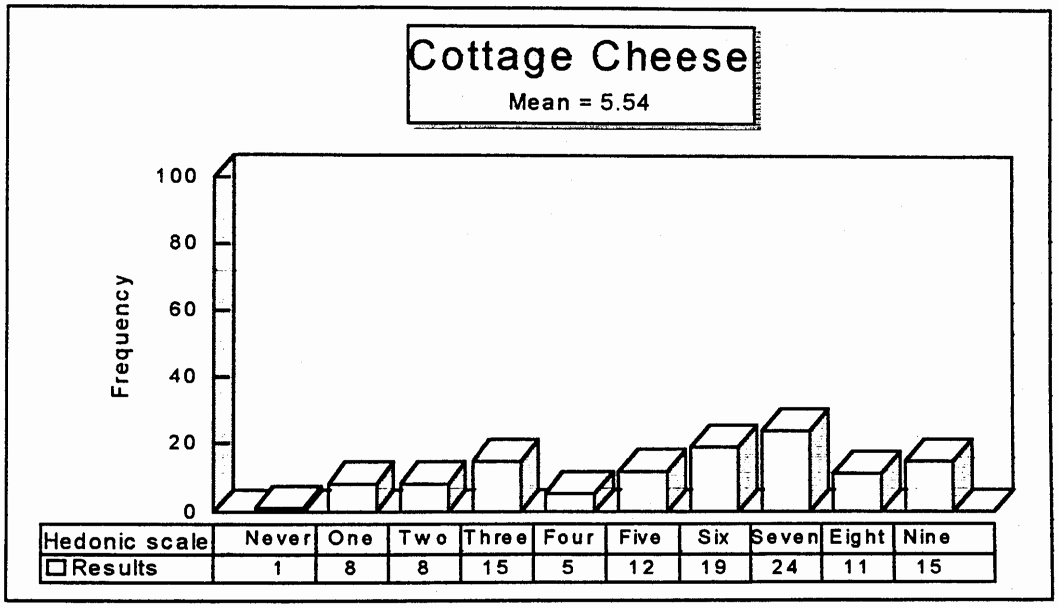


Figure 30. Hedonic rating for cottage cheese.

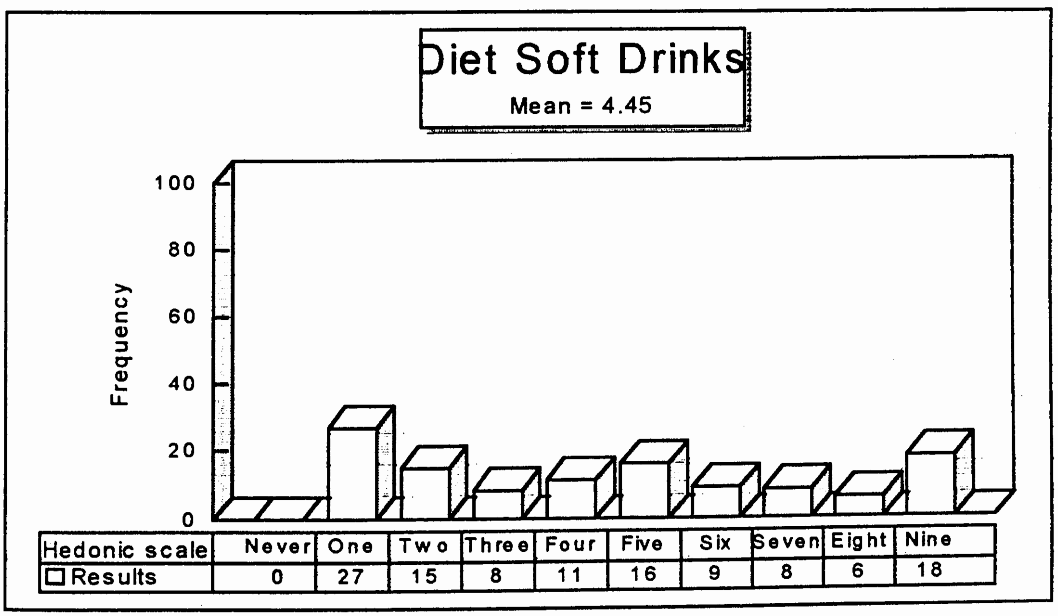


Figure 31. Hedonic rating for diet soft drinks.

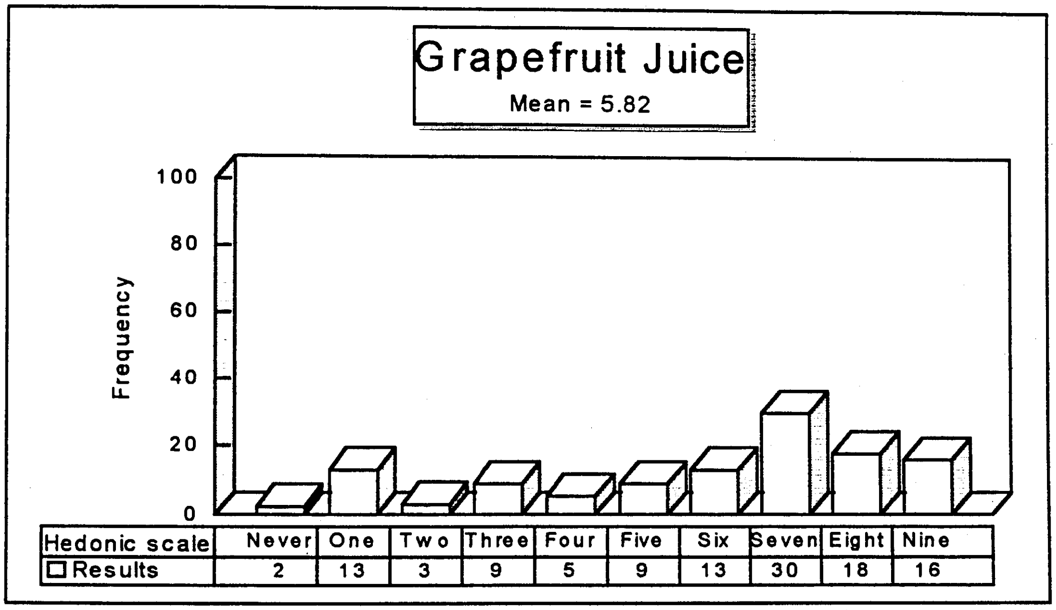


Figure 32. Hedonic rating for grapefruit juice.

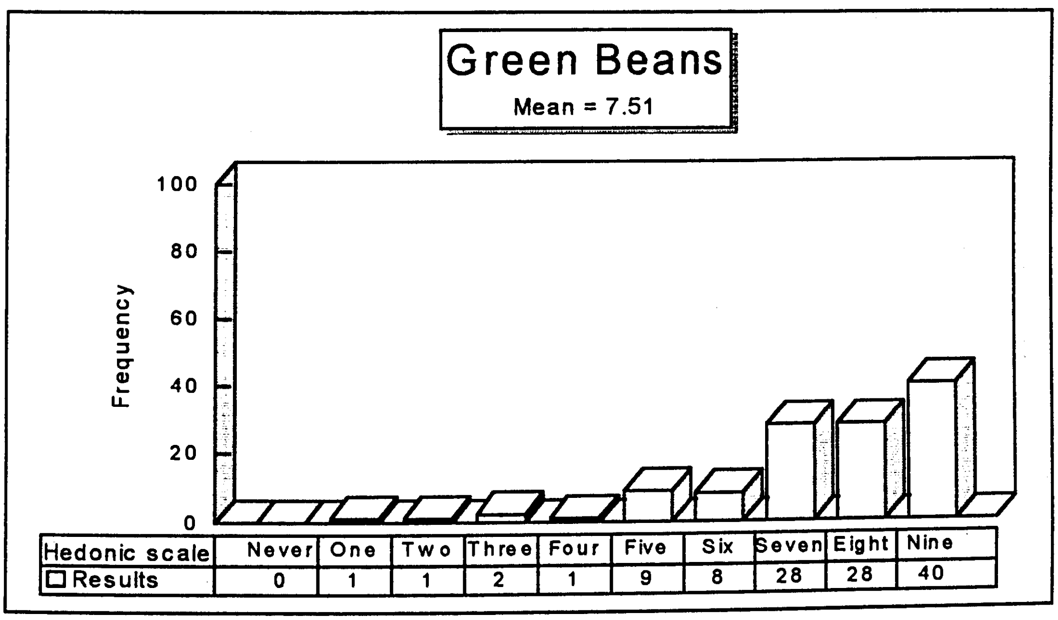
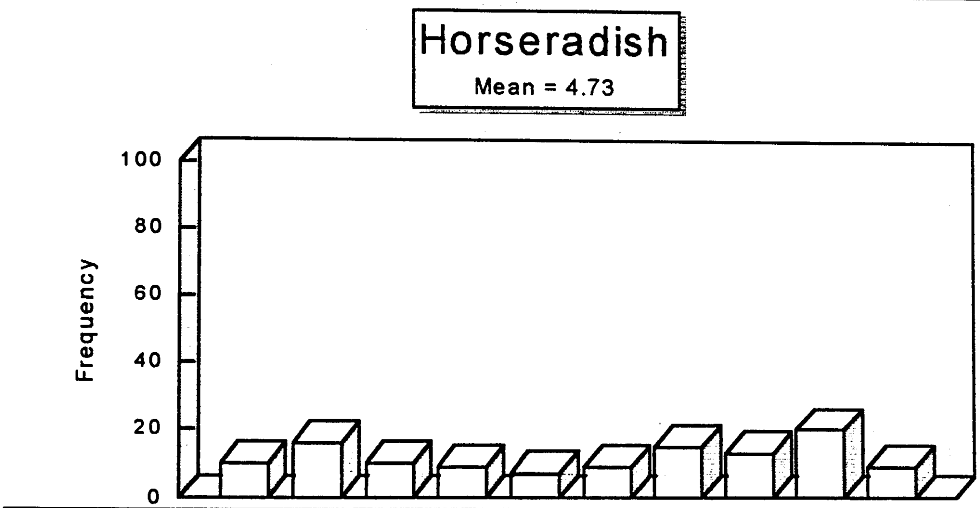
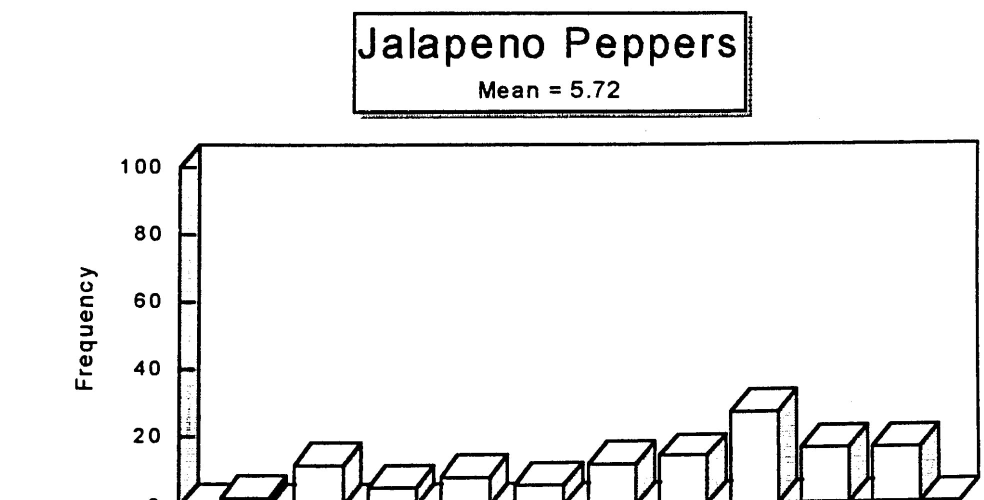


Figure 33. Hedonic rating for green beans.



Hedonic scale	Never	One	Two	Three	Four	Five	Six	Seven	Eight	Nine
Results	10	16	10	9	7	9	15	13	20	9

Figure 34. Hedonic rating for horseradish.



Hedonic scale	Never	One	Two	Three	Four	Five	Six	Seven	Eight	Nine
Results	2	12	5	8	6	12	14	27	16	16

Figure 35. Hedonic rating for jalapeno peppers.

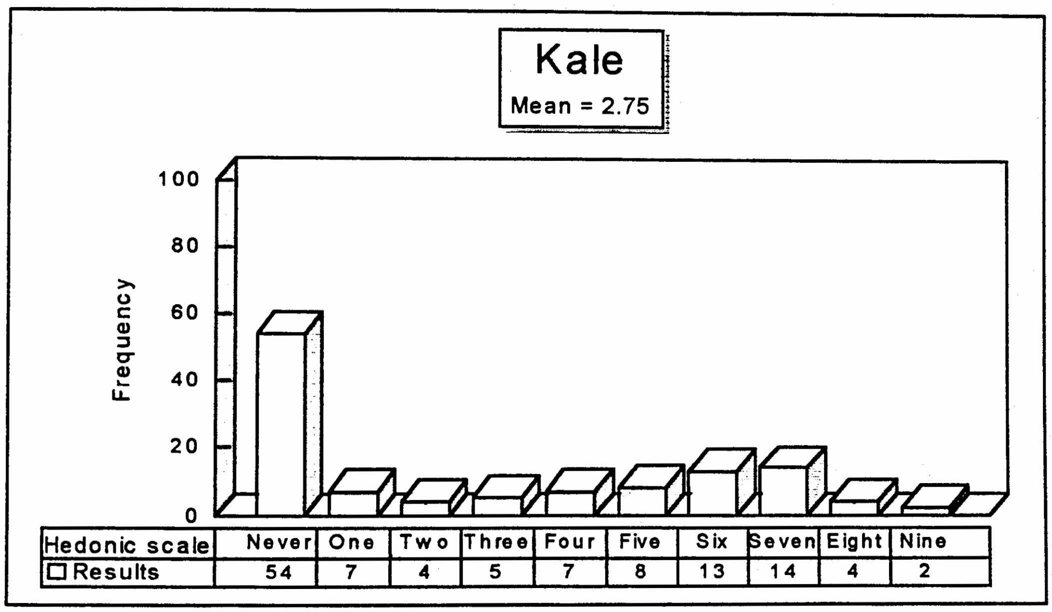


Figure 36. Hedonic rating for kale.

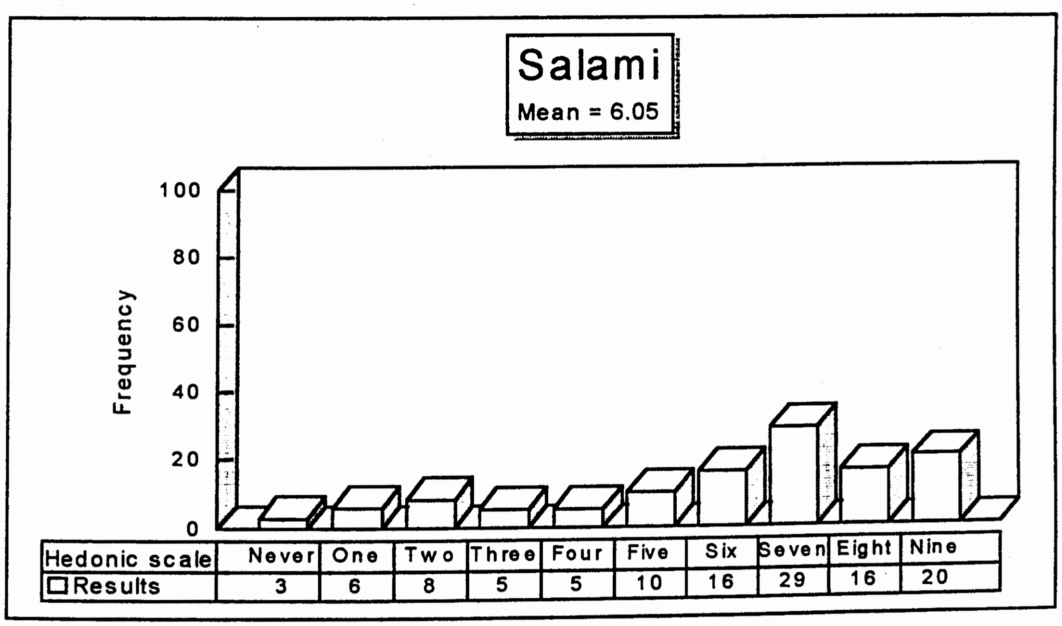
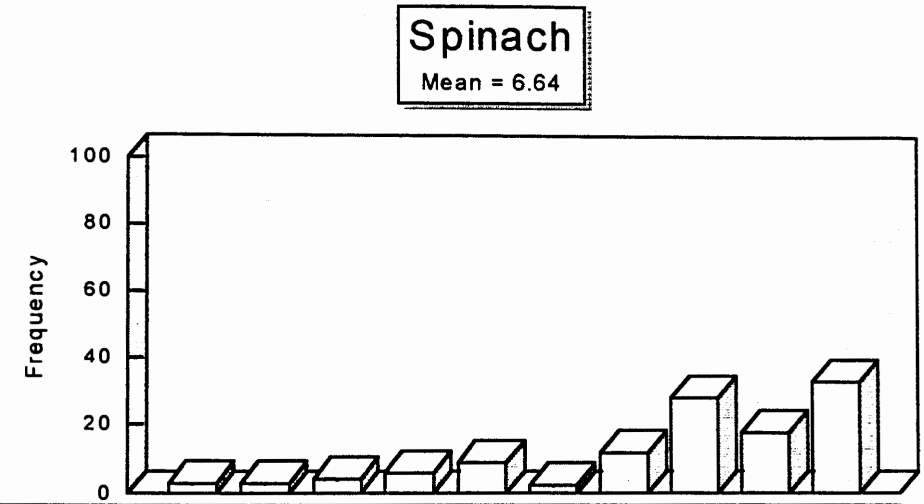
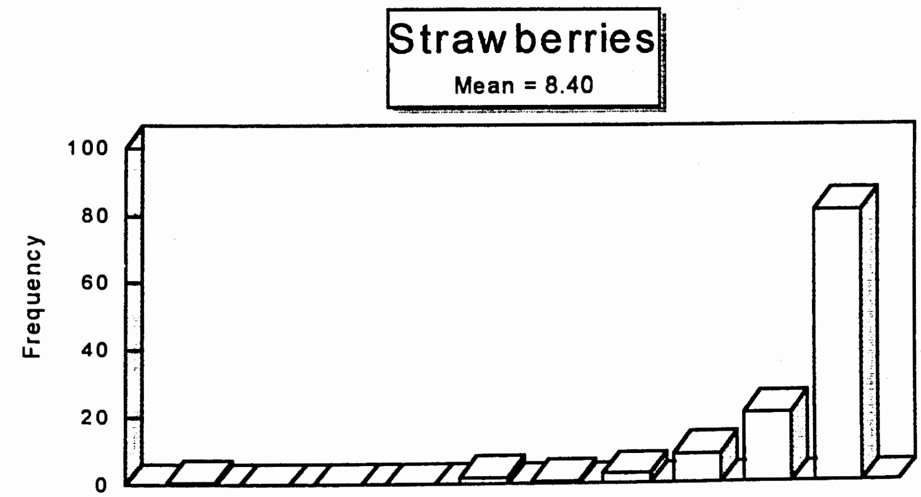


Figure 37. Hedonic rating for salami.



Hedonic scale	Never	One	Two	Three	Four	Five	Six	Seven	Eight	Nine
Results	3	3	4	6	9	2	12	28	18	33

Figure 38. Hedonic rating for spinach.



Hedonic scale	Never	One	Two	Three	Four	Five	Six	Seven	Eight	Nine
Results	1	0	0	0	2	1	3	9	21	81

Figure 39. Hedonic rating for strawberries.

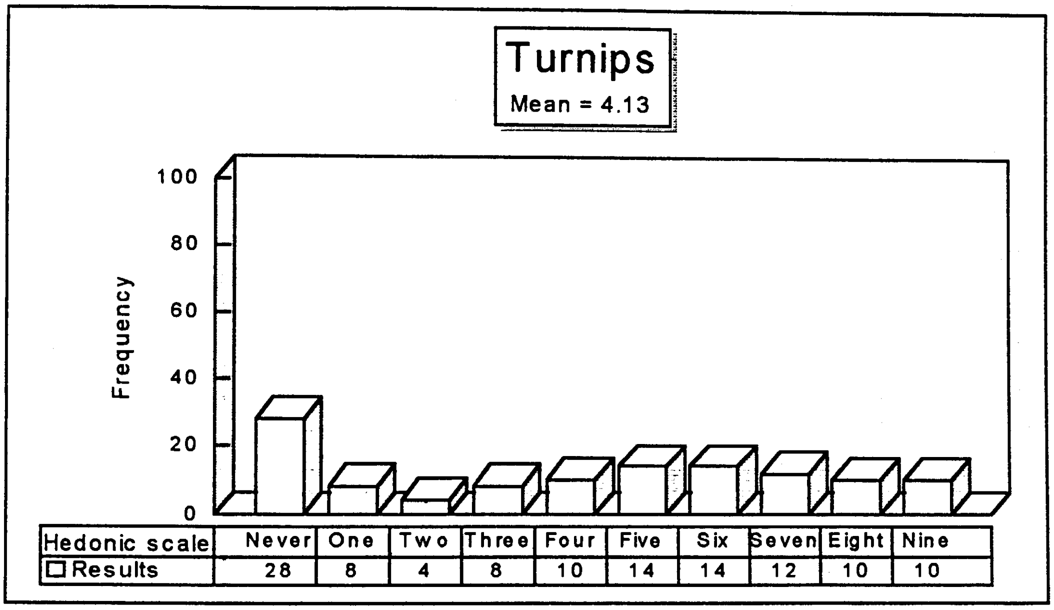


Figure 40. Hedonic rating for turnips.

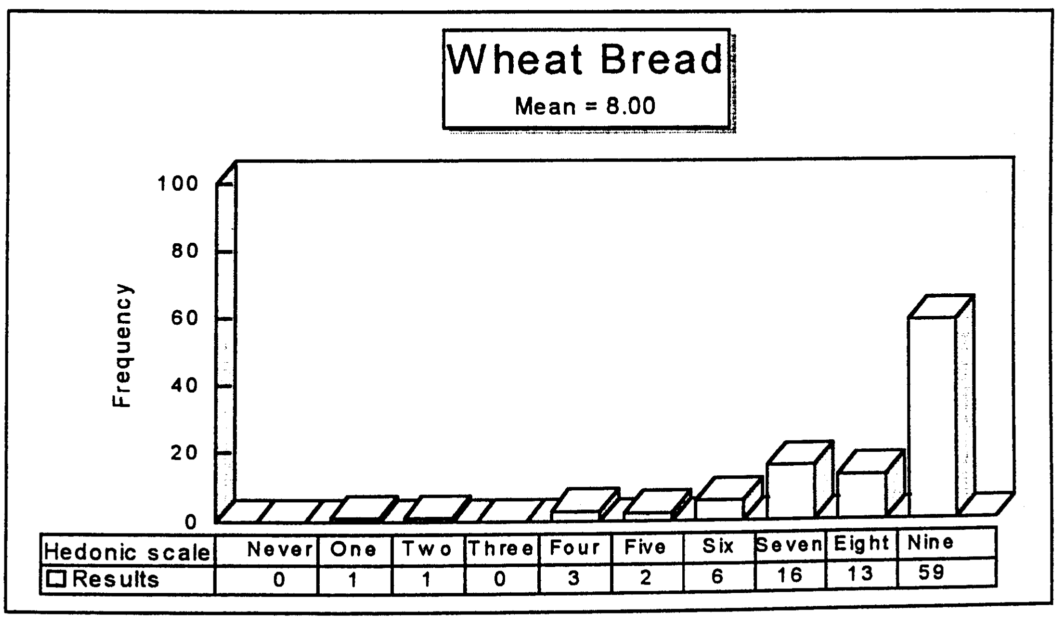


Figure 41. Hedonic rating for wheat bread.

Food Preference Groups

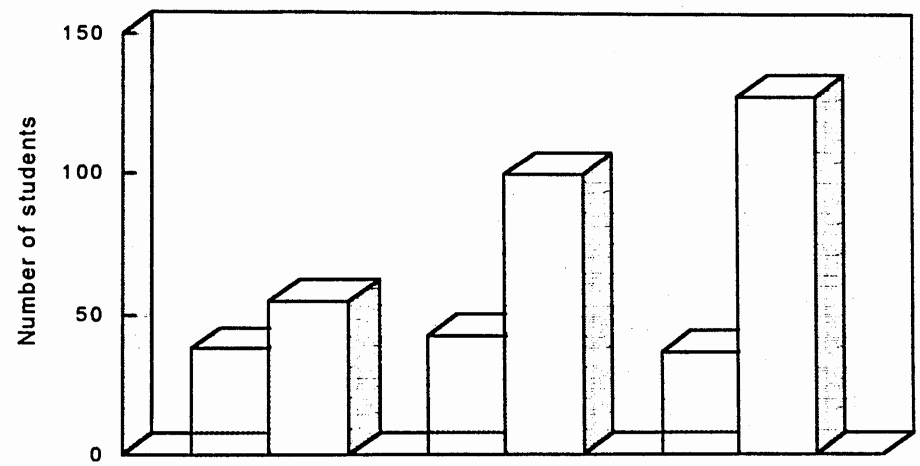
Categories

Food preferences were also analyzed according to the sum of each individual's food preference ratings. These overall food preference scores ranged from a low of 55 to a high of 156. The highest possible score, if all 20 foods surveyed had been given a "9" on the Hedonic scale, would have been 180.

Categories were devised to distribute this range of scores into groups which facilitated the comparison of food preference scores with PTC taster status as well as other factors in the questionnaire. The scores were divided into three groups which were labeled high, medium and low food preference (Figure 42). The group referred to as having high food preference scores consisted of thirty-seven students with an overall score of 128 to 156. There were forty-three participants in the medium group with scores from ranging from 100 to 125. The low score group had thirty-eight students with a range from 55 to 98.

Food Preference Groups and PTC Status

Of the students whose PTC taster status could be determined, twenty-seven each, were in the high and low food



	Low	Medium	High
Group size	38	43	37
Minimum	55	100	128

Figure 42. Food preference group divisions.

preference groups. Thirty were in the medium food preference group. There were twice as many PTC non-tasters in the low food preference group as in the high (Figure 43).

Food Preference Groups by Major

The comparison of food preference groups by major revealed that more than half of the culinary students were in the high food preference group, exactly half of the nutrition majors were in the medium food preference group while more than half of the hospitality majors were in the low food preference group. Close to ten percent of the food science majors were in the high food preference group with the rest evenly divided between the medium and low groups (Figure 44).

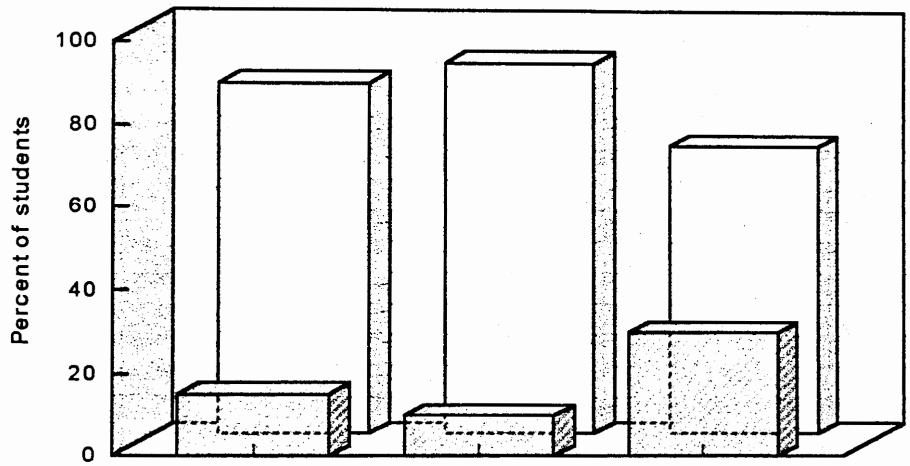
Statistical Analysis

Mann Whitney U Test

The Mann Whitney U (Wilcoxon Rank Sum) test was used to determine if the mean Hedonic score for each food was significantly different ($\alpha = 0.05$) for PTC tasters compared to non-tasters (Table 1). There was no significant difference between mean Hedonic scores for any of the foods at an α of 0.05. Only grapefruit juice and buttermilk even approached a significant difference with p-values of 0.07 each.

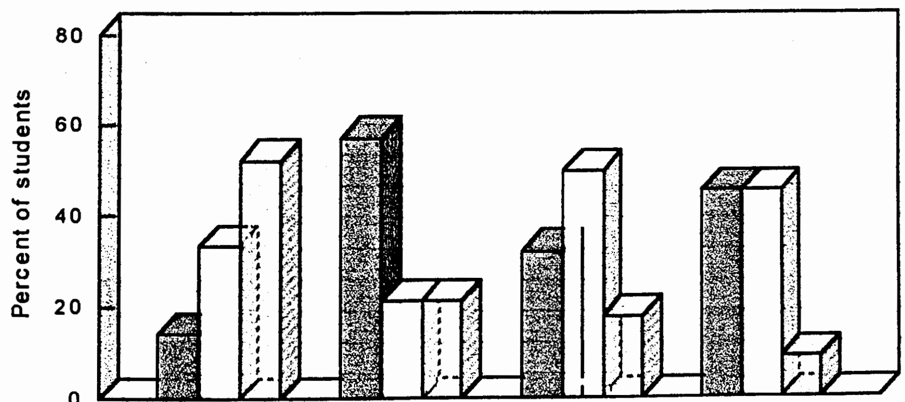
Correlation Analysis

The intensity ratings given to the PTC taste papers were compared to the ranks given to each food. The purpose of the correlation analysis was to find if there was any type of relationship between the perception of bitterness in the PTC and liking or disliking of any of the foods. There was no significant correlation (Table 2).



Groups	High	Medium	Low
Non-taster	15	10	30
PTC tasters	85	90	70

Figure 43. Percentage of PTC tasters and non-tasters in each of the food preference groups.



Majors	Culinary	Hospitality	Nutrition	Food Sci
low	14.3	57.2	32.3	45.5
medium	33.3	21.4	50	45.5
high	52.4	21.4	17.7	9

Figure 44. Percentage of students from each major in high, medium and low food preference groups.

Surveyed Food	P value
Grapefruit	0.0671
Buttermilk	0.0699
Cheddar Cheese	0.1505
Cottage Cheese	0.2151
Kale	0.2221
Horseradish	0.2423
Turnips	0.2828
Diet Soft Drink	0.2934
Broccoli	0.3059
Spinach	0.3539
Jalapeno Pepper	0.3602
Black Coffee	0.4864
Brussels Sprouts	0.5211
Cabbage	0.5457
Green Beans	0.6071
Wheat Bread	0.6071
Beer	0.6825
Strawberries	0.7716
Salami	0.8086
Anchovies	0.9020

Table 1. Mann Whitney U test p-values for the mean Hedonic rating of foods surveyed.

Surveyed Food	***r***
Broccoli	0.16285
Spinach	0.15445
Horseradish	0.13721
Anchovies	0.13275
Cabbage	0.12679
Green Beans	0.12370
Turnips	0.12069
Buttermilk	0.12040
Black Coffee	0.10213
Jalapeno Pepper	0.08134
Salami	0.07214
Cheddar Cheese	0.06448
Cottage Cheese	0.03396
Brussels Sprouts	0.03117
Strawberries	-0.03133
Kale	-0.03260
Grapefruit	-0.03843
Beer	-0.08330
Wheat Bread	-0.08713
Diet Soft Drink	-0.10637

Table 2. Pearson's product moment correlation coefficients for the mean Hedonic rating of foods surveyed.

Food Choice Priority

Categories

The results of the attitude questions were divided into three categories referred to as "priority" in food choice. Students that ranked nutrition higher than taste were listed as "nutrition priority". Those ranking taste higher were designated as "taste priority" and the remaining set that rated nutrition and taste equally were designated as the "balanced priority" group. One hundred and seventeen students responded to this question (Figure 45). More than one half of the students chose taste as a priority. Twelve percent rated nutrition as higher in importance. Thirty percent rated the importance of nutrition and taste as equal.

Food Choice Priorities and PTC Taster Status

Separating the priority in making food choices into PTC taster and non-taster (Figures 46 and 47) reveals more than half of each group still choose taste but there is a difference in the breakdown between balance and nutrition. Less than 10% of PTC tasters put greater emphasis on nutrition while more than 25% of the non-tasters did.

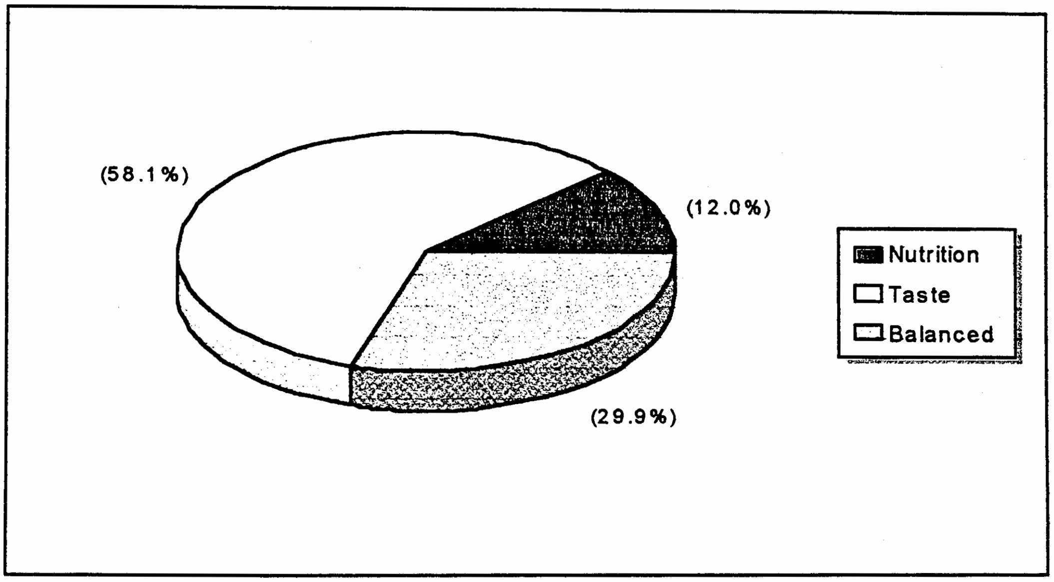


Figure 45. Priorities in making food choices.

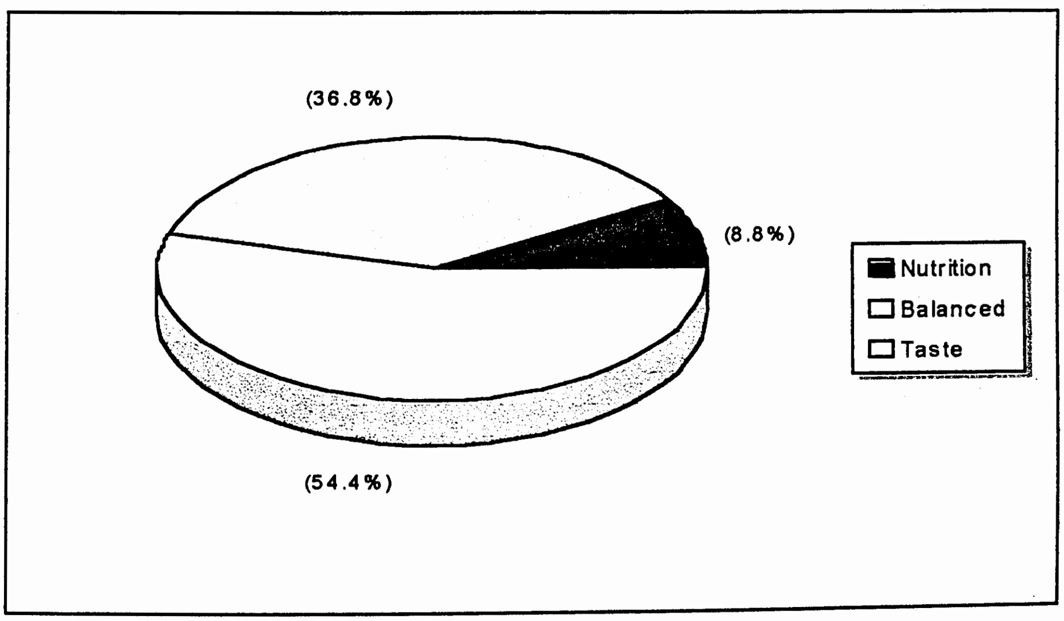


Figure 46. Priorities in food choices for PTC tasters.

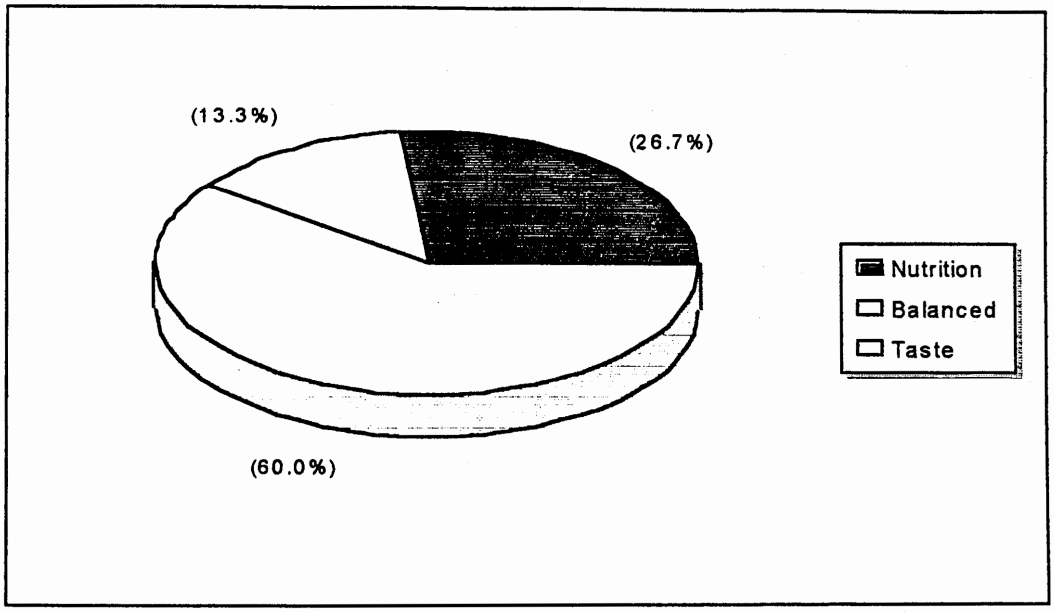
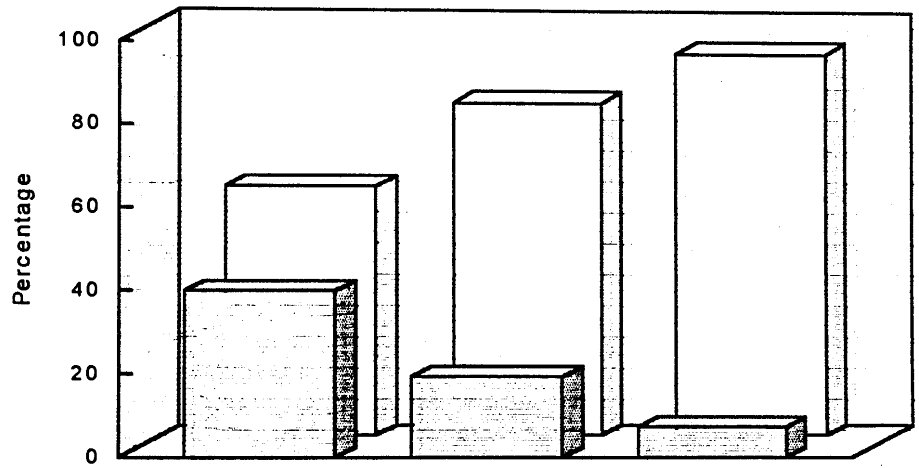


Figure 47. Priorities in food choices for non-tasters.

The same information taken from the perspective of the food choice priorities (Figure 48) shows that 40% of the students ranking nutrition higher than taste are non-tasters. That is double the percentage of students giving taste the higher rating and more than five times the percentage of students rating nutrition and taste equally.

Food Choice Priorities and Major

Grouping the students by majors and analyzing the priorities reveals only small percentages (2.4 to 9) of the culinary, hospitality and food science students gave nutrition a higher rating than taste. Culinary and



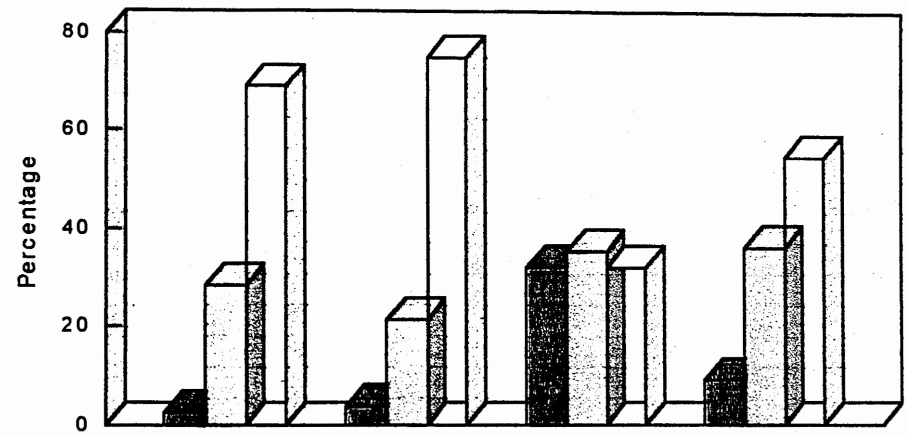
Priority	Nutrition	Taste	Balanced
Non-taster	40	19.6	7.4
PTC taster	60	80.4	92.6

Figure 48. PTC taster priority in making food choices.

especially hospitality students were heavily weighted toward taste but the food science majors were a little more evenly distributed between taste and a balanced priority. The nutrition students were almost evenly divided between the three categories (Figure 49).

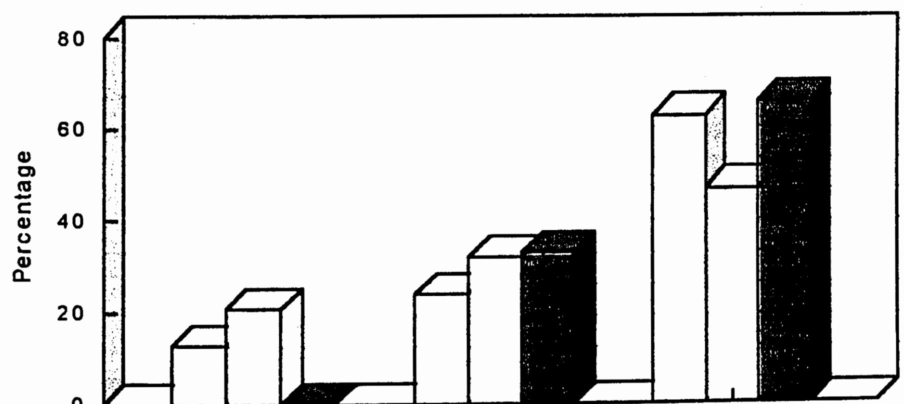
Food Choice Priorities and Food Preference Groups

Sorting the food choice priorities by food preference groups yields interesting extremes. No individual rating nutrition as the higher priority was classified in the high food preference group. The highest percent (66) of any



Major	Culinary	Hospitality	Nutrition	Food Sci
Nutrition	2.4	3.6	32.3	9
Balanced	28.6	21.4	35.3	36.4
Taste	69	75	32.3	54.6

Figure 49. Priorities in making food choices by major.



Priority	Nutrition	Balanced	Taste
Low	13	24	63
Medium	21	32	47
High	0	33	66

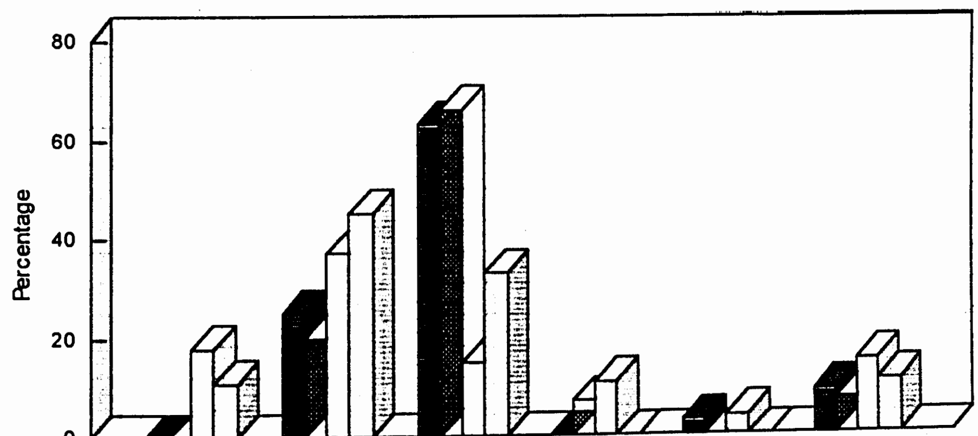
Figure 50. Food choice priorities separated into food preference groups.

category was the combination of taste priority and high food preference group (Figure 50).

<u>Major, Status, Food Choice Priorities</u>

<u>and Food Preference Groups</u>

The final section of analysis delves into the combination of major and PTC taster status and how that relates to food choice priorities and food preference groups (Figure 51 and Figure 52).



Status by Priority	PTC/ Nut	PTC/ Bal	PTC/ Taste	Non/ Nut	Non/ Bal	Non/ Taste
■ Culinary	0	25	63	0	3	9
□ Hospitaltiy	0	20	66	7	0	7
□ Nutrition	18	37	15	11	4	15
□ Food Sci	11	45	33	0	0	11

<u>Figure 51.</u> Major and PTC taster status divided into the food choice priorities.

Major, status and food choice priorities

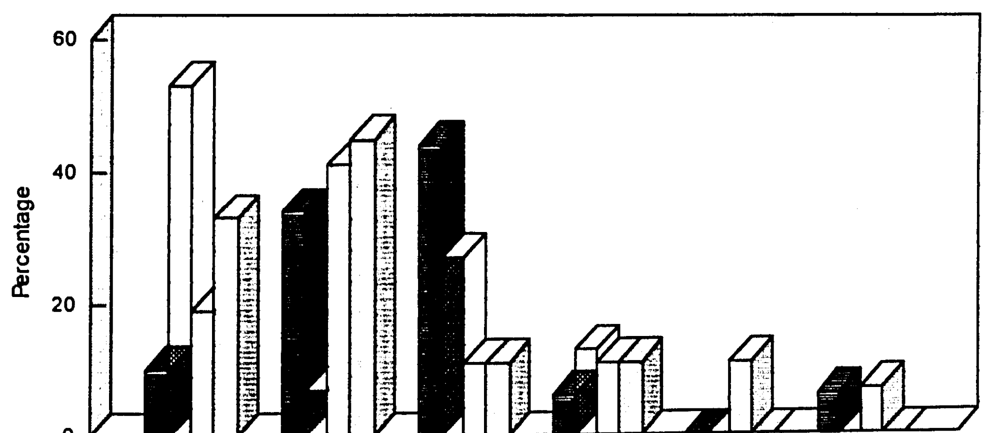
More than 60% of the culinary students were PTC tasters and gave taste the highest rating. One quarter of these future chefs were PTC tasters and gave nutrition an equal rating to taste. Of all the majors, hospitality students, had the greatest percentage of students that rated taste as the highest priority and were PTC tasters. About 20% of the hospitality PTC tasters gave nutrition and taste equal ratings.

The highest percentages of both nutrition and food science majors were PTC tasters balancing the priorities of nutrition and taste when making food choices. Nutrition students were the most evenly dispersed across the six different categories.

Most non-tasters rated taste equal to or higher than nutrition, regardless of their major.

Major, status and food preference groups

Using this same approach of dividing majors into tasters and non-tasters of PTC, then further classifying them by food preference groups, showed the greatest number of PTC tasting culinary students were in the high food preference group (Figure 52). More than 50% of the PTC taster hospitality majors were in the low category for food preferences. Again, the highest percent of PTC taster nutrition and food science majors were together in the medium food preference group. And again, regardless of major, most non-tasters were in the same category – the low food preference group.



Status by Group	PTC/ low	PTC/ med	PTC/ high	Non/ low	Non/ med	Non/ high
Culinary	10	34	44	6	0	6
Hospitaltiy	53	7	27	13	0	0
Nutrition	19	41	11	11	11	7
Food Sci	33	45	11	11	0	0

Figure 52. Major and PTC taster status divided into the food preference groups.

CHAPTER V

Summary and Conclusion

According to the results of this study, students majoring in food related fields are more likely to be PTC tasters than the general population. While there is a bimodal distribution of tasters and non-tasters of PTC, the percentage of non-tasters is smaller than would be expected if these students followed the typical genetic distribution found in the population as a whole.

When examining the PTC status of the sample group of students categorized by major, three of the four have a higher percentage of tasters than would be expected if they were drawn from the general population. Compared to culinary, hospitality and food science students, the nutrition majors have a higher percentage of non-tasters. The nutrition students were also found to have a lower level of tasters than the general population. The nutrition majors were also predominately Caucasian which may explain this lower than average rate of tasters since about one third of Caucasians are non-tasters.

Falciglia & Norton (1994) found that PTC tasters tended to have more food dislikes than non-tasters. In this group of students there were no more PTC tasters in the low food preference group than there were in the high. Most of the students in the high food preference group were PTC tasters. If taster status was an influence in food preferences, it appears to have been an inverse relationship.

The culinary students were the group that tended to have the highest food preference scores. This reinforces Rozin's (1990) assertion that one of the overwhelming determinants of food acceptance is exposure to that food. This group of students is exposed to a wide variety of foods on a daily basis which may have had a strong influence on their high food preference scores. The hospitality students had the greatest percentage of students in the lowest group of food preference scores. More than 50% of the PTC tasters that were in the low food preference group were hospitality students. This group may more closely reflect the general population and the sample of PTC tasters that Falciglia & Norton studied. (1994)

In conclusion, while there are genetic differences in taste, this study did not show any PTC taster related hereditary predisposition toward liking or disliking of foods containing bitter compounds. Of the whole realm of influences that shape each individual's food preferences, PTC taster status seems to have been overridden by the increased exposure to foods and the extensive education and training in foods that these groups of students have received. Since the group of students in this study was not a random sampling of the population their background may have offset the normal expectations.

Bartoshuk (1980) has said that we live in separate worlds of taste. Perhaps we do. The increased education and exposure of students in food related fields has set them apart from the population as a whole both in awareness and in perception. These students need to be made more aware of these differences and their causes so that they can gain better insight into the taste worlds of the people they serve.

Future work should be undertaken with a larger, ethnically more diverse group of nutrition students for further comparison of their PTC taster status with that of the general population and to other students in food related fields.

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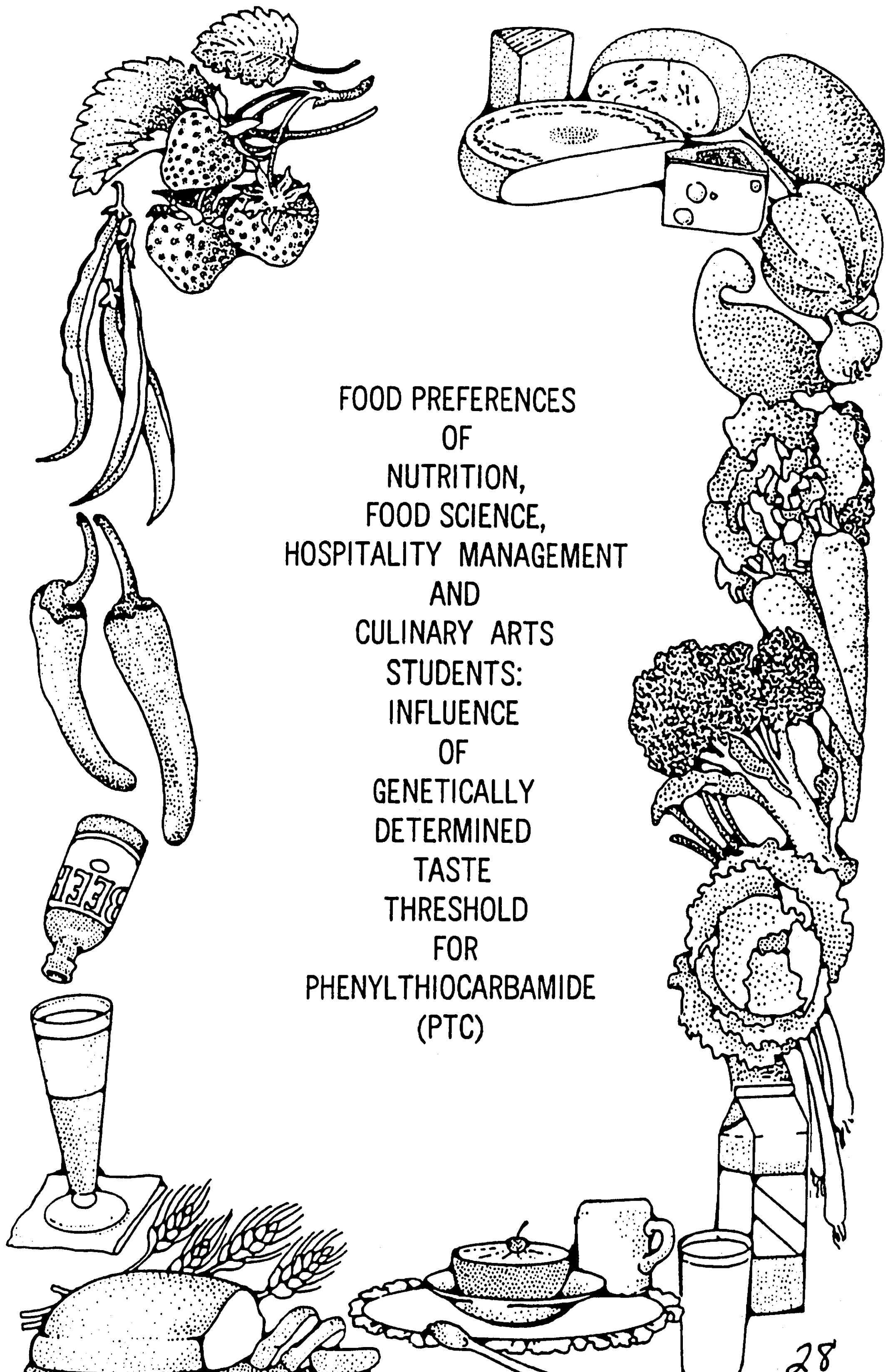
APPENDIX A



FOOD PREFERENCES OF NUTRITION, FOOD SCIENCE, HOSPITALITY MANAGEMENT AND CULINARY ARTS STUDENTS: INFLUENCE OF GENETICALLY DETERMINED TASTE THRESHOLD FOR PHENYLTHIOCARBAMIDE (PTC)

28

Food Preference Questionnaire
Please circle the number that best indicates how well you like or dislike the taste of the following foods. Ask the test administrator any questions you may have.

1. **Anchovies** Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

2. **Beer** Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

3. **Black Coffee** Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

4. **Broccoli** Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

5. **Brussels Sprouts** Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

6. **Buttermilk** Never Tried ☐

1 2 3 4 5 6 7 8 9
dislike extremely — neither like nor dislike — like extremely

7. **Cabbage** Never Tried ☐

1 2 3 4 5 6 7 8 9
dislike extremely — neither like nor dislike — like extremely

8. **Cottage Cheese** Never Tried ☐

1 2 3 4 5 6 7 8 9
dislike extremely — neither like nor dislike — like extremely

9. **Diet Soft Drinks** Never Tried ☐

1 2 3 4 5 6 7 8 9
dislike extremely — neither like nor dislike — like extremely

10. **Grapefruit Juice** Never Tried ☐

1 2 3 4 5 6 7 8 9
dislike extremely — neither like nor dislike — like extremely

11. Green Beans Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

12. Horseradish Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

13. Jalapeno Peppers Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

14. Kale Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

15. Salami Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

16. **Sharp Cheddar Cheese** Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

17. **Spinach** Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

18. **Strawberries** Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

19. **Turnips** Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

20. **Whole Wheat Bread** Never Tried ☐

1	2	3	4	5	6	7	8	9
dislike extremely				neither like nor dislike				like extremely

Genetic Taste Test

Lift off the dot holding the filter paper for the first sample and test by placing the filter paper on your tongue. You may close your mouth to help taste the paper but please do not swallow it. After you have tasted the first paper, please respond to the questions on taste and intensity before repeating the process for the second sample. Gum or candy will be provided to prevent any aftertaste from lingering. Keep the dots to learn test results.

Sample 480

Please circle the response that best indicates your taste perception of this sample.

tasteless sweet sour salty bitter

Please circle the response that best indicates your perception of the intensity of this sample's taste.

1	2	3	4	5	6	7	8	9
extremely weak								extremely strong

Sample 914

Please circle the response that best indicates your taste perception of this sample.

tasteless sweet sour salty bitter

Please circle the response that best indicates your perception of the intensity of this sample's taste.

1	2	3	4	5	6	7	8	9
extremely weak								extremely strong

Demographics Questions

The following questions will help me to better analyze the results of the food preference questionnaire. Please circle the response that best describes you.

Major	Nutrition or Dietetics Hospitality Management	Food Science Culinary or Pastry	
Gender	Male	Female	
Age	under 20 20-29 30-39 40-49 50-59 60 or over		
Ethnic Heritage	African American Native American	Asian Hispanic	Caucasian Multiracial

Do you smoke cigarettes? Yes No

When making food choices, the **nutritional** properties of that food are:

1	2	3	4	5	6	7	8	9
not at all important to me				neither important or not				extremely important to me

When making food choices, the **taste** qualities of that food are:

1	2	3	4	5	6	7	8	9
not at all important to me				neither important or not				extremely important to me

Monica Coulter
(612) 519-0327

Dear Student:

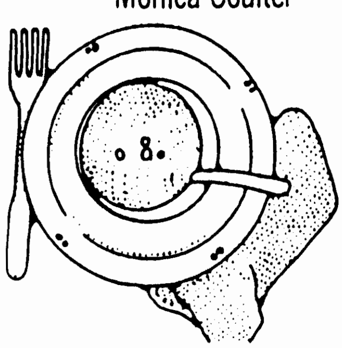
I am doing research as a part of a Masters in Nutrition degree for Texas Woman's University. I am investigating the food preferences of a variety of students in food related fields -- nutrition, food science, hospitality management and culinary arts. I am interested in how their food preferences compare and also in what role genetics may play in the development of food preferences.

This booklet contains a questionnaire and a taste test. The taste test uses slips of paper containing a compound that tastes different to people depending upon their genetic make-up.

Participation in this research is completely voluntary. I only want students that are interested and comfortable participating. If you do not wish to take part in the study, if you are under 18 years of age or if you are on any type of thyroid medication please feel free to read through the booklet while others are testing but do not answer the questions or take the taste test. Refusal to particpate will not impact your grade in this class.

Thank you so much for your help and good luck with your career,

Monica Coulter



"I understand that the return of my completed questionnaire constitutes my informed consent to act as a subject in this research."

Food Preferences and Genetics

"What to some is food to others may be sharp poison." Lucretius, the Roman poet and philosopher may have died in 55 BC, but his sentiments hold true even today.

Individual food preferences depend upon variety of different factors. Before a food can be liked or disliked, a person has to be exposed to that food. For that reason the culture in which we live plays a huge role. The geographic location, agricultural and economic availability, our ethnic background and religious beliefs are all important. Even within the same culture there is great diversity among individuals. There are complex interactions between factors -- experience, social statue, income, education and even occupation all play a role in food preferences.

Added to this increasingly involved scenario are genetic differences in our taste perception. The end result is that we each wind up living in our own individual worlds of taste.

In 1931 Dr. A. L. Fox, working in E. I. duPont deNemours laboratories in Wilmington, Delaware, accidentally spilled a powder called phenylthiocarbamide (PTC). Particles floating in the air found their way to some of his colleagues. Dr. Fox reported that they found the powder "bitter enough to make them go round sticking out their tongues and making wry faces for an hour" — while others exposed to the same chemical found it to be tasteless. This chance discovery was the start of what was to become the most thoroughly studied genetic trait involving taste.

Extensive testing has determined that the population is roughly divided into two groups, tasters and nontasters of PTC. While nontasters is the popular term used in the literature, most individuals can actually taste the compound. The difference is that they require a higher concentration of PTC or have what is called a higher taste threshold for tasting the chemical.

Phenylthiocarbamide or PTC is a compound containing nitrogen, carbon and sulfur with the particular chemical structure of $C_7H_8N_2S$. PTC is not used in commercial food production or medically but it is related to compounds that are used to treat thyroid disorders. It is just one of <u>many</u> different compounds that impart a bitter taste. It is one of the most frequently used compounds to determine genetic taste differences among individuals.

Perception of flavor is considered to have served an evolutionary purpose. Sweetness indicated a food naturally high in calories. Salt signaled the presence of necessary minerals. Sourness is thought to point out under-ripe fruit or potentially harmful acids and bitterness cautioned on the potential presence of poisons.

Taking this into account, research has been done to determine if perception of the bitterness in PTC plays a role in food preferences. A variety of commonly disliked foods, such as the cruciferous vegetables, contain similar bitter components. Since these vegetables also happen to exhibit antithyroid properties, some think that PTC taster status perhaps played a protective role in helping to determine what foods were accepted or rejected.

The questionnaire and taste test you just completed were designed to see what role this genetic difference may have on food preferences. PTC taste thresholds also tend to vary with gender. Women tend to perceive this bitter compounds more intensely. Age makes a difference too. Children find the bitterness more pronounced and older individuals find it less so. Even your ethnic group makes a difference. More individuals with European backgrounds are PTC nontasters. Relatively few people of Asian, Native American or African ancestry are PTC nontasters. Cigarette smoking tends to decrease sensitivity to bitterness.

In the taste test you just took, Samples _____ & _____ contained PTC and Samples _____ & _____ did not contain PTC. So what difference does it make to you if you are a taster or a nontaster of PTC? Well, if you are working in some aspect of the food industry it helps to realize that not everyone perceives foods in the exact same the same way you do. The foods listed on the questionnaire contain compounds that PTC tasters may find distasteful. There is a lot more involved in food preferences, though than just genetics. A lot of PTC tasters develop a liking for bitter foods. PTC nontasters may dislike the foods for other reasons.

Again, thank you so much for your help. I hope you enjoyed learning a little more about yourself. If you like to be informed of the final results of this research, fill out the information below and I will mail the information to you when my research is complete.

If you have any questions contact:
Monica Coulter (612) 519-0327
Dr. Andie Hsueh (817) 898-2646

✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂Please Print Clearly
Name:
Address:

APPENDIX B

Instructions for
Administering Questionnaire

This package should include:

An envelope addressed to me
_____ Booklets
_____ Information sheets
Gum and candy

A questionnaire is included for your information. Please read through it and the information sheet. Call me (612) 519 - 0327 if you have any questions.

This should not take more than 30 minutes of class time at the very most. Give one booklet to each of the students. The booklets should be turned so that they see the cover letter. Please make sure all students realize that their participation in this study is purely voluntary and that refusal to participate will not impact their grade in class.

Ask the students to read the cover letter before turning the booklet over and opening it. They may begin the questionnaire when they are ready. Please ask them not to talk amongst themselves as they work through the questions.

Pass out the candy or gum that I have provided. Please instruct the students to eat the candy or gum only after they have completed the taste test.

Instruct them not to chew or swallow the taste paper. If they keep their taste papers they can find out whether or not they are PTC tasters later.

After collecting the completed booklets, give each student the information sheet. It will give them additional information on food preferences and this taste test. It will also give them the numbers on the taste papers that contain PTC so that they will know whether or not they are "tasters".

The bottom of the information sheet contains a form that they may fill out if they want to know the results from this study. Have any interested students fill it out, tear it off and return it to you.

The envelope that is returned to me should include:

- All student booklets
- Requests for study results from the information sheets

Thank you so much for your help.

APPENDIX C

Panelist	PTC 562 / 914	Color	Control 237 / 480	School	Completed /returned
1	B 562	Red	A 237	TWU Houston	
2	A 914		B 480		
3	A 562		B 237		
4	B 914		A 480		
5	B 562	Yellow	A 237		
6	B 914		A 480		*
7	A 562		B 237		*
8	B 914		A 480		*
9	A 562	Red	B 237		*
10	A 914		B 480		*
11	B 562		A 237		*
12	A 914		B 480		*
13	A 562	Yellow	B 237		*
14	B 914		A 480		*
15	B 562		A 237		*
16	B 914		A 480		*
17	A 562	Red	B 237	TWU Denton	
18	B 914		A 480		
19	A 562		B 237		
20	A 914		B 480		
21	B 562	Yellow	A 237		
22	A 914		B 480		
23	A 562		B 237		
24	B 914		A 480		
25	B 562	Red	A 237		
26	A 914		B 480		
27	A 562		B 237		
28	B 914		A 480		
29	B 562	Yellow	A 237		
30	B 914		A 480		
31	A 562		B 237		
32	B 914		A 480		
33	A 562	Red	B 237		
34	A 914		B 480		
35	B 562		A 237		
36	A 914		B 480		
37	A 562	Yellow	B 237		
38	B 914		A 480		
39	B 562		A 237		
40	B 914		A 480		

Panelist	PTC 562 / 914	Color	Control 237 / 480	School	Completed /returned
41	A 562	Red	B 237		
42	B 914		A 480		
43	A 562		B 237		
44	A 914		B 480		
45	B 562	Yellow	A 237		
46	A 914		B 480		
47	A 562		B 237		
48	B 914		A 480		
49	B 562	Red	A 237	UNT	
50	A 914		B 480		*
51	A 562		B 237		*
52	B 914		A 480		*
53	B 562	Yellow	A 237		*
54	B 914		A 480		*
55	A 562		B 237		*
56	B 914		A 480		*
57	A 562	Red	B 237		*
58	A 914		B 480		*
59	B 562		A 237		*
60	A 914		B 480		*
61	A 562	Yellow	B 237		*
62	B 914		A 480		*
63	B 562		A 237		*
64	B 914		A 480		*
65	A 562	Red	B 237		*
66	B 914		A 480		*
67	A 562		B 237		*
68	A 914		B 480		*
69	B 562	Yellow	A 237		*
70	A 914		B 480		*
71	A 562		B 237		*
72	B 914		A 480		*
73	B 562	Red	A 237		*
74	A 914		B 480		*
75	A 562		B 237	TWU Denton	*
76	B 914		A 480		*
77	B 562	Yellow	A 237		*
78	B 914		A 480		*
79	A 562		B 237		*
80	B 914		A 480		*

Panelist	PTC 562 / 914	Color	Control 237 / 480	School	Completed /returned
81	A 562	Red	B 237		*
82	A 914		B 480		*
83	B 562		A 237		*
84	A 914		B 480		*
85	A 562	Yellow	B 237		*
86	B 914		A 480		*
87	B 562		A 237		*
88	B 914		A 480		*
89	A 562	Red	B 237		*
90	B 914		A 480		*
91	A 562		B 237		*
92	A 914		B 480		*
93	B 562	Yellow	A 237		*
94	A 914		B 480		
95	A 562		B 237		*
96	B 914		A 480		*
97	B 562	Red	A 237		*
98	A 914		B 480		*
99	A 562		B 237		*
100	B 914		A 480		*
101	B 562	Yellow	A 237		*
102	B 914		A 480		*
103	A 562		B 237		*
104	B 914		A 480		*
105	A 562	Red	B 237		*
106	A 914		B 480		*
107	B 562		A 237		*
108	A 914		B 480		*
109	A 562	Yellow	B 237		
110	B 914		A 480		
111	B 562		A 237		
112	B 914		A 480		
113	A 562	Red	B 237		
114	B 914		A 480		
115	A 562		B 237		
116	A 914		B 480		
117	B 562	Yellow	A 237		
118	A 914		B 480		
119	A 562		B 237		
120	B 914		A 480		*

Panelist	PTC 562 / 914	Color	Control 237 / 480	School	Completed /returned
121	B 562	Red	A 237	CIA	*
122	A 914		B 480		*
123	A 562		B 237		*
124	B 914		A 480		*
125	B 562	Yellow	A 237		*
126	B 914		A 480		*
127	A 562		B 237		*
128	B 914		A 480		*
129	A 562	Red	B 237		*
130	A 914		B 480		*
131	B 562		A 237		*
132	A 914		B 480		*
133	A 562	Yellow	B 237		*
134	B 914		A 480		*
135	B 562		A 237		*
136	B 914		A 480		*
137	A 562	Red	B 237		*
138	B 914		A 480		*
139	A 562		B 237		*
140	A 914		B 480		*
141	B 562	Yellow	A 237		*
142	A 914		B 480		*
143	A 562		B 237		*
144	B 914		A 480		*
145	B 562	Red	A 237		*
146	A 914		B 480		*
147	A 562		B 237		*
148	B 914		A 480		*
149	B 562	Yellow	A 237		*
150	B 914		A 480		*
151	A 562		B 237		*
152	B 914		A 480		
153	A 562	Red	B 237		
154	A 914		B 480		*
155	B 562		A 237		*
156	A 914		B 480		*
157	A 562	Yellow	B 237		
158	B 914		A 480		*
159	B 562		A 237		
160	B 914		A 480		*

Panelist	PTC 562 / 914	Color	Control 237 / 480	School	Completed /returned
161	A 562	Red	B 237		
162	B 914		A 480		*
163	A 562		B 237		
164	A 914		B 480		*
165	B 562	Yellow	A 237		*
166	A 914		B 480		*
167	A 562		B 237		*
168	B 914		A 480		*
169	B 562	Red	A 237		*
170	A 914		B 480		*
171	A 562		B 237		*
172	B 914		A 480		*
173	B 562	Yellow	A 237		*
174	B 914		A 480		*
175	A 562		B 237		