PALATABILITY OF BITTER MELON AND THE EFFECT OF HEALTH INFORMATION ON CONSUMPTION INTENTIONS: A PILOT STUDY

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ABSTRACT

Diabetes is a complex disease that can lead to many complications. In the US, diabetes morbidity and mortality are more prevalent among minorities, including Native Hawaiians. Current treatments focus on diet, exercise, and drug therapies. However, effectiveness of such therapies has often been poor. The complex disease pathophysiology, disease progression, and expense or ineffectiveness of medications can be discouraging to diabetics. Therefore, alternative therapies are becoming more sought after and researched for their potential effectiveness in diabetes treatment.

Momordica charantia (bitter melon) has been effectively used in traditional medicine to treat diabetes and its complications. Hypoglycemic activity has been demonstrated in animal models, *in vitro* studies, and a few clinical trials. More recently, it has been investigated for its potential to improve blood lipid profiles.
Bitter melon's active compounds are not entirely known and therefore future clinical trials require the use of whole bitter melon to determine safety and efficacy. However, subject compliance with consumption is of concern due to its bitter taste.

Taste is regarded as the primary reason for individual food choice, but evidence suggests that health information can affect consumption. It is hypothesized that bitter melon preparations that mask bitterness will increase acceptability and consumption intentions and that providing bitter melon health information will increase consumption intentions. The objective of this study was to develop and determine the palatability of recipes containing bitter melon and to determine the effect of health information on future consumption intentions.

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CHAPTER 1

REVIEW OF LITERATURE

Diabetes

Diabetes mellitus is a chronic disease generally characterized by hyperglycemia (high blood glucose) due to the abnormal metabolism of carbohydrate, protein, and fat. Diabetes is classified into several different types according to insulin production and action, as well as onset of the disease. Insulin is a hormone produced by the β-cells of the pancreas and is required for uptake of glucose from the bloodstream into the body's cells. Without enough or properly functioning insulin, glucose cannot be taken up by the cells and blood glucose or "blood sugar" will increase to abnormal levels. Type 1 diabetes was previously referred to as insulin-dependent diabetes mellitus or IDDM because affected individuals typically are unable to produce insulin and, therefore, require insulin administration. Type 1 diabetes is often, but not always, diagnosed in childhood and is either idiopathic or immune-mediated. The latter occurs when an individual's own immune system attacks and destroys the β-cells of the pancreas, reducing or eliminating insulin production. Approximately 5-10% of diagnosed diabetes cases are classified as type 1. Type 2 diabetes typically experience hyperinsulinemia (high blood insulin levels), their peripheral cells become resistant to insulin action, and their pancreas may eventually reduce or stop insulin secretion. Diagnosis typically occurs in adulthood, although the prevalence of children with type 2 is on the rise. This type was previously known as non-insulin dependent diabetes mellitus or NIDDM and makes up 90-95% of all diabetes cases (1).

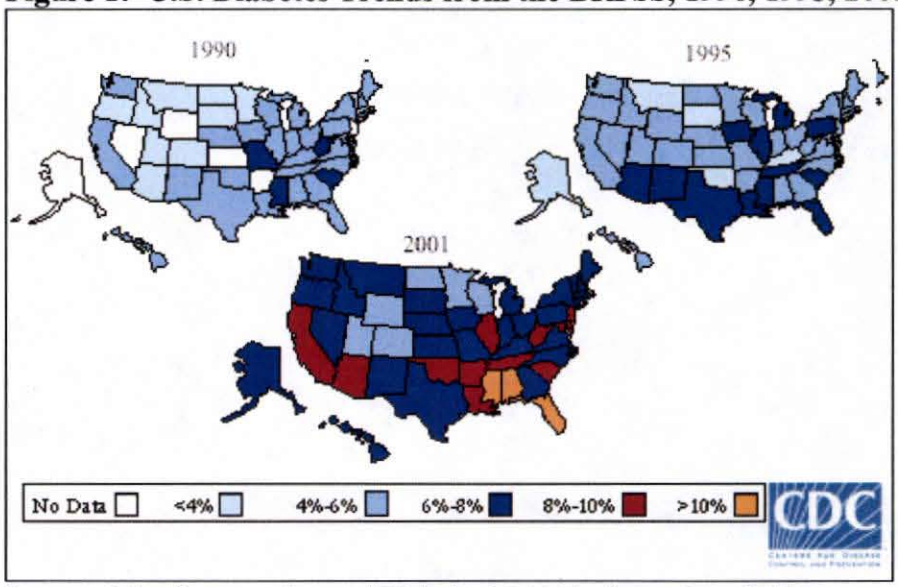
Prevalence of Diabetes

Globally, the prevalence of diabetes, especially type 2 diabetes, is increasing (2-4). Over the past two decades, a diabetes epidemic has emerged with little to no evidence of slowing in sight. In 1985, the World Health Organization (WHO) estimated that 30 million people were living with diabetes worldwide. This number jumped to 177 million in the most current estimate determined for the year 2000. It is expected to increase further to upwards of 300 million by the year 2025 (2). A recent report based on the WHO Global Burden of Disease Study projects the number of people with diabetes to reach 366 million people by the year 2030. This would represent a worldwide prevalence of diabetes equal to 4.4% for all age groups. However, this estimate assumes that two important factors contributing to this disease, obesity and physical inactivity, remain constant (4). Thus, it is very likely that the worldwide prevalence is actually higher than the 4.4% prediction considering that the prevalence of obesity is also increasing (5). Potential factors contributing to the increasing prevalence of diabetes may include not only the rise in obesity and lack of physical activity but also the increasing world population, urbanization, and increased lifespan (4).

In the United States (US) alone, an estimated 20.8 million people (approximately 7% of the population) have diabetes. Of these individuals, 14.6 million have been diagnosed, however, an estimated 6.2 million remain undiagnosed. The prevalence of diabetes varies from state to state, but is increasing nationwide according to data from the Behavioral Risk Factor Surveillance Survey (BRFSS) (6). Figure 1 depicts the BRFSS diabetes trends in the U.S. from 1990 to 2001. In Hawaii, an estimated 100,000 people are living with diabetes. Approximately 25% of these individuals are undiagnosed

according to the most recent statistics given in the 2004 Hawaii Diabetes Report (7). The overall prevalence of diagnosed diabetes is nearly 6% of the adult population with unequal distribution among the various ethnic groups. Native Hawaiians have the highest prevalence of the disease (7.9%), followed by Filipinos (7.5%) and Japanese (6.6%). Whites in Hawaii have a significantly lower prevalence of diabetes (3.4%) when adjusting for age and Native Hawaiians have the lowest mean age of diabetes (44.6 years) diagnosis of all ethnic groups in Hawaii.

Figure 1: U.S. Diabetes Trends from the BRFSS, 1990, 1995, 2001



Source: http://www.cdc.gov/Diabetes/statistics/maps/map1.htm

Although the 2004 Hawaii Diabetes Report provides the latest figures on diabetes in the state, prevalence of this disease is likely higher today because these numbers are based on data from the 2000-2002 Hawaii BRFSS. Even if these figures are underestimated, no age group over 35 meets the Healthy People 2010 objective for a maximum diabetes prevalence of 2.5% (8). The data are based on self-reported diabetes and therefore

prevalence may be higher in younger age groups due to lack of symptoms and a number of undiagnosed cases in the population. The enormity of the problem is clearly evident with over 900 deaths reported annually in Hawaii due to diabetes-related complications. It is the seventh leading cause of death statewide and a significant contributor to morbidity among adults. Notably, the major contributing factor to end stage renal disease (ESRD) dialysis in Hawaii is diabetes. This is due to the fact that high blood glucose causes damage to the blood vessels of the kidneys, eventually leading to kidney failure. Individuals then require dialysis to adequately filter their blood. Both the incidence rate and prevalence of ESRD are higher in Hawaii (incidence = 393.6 per million; prevalence = 1502.1 per million) than the national average (incidence = 292.5 per million; prevalence = 1039.7 per million) (7).

The rising number of children and adolescents with type 2 diabetes is of further concern (9). Children with diabetes are at greater risk for serious medical complications earlier in life and throughout adulthood (10). According to results from the 1999-2002 National Health and Nutrition Examination Survey (NHANES), the self-reported prevalence of diabetes in US adolescents was 0.5%. Among the same sample, the prevalence of impaired fasting glucose (IFG), a diagnostic condition that puts these individuals at greater risk for developing type 2 diabetes and cardiovascular disease (CVD), was 11% (2, 11). These numbers represented increases from NHANES III (1988-1994) in which the prevalence of IFG was less than 2% and the prevalence of type 2 diabetes was so low that it could not precisely be estimated from the small sample size (12). The redefining of IGF from <100 mg/dL to <110 mg/dL may be largely responsible for the increase in diabetes prevalence seen between NHANES II and NHANES III.

However, a general increase in the diagnosis of type 2 diabetes in children has widely been reported elsewhere (10, 13-15).

Complications of Diabetes

Both microvascular and macrovascular complications can arise from diabetes. In the general population, diabetes is the leading cause of lower limb amputations due to nerve damage and the leading cause of new cases of blindness among those ages 20-74 (16). Over 20% of those with the disease in Hawaii have diabetic retinopathy (7). In addition to neuropathy and retinopathy, diabetes is the main contributor to ESRD; and diabetics are two to four times more likely to develop coronary artery disease (CAD) (15-18) Dyslipidemias (abnormal blood lipid profiles), hypertension (high blood pressure), and abdominal obesity (waist circumference ≥35 in. for women; ≥40 in. for men) are all risk factors for heart disease that diabetics experience. Collectively, the combination of such factors with insulin resistance is referred to as the metabolic syndrome, also known as insulin resistance syndrome or "syndrome X" (15, 17). Untreated insulin resistance can eventually lead to the development of diabetes (19). Even individuals with slightly impaired blood glucose are at a higher risk for CAD (15, 17). Based on the most recent data from 2002, the National Institutes of Health (NIH) reports that diabetes is the sixth leading cause of death nationwide (20). Mortality among people with type 2 diabetes is primarily due to macrovascular complications, especially CVD (21). Although CAD is the most prevalent manifestation of macrovascular changes, peripheral artery disease (PAD) and cerebrovascular disease or strokes are also potential concerns for the diabetic individual. Also, over 70% of diabetics use antihypertensive medications or are at risk for hypertension with blood pressure >130/80 mm Hg. Since there is a wide spectrum of

potential problems that can result from the disease, treatment requires an integrated approach that focuses on prevention of both microvascular and macrovascular complications (17).

Treatment for Diabetes

Individual behavior change and a need for self-care over the long term are crucial in diabetes treatment. A recent study suggested that patient education in the areas of glucose monitoring, nutrition, exercise, and disease pathophysiology increases diabetic self care and disease knowledge (22). Maintenance of blood glucose levels at normal or near normal levels is integral in the treatment of both types of diabetes due to the cascade of problems that stem from abnormal glycemic control (18). Thus, therapies that reduce high blood glucose are the primary focus in most treatment plans (17). Clinical studies have shown that therapies aimed at lowering blood glucose can significantly reduce microvascular complications (18). However, glycemic control therapies alone have not been proven to reduce all macrovascular complications (17). Treatment for individuals with heart disease risk factors, such as dyslipidemias and hyptertension, require control of blood glucose, blood pressure, and blood lipids. These diabetics are more likely to experience morbidity and mortality from macrovascular complications, such as CVD. Strategies should typically integrate nutrition, exercise, and pharmacologic therapies.

Nutrition Therapy for Diabetes

An individualized approach to nutrition therapy should be based on the presence of other risk factors, such as a Body Mass Index (BMI) $\geq$25 kg/m^2 and hypertension, generally defined as blood pressure $\geq$140/90 mm Hg. Individuals who are overweight (BMI 25-

29.9 kg/m^2), obese (BMI = 30-30.9 kg/m^2), or extremely obese (BMI ≥40 kg/m^2) are encouraged to lose weight to improve insulin resistance and prevent complications. Reduced energy and fat intake less than 30% of total caloric intake without extreme carbohydrate restriction (<130 grams/day) are generally recommended for these individuals (23). Diet alone may not be sufficient to prevent or control diabetes. Regular physical activity, in conjunction with improved nutrition, is recommended to help achieve weight loss and improve insulin sensitivity in the overweight or obese individual. However, exercise alone has been shown to decrease insulin resistance and lower blood glucose, independent of weight loss. Regular physical activity is therefore also recommended for individuals with abnormal or impaired blood glucose who are at a normal weight for height (BMI = 18.5-24.9 kg/m^2) (23).

The basic nutrition recommendations for type 2 diabetes are similar to those for the general population. In particular, individuals should consume 55-60% of calories from carbohydrate sources such as fruits, vegetables, whole grains, low-fat dairy, and legumes. A "high" fiber diet, at least 20-35 grams/day, from a variety of food sources is generally recommended. Protein should make up 12-15% of energy intake for individuals with sufficient renal function, while total fat and saturated fatty acid consumption should not exceed 30% and 7% of energy intake, respectively. Additionally, carbohydrate monitoring methods are encouraged to ensure the amount and timing of consumption is optimal for blood glucose control. Moderate alcohol consumption (≤1 drink/day for women and ≤2 drinks/day for men), especially when mixed with carbohydrates as a "mixed drink" is also recommended for diabetics. Alcohol consumed alone can cause nocturnal hypoglycemia in individuals receiving

insulin therapy. Therefore, these individuals should consume food when drinking alcohol beverages (23). Individuals who cannot control elevated blood glucose, blood lipids, or blood pressure with diet and exercise eventually require pharmacologic interventions (18).

Medications for Diabetes

Pharmacologic agents for hyperglycemia include a group of drugs known as oral hypoglycemic agents, such as the sulphonylureas and metformin, as well as insulin therapy. Metformin reduces blood sugar by inhibiting glucose absorption in the gastrointestinal (GI) tract, reducing hepatic glucose production, and increasing cellular insulin sensitivity. The sulphonylureas stimulate the pancreas to increase insulin production. Nearly 60% of all diabetics take oral hypoglycemics while 28% use insulin alone or in conjunction with oral agents (20). However, approximately 40% of those with type 2 diabetes will eventually require insulin for glucose control (1). Unfortunately, results from both the University Group Diabetes Study and the United Kingdom Prospective Diabetes Study (UKPDS) have shown that diabetes is a disease that progresses over time even with the use of pharmacologic agents (18).

Co-morbidities associated with diabetes often necessitate the use of multiple pharmacologic agents. For example, individuals may require medication to control high blood pressure. Blood pressure-lowering treatment is important for lowering CVD risk and can also reduce microvascular complications significantly in the diabetic individual. Reduction in blood pressure can lower the risk for CVD by up to 50% and for any complication by 12% for every 10 mm Hg decrease in systolic blood pressure (20). However, pharmaceuticals in general may not completely prevent or control diabetic

complications and they often have undesirable side effects, such as gastrointestinal distress, liver toxicity, increases in plasma LDL cholesterol, or weight gain. Additionally, the sulfonylureas can cause the pancreas to experience "β-cell burnout" in which the insulin-producing cells of the pancreas decrease or stop producing insulin after repeated stimulation by this class of drugs (5, 24) .

Diabetes and Dyslipidemias

Individuals with type 2 diabetes commonly have a blood lipid profile that increases their risk for cardiovascular disease. They often have blood values that are high in triglycerides and very low density lipoprotein cholesterol (VLDL-C) and low in high-density lipoproteins (HDLs), also known as "good cholesterol." Although low-density lipoproteins (LDLs) or "bad cholesterol" and total blood cholesterol are not significantly different between those with and without diabetes, they still may play a role in the progression of CVD in diabetics. The National Cholesterol Evaluation Program recommends that diabetes be considered equal in risk to coronary heart disease for the management of abnormal lipid profiles (15, 23). Therefore, recommendations for individuals with type 2 diabetes are the same as those for nondiabetic individuals with CVD. For example, it is recommended that dietary intake of fats high in saturated fatty acids not exceed 7% of caloric intake versus 10% in the general population and that cholesterol intake not exceed 200 mg/day. Periodic monitoring of blood lipid levels and treatments aimed at maintaining near normal levels are recommended. HDL levels can be improved through exercise while medications are available to treat high triglycerides and total cholesterol (1). Unfortunately, medications do not completely control or prevent complications and may have undesirable side effects. For such reasons, many

individuals with diabetes and other chronic diseases are more often looking to complementary and alternative medicine (CAM) in addition to conventional medical treatments (25, 26).

Complementary and Alternative Medicine

CAM is defined by NIH's National Center for Complementary and Alternative Medicine (NCCAM) as "a group of diverse medical and health-care systems, practices, and products that are not presently considered part of conventional medicine" (26, 27). Complementary medicine is used in conjunction with conventional medicine rather than completely replacing it, as is done in alternative medicine. NCCAM designates the types of CAM as biologically based practices, such as pharmacologic use of vitamins and herbal use, as well as energy medicine, mind-body medicine, and manipulative and body-based practices (28). Biologically-based practices are the most commonly used CAM in the US when prayer is not included in the definition. In recent years, national surveys have shown that the number of people using CAM is increasing (29). Approximately 40% of the US population uses one or more types of CAM, and those more likely to use CAM include women, more educated individuals, nonsmokers or former smokers, and those recently hospitalized (26, 28). Alternative medicine is even more common in developing countries which make up the majority of the estimated 75% of the world population relying on herbal medicine as their primary means of health care (26, 30).

Diabetes is a common condition for which the use of CAM is prevalent. A national survey of CAM use in the US found that 57% of those with diabetes reported use of one or more therapies in the preceding year and 35% of those individuals reported use specifically for their diabetes (28). These therapies were reported to be "very helpful" by

over 60% of diabetics surveyed. If prayer is removed from the analysis, only 20% reported CAM use specifically for their diabetes. Use of therapies that excluded prayer was reported to be "very helpful" by nearly 40% of users. CAM use may be even higher than this survey indicates because the "national sample" excluded those who spoke languages other than English, and previous research has shown that people from various ethnic backgrounds use a variety of CAM therapies for diabetes (31). A study among patients in India with diabetes found that "naturopathy" was the most common type of CAM use and the most common perception among users was that it lowered blood sugar (26). Other types of CAM used by diabetics include acupuncture, herbal medicine, meditation, massage therapy, homeopathy, spiritual healing, and hypnosis (16). Herbal therapies or remedies and nutritional advice from CAM providers are the most common type of CAM used by diabetics in the US (16, 31). Over 800 plants in various forms are reportedly used to treat diabetes (32).

***Momordica charantia* (Bitter Melon)**

Momordica charantia (bitter melon) is traditionally used in Ayurvedic and Chinese medicine to treat diabetes. It is widely available in local markets or as a supplement in health food stores. Bitter melon is a member of the *Cucurbitaceae* family of vegetables which also includes the cucumber, squash, and a variety of melons (33). It is widely cultivated in the subtropical regions of South America, Asia, Africa, the Amazon, and the Caribbean (30). There are slight variations in cultivars of the fruit, but it generally is orange-yellow to light green in color and looks like a cucumber with more pointed ends and ridges with protrusions along the sides (see Appendix A, p. 60). Bitter melon is also referred to as bitter gourd, balsam pear, *ku gua*, balsam apple, and *caraille* (30, 33-35).

For centuries, it has been used throughout the world as both a food and a medicinal remedy. The fruit, immature leaves, and roots of the bitter melon plant can each be consumed, although all parts of the plant are bitter tasting. Food preparations range from stir-fried bitter melon to bitter melon curries, such as those found in China and India, respectively. It may also be stuffed with pork or other meats or it may be pickled. Often it is first blanched or immersed in salt water prior to preparation in order to remove or reduce the bitterness (36).

Bitter melon has been used as a remedy for many conditions and research has shown its potential effectiveness as an antibacterial, anticancer, anti-diabetic, and antiviral agent (30). It has gained popularity recently in the realm of CAM in the treatment of obesity, metabolic syndrome, and diabetes. Complementary use of bitter melon may include herbal or botanical preparations. Herbal use includes consumption of the roots and leaves whereas botanical use refers to the inclusion of parts of the entire plant (37).

Hypoglycemic Activity of Bitter Melon

Hypoglycemic properties have been exhibited in numerous animal studies by all parts of the plant, including the fruit, seeds, and leaves (24). The most common medicinal use of bitter melon is as an anti-diabetic agent to reduce blood sugar, especially in China, India, and Central America (35). A few clinical trials in humans have demonstrated its potential use as a hypoglycemic agent. Table 1 lists clinical trials that have been conducted using bitter melon. Most of these studies were neither randomized nor placebo-controlled trials and were conducted on type 1, type 2, or both types of

Table 1: Clinical Trials Investigating the Anti-Diabetic Potential of Bitter Melon

Clinical Trial	Population	Bitter Melon Preparation & Administration	Dosage & Duration	Primary Disease Outcomes	Results
Ahmad 1999 (38)	100 NIDDM diabetics	Aqueous suspension of pulp Oral	100g/200mL water reduced to 100mL suspension 2 days	2 hr. post-prandial glucose (75g) & FBG*	86% subjects had significant reduction in post-prandial glucose & FBG; 5% had significant reduction in FBG only
Akhtar 1982 (39)	8 NIDDM diabetics: -4 males -4 females	Dried powder Oral	50 mg/kg body weight twice daily 7 days	50g OGTT*, "Urine sugar level" & FBG	Significant reduction in FBG, area under glucose curves, and urine sugar levels
Baldwa 1976 (40)	9 diabetics: 6 - type 1 1 - type 2 2 - "chemical"	"Plant insulin" Subcutaneous injection	10-30 units	BG*	Mean fall in BG by 45±13.6%
Leatherdale 1981 (41)	9 NIDDM diabetics: -6 males -3 females	1)Fruit juice/oral 2)Fried/oral	1)50 ml 1 day 2) 0.23kg daily; 8-11 weeks	1)plasma glucose & 50g OGTT 2)50g OGTT & HbA_{1c}*	1) Significant reductions in plasma glucose & area under glucose curves 2) Significant reduction in HbA_{1c} and area under glucose curves
Srivastava 1993 (42)	12 type 2 diabetics	Aqueous extract or dried fruit powder oral	1)100g/200mL water reduced to 100mL extract (n=7) 2)5g dried powder (n=5) 21 days	BG, HbA_{1c}	1)54% decrease in mean BG & significant decrease in HbA_{1c} 2) 25% BG decrease (not significant)
Wellhinda 1986 (43)	18 type 2 diabetics	fruit juice oral	100mL 2 days	50g OGTT	73% of subjects showed significant improvement

***Abbreviations used: Fasting Blood Glucose (FBG), Oral Glucose Tolerance Test (OGTT), Blood Glucose (BG), Hemoglobin A_{1c} (HbA_{1c})**

diabetic individuals. Also, they were conducted with relatively small samples using a variety of preparations, dosages, and for varying amounts of time. Although bitter melon preparation and dosages varied greatly among these trials, results generally suggest that bitter melon has potential as a treatment for high blood sugar. The extent of bitter melon's hypoglycemic effect varied by onset, duration, and peak effect on blood glucose(33). It has been hypothesized that bitter melon lowers blood glucose by inhibiting glucose absorption in the gastrointestinal tract, by decreasing hepatic glucose production, or increasing insulin production in the pancreas (33, 44).

Although no known previous clinical trials have been conducted with whole bitter melon fruit, there have been two studies that investigated the effects of an aqueous extract of bitter melon (38, 42). Srivastava found a significant reduction in blood glucose when subjects consumed an aqueous extract of bitter melon prepared when 100 grams of bitter melon and 200 milliliters of water were reduced by 50% to 100 milliliters (42). Ahmad found that out of 100 individuals with "mild" NIDDM, 86% showed significant reduction in post-prandial glucose and fasting blood glucose after consumption of an "aqueous suspension" of bitter melon pulp (38).

Precautions must be taken when providing bitter melon to diabetics because research suggests that bitter melon consumed in conjunction with some medications for diabetes, namely sulfonylureas, can have a cumulative lowering effect on blood glucose and therefore increase the risk of hypoglycemia or a hypoglycemic coma (33). Consumption of bitter melon may also put non-diabetic individuals with preexisting problems with hypoglycemia at similar risk. Additionally, a recent review of bitter melon safety and efficacy cited two reported cases of hypoglycemic coma and

convulsions in children who consumed bitter melon tea (33). Other research has shown that proteins in bitter melon may lead to spontaneous abortion in mice and rats (45).

Lipid Normalizing Activity

There is evidence from animal and *in vitro* studies that bitter melon is a viable treatment for dyslipidemias (35, 46-49). Rats fed either a cholesterol-enriched or non-cholesterol-enriched diet showed significant increases in serum HDLs and decreases in total cholesterol and triglycerides in the liver when fed freeze-dried bitter melon powder. However, total cholesterol and triglyceride levels in the blood decreased in a dose-dependent manner only in the rats fed a non-cholesterol-enriched diet (47). Another study by Ahmed, *et al.*, reported that streptozotocin-induced type 1 diabetic rats fed the fruit extract of bitter melon had reduced levels of blood cholesterol and triglycerides and increased HDLs compared to diabetic rats not fed bitter melon. Additionally, non-diabetic control rats fed bitter melon had significantly lower total blood cholesterol levels than controls fed a diet without bitter melon (48).

Bitter melon has also been shown to decrease very-low density lipoprotein (VLDL) levels. This could be promising for some type 2 diabetics because VLDLs are often increased in these individuals. Research suggests that increases in VLDL levels occur because insulin resistance leads to an increase in plasma free fatty acids available for the formation of VLDLs in the liver. As the number of VLDLs increases, HDL particles decrease and LDLs become smaller and denser because VLDLs affect the exchange of cholesteryl esters among lipoproteins. Having fewer HDLs and increased small, dense LDLs is an undesirable lipid profile that increases one's risk for CVD (17).

An aqueous extract of whole, fresh fruit of bitter melon fed to alloxan-induced diabetic rats and control rats decreased elevated VLDL levels in the diabetic rats and lowered blood glucose in a manner similar to glibenclamide, a oral hypoglycemic sulfonylurea, currently used by many diabetics (50). An *in vitro* study using human hepatoma cells found that bitter melon juice decreased the secretion of apoprotein B (apoB), a lipoprotein-containing molecule (35). Reduced apoB secretion may explain one pathway in which bitter melon acts to decrease VLDLs as shown in previous research. Although many studies have demonstrated efficacy using various bitter melon preparations, the exact components that are responsible for its effects on lipids and blood sugar are not entirely known. Safety issues are also a concern when using concentrated preparations of the plant due to the potential for increased potency and documented adverse effects in animals (33).

"Plant insulin" extracted from bitter melon has been injected subcutaneously in a clinical trial (40), but there are safety concerns with the dosage and administration using such methods. Several sources have suggested that additional randomized, controlled clinical trials be performed especially to verify dosage, safety, and benefits of bitter melon (4, 51). Despite a lack of data on optimum dosage and preparations, consumption of the whole fruit has occurred for centuries and more likely incorporates all active ingredients with the least risk to the general population. Therefore, clinical trials using the whole fruit of the plant are warranted. However, the feasibility of such a trial may be limited due to the unacceptability of the bitter taste associated with consuming bitter melon, especially in western countries. The palatability or acceptability of bitter melon

preparations should first be examined prior to conducting clinical trials in which the consumption of whole bitter melon fruit is included in research protocol.

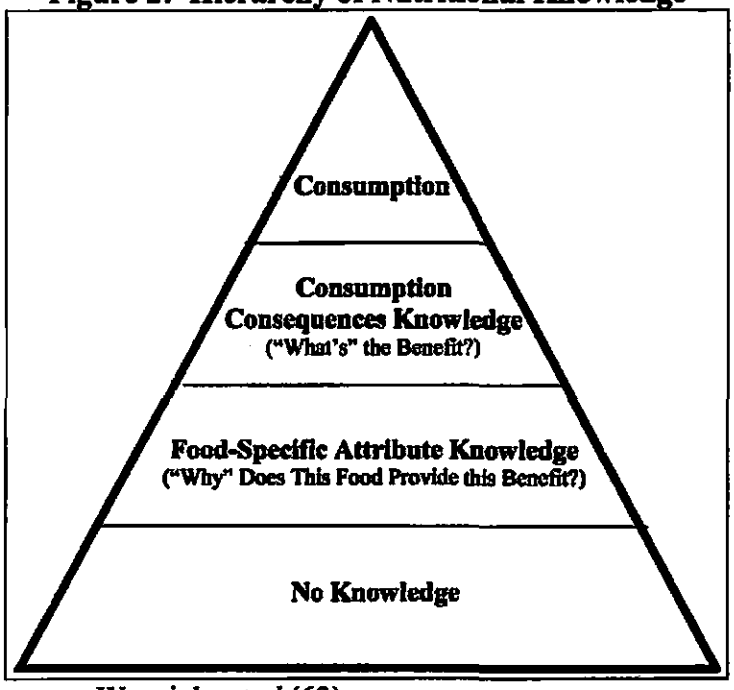
Palatability of Bitter Melon

Many factors influence individual food choices. It is reported that acceptance of food depends on an individual's attitude toward the food. Attitudes are formed by many factors that make up one's perception of a food's overall quality (52). For example, social, cultural, and religious factors can all be important determinants of what one chooses to eat (53). However, taste is typically the most important factor in food choice (54). Bitter foods make up only a small percentage of the total caloric intake for individuals in industrialized nations where food choices are unlimited for many people (55, 56). This could pose a problem with the successful execution of a clinical trial using whole bitter melon in which the bitterness is not decreased by blanching or immersion in a salt solution. The palatability or acceptability of bitter melon-containing food in a clinical trial is likely one of the most, if not the most, important factor of subject compliance with daily consumption. Mattes (57) previously suggested that acceptance of bitter foods is due to the addition of other substances, such as sugar, that hide the bitterness. To date, there are no previously published studies in English language journals that specifically investigate the palatability of food dishes prepared with bitter melon. However, there have been studies that investigated sensory perceptions of other novel bitter foods, such as pecorino cheese, a commercially available bittersweet beverage, and pickled eggplant (55, 56). These studies examined additional factors other than taste, such as exposure and health information, that influence acceptance of bitter food products. Of particular interest was the investigation of the effect of health

information on liking and acceptance of bitter foods. Results from a study conducted by Glanz, *et al.*, suggest that health is less important in food choice than cost and taste (58). However, there have been mixed results from studies investigating the effect of health information on sensory evaluation and acceptance of various foods, including cranberry juice, corn chips, dairy products, and soy products. Many of these studies have looked at new or "novel" foods, but few have specifically examined the effect of health information on the acceptance of bitter foods. This is unfortunate because there are many bitter foods that contain phytochemicals with known health benefits, including cruciferous vegetables and some citrus fruits (59, 60). Drewnowski and Gomez-Carneros provide a comprehensive review of bitter phytochemicals and the various plant foods that contain them (61). The intent to purchase foods with specific benefits, often referred to as functional foods, has been shown to depend on both taste and health claims. Tuorila and Cardello found that increased "off-flavor" in a beverage, from increasing concentrations of potassium chloride, resulted in a decline in consumption intentions (62). However, health information slightly increased liking and largely increased consumption intentions in certain groups. The expectation of physical and cognitive benefits increased consumption intentions more than the expectation of emotional benefits. Another study on the effect of repeated exposure and health information on the sensory evaluation and acceptance of a bitter beverage suggests that information does not change sensory judgments, but may affect behavior related to consumption (56). Information on the bitter product in this study focused primarily on positive qualities, such as "healthy" and "helpful to the body and mind," and less on potential positive consequences associated with ingestion. Other research has investigated the effect of different levels of nutrition

or health knowledge on the acceptance and consumption of foods, especially "functional foods." Wansink, *et al.*, suggests that the type of information is more important than the amount provided (63). They outline a hierarchy of knowledge that underlies the gradual acceptance of "functional food" (Figure 2).

Figure 2: Hierarchy of Nutritional Knowledge



Source: Wansink, *et al.*(63)

According to this hierarchy, attribute knowledge is information about specific characteristics or qualities of the food, whereas consumption consequences knowledge is information that explains how consuming a food will benefit an individual. Results from Wansink, *et al.*, indicated that consumption of soy products was more likely when individuals had both attribute- and consequence-specific information about these foods rather than only one type of information. However, other sources have implied that any

level of knowledge by itself may or may not have an effect on sensory perceptions and food-related behaviors (56).

An individual's beliefs are based on many factors and can largely be used to predict behavior. It is thought that one's particular beliefs about food, whether nutritional or otherwise, play an important role in predicting food choices. Behavior changes and individual attitudes or perceptions related to food choice have largely been studied in the area of social psychology (53). Both the Theory of Planned Behavior (TPB) and the Transtheoretical Model, otherwise known as the Stages of Change model, are commonly used to structure investigations into the many influences on behavior.

Social Psychology Behavior Models

Theory of Planned Behavior (TPB)

The TPB expands on the Theory of Reasoned Action which is a model that has been used over the past two decades to predict behaviors thought to be only under individual control (53). The TPB adds factors not solely under the individual's control, such as social norms, to this model and is based on the precept that behaviors are predicted by intentions. Intentions are determined not only by norms and motivation to comply with such norms, but also by one's attitude. Attitudes are determined by one's beliefs about the potential outcomes of behavior and whether the person rates such an outcome as positive or negative. Intentions may also be determined by the perception of control or empowerment. This factor is integral in persons with chronic diseases, such as diabetes, where self-care is important to managing their condition.

Stages of Change

The Transtheoretical Model, commonly known as the "Stages of Change" model, has been used to enact behavior change through tailoring interventions that encourage self-care based on an individual's motivation determined by their "stage" classification (64). The Stages of Change (SOC) model was first developed by Prochaska and DiClemente to explain the stages individuals proceed through and actions necessary for successful cessation of addictive behaviors such as smoking (65). It has since been applied to numerous behaviors including drug use, sunscreen use, condom use, adolescent delinquency, health screenings, physical activity, and dietary behaviors (66). The primary dietary uses of this model are in weight loss and reduction of dietary fat consumption. Additionally, there are studies that have used SOC to investigate fruit and vegetable, grain, and dairy consumption (67). To date there have been few, if any, applications in the areas of CAM or functional food use. However, SOC has been validated as a useful tool in conventional dietary changes for diabetics (64).

The model is based on six stages (67, 68):

1. *Precontemplation*: individual is not thinking of making behavior changes in the near future (within 6 months) and remains resistant to change. They may lack awareness of problems or risks.

2. *Contemplation*: individual has some awareness of potential problems or risks and contemplates or thinks about making changes. No action has occurred, but typically will within 6 months.

3. *Preparation*: individual is preparing or planning to make a change by taking steps toward the specific action and committing to specified changes within the next month.

4. *Action*: the individual is carrying out the specific behavior.

5. *Maintenance*: classified as the point in which the behavior has been occurring for at least 6 months.

6. *Termination*: the point at which a previous behavior is completely eliminated and is no longer a possibility when temptation arises.

The termination stage is not used for dietary applications of the model because dietary intake is a required process throughout an individual's life and eating cannot be terminated. For this reason, there will always be temptations to resume poor eating habits and maintenance will be a lifelong process (68). As expected, relapse is a common occurrence and some behaviors may be cyclical in nature (64). General application requires identification of the five stages which can, in turn, provide valuable information to clinicians or researchers about barriers to behavior change. Once these are identified, the necessary steps can be taken to overcome such barriers. The stage-based approach allows interventions to be tailored to the individual receiving it. Additionally, the model can be used to market a program more effectively or even to evaluate intervention effectiveness (68). One study used the SOC model not only to develop stage-tailored interventions in a community-based diabetes education program, but also to evaluate the program's effectiveness by evaluating movements through the various stages (69).

CHAPTER II

PALATABILITY OF BITTER MELON AND EFFECT OF HEALTH INFORMATION ON CONSUMPTION INTENTIONS

Introduction

The treatment of diabetes is a complex process due to the many effects of this disease on the human body. Additionally, the coexistence of hyperglycemia and insulin resistance, along with various heart disease risk factors, may dictate the simultaneous use of a variety of therapies in an effort to prevent or manage diabetes complications. Unfortunately, the effectiveness of such therapies has often been poor for a number of reasons. These include non-compliance of the diabetes patients, as well as the complex pathophysiology and general progressive chronic nature of this disease (3). Therefore, a number of plant substances have been investigated for their effectiveness as a treatment for diabetes and related complications. One such substance is the vegetable, *Momordica charantia* (bitter melon). Active components are not completely known at this time and therefore use of the whole fruit is desired for investigating its safety and its efficacy in diabetes treatment. Clinical trials with bitter melon are desirable, but feasibility of subject compliance due to its bitter taste is unknown at the present time and warrants further investigation.

Study Purpose

The goal of this study was to determine the feasibility of daily consumption of bitter melon in future clinical trials in Hawaii. The objectives were 1) to develop recipes containing bitter melon and determine the palatability or acceptability of these food

dishes, and 2) to determine the effects of varying levels of nutrition and health information about bitter melon on individual willingness or intent to consume it in the future, despite its bitterness.

Protocol Approval

This research project was reviewed by the University of Hawaii's Committee on Human Studies and determined exempt from Department of Health and Human Services regulations, 45 CFR Part 46.

Materials and Methods

Population Sample

A convenience sample of 50 adults (18 years and older) were recruited from the University of Hawaii (UH) Mānoa campus to participate in a cross-sectional sensory evaluation and survey. Recruitment included the use of paper flyers (see Appendix A, pp. 60-61) posted in the Agricultural Sciences Building on campus and by word-of-mouth. Also, announcements were sent via electronic mail to the Food Science and Human Nutrition Department at UH and some individuals at the John A. Burns School of Medicine. Exclusion criteria included individuals who indicated that they had problems with hypoglycemia, were taking medications for diabetes, and those with allergies to the study food components, as indicated on the sensory evaluation form. Children were not included in this study due to safety concerns posed by previously documented cases of hypoglycemic coma in children consuming bitter melon tea (33). Additionally, women who were pregnant, who thought they may have been pregnant, or who were breastfeeding were not allowed to participate. One pregnant woman wished to take part

in the study, but she was not permitted to consume the bitter melon even though she stated that bitter melon is a regular part of her diet. Her participation was not allowed due to the potential risks to the fetus associated with consumption of bitter melon.

Food Sample Preparation

Bitter melon was incorporated into a total of 4 food dishes (chili, curry, vegetable soup, and tomato sauce) that were representative of a small sample of traditional dishes consumed in Hawaii. Three of the four recipes (chili, soup, and tomato sauce) were chosen because of the potential for other ingredients to mask bitterness. Each dish originally included bitter melon or was modified to incorporate bitter melon at a level of at least 50 grams per "usual serving." The usual serving for each dish was determined by the Food and Drug Administration's (FDA) definition for the specific type of food (70). A total of 50 grams per serving was chosen to approximate the daily amount to be provided to subjects in future clinical trials.

A small convenience group (n=7) pilot-tested the initial food dishes (chili, tomato sauce, curry, stir fry, and hummus) and completed a draft sensory evaluation form. Changes to the final recipes were made as a result of the group's suggestions. Specifically, more spices were added to the final chili and tomato sauce recipes based on responses from the group members that these dishes were too bland. The pilot test included a stir fry of bitter melon and hummus prepared with bitter melon. The stir fry bitter melon was deemed unpalatable by the group as evidenced by low acceptance scores and by all but one individual indicating on the form that they would not eat it again in the future. Additionally, it was later determined that the amount of hummus required to consume 50 grams of bitter melon would have been unrealistic in a clinical trial. The

final bitter melon-containing recipes (see Appendix B, pp. 62-65) selected for this study were vegetable soup, vegetarian chili, curry, and tomato sauce. The tomato sauce and chili were chosen based on results from the pilot test, ease of preparation, and versatility. Both of these dishes included ingredients, such as tomato and spices, which were intended to mask the bitterness of the bitter melon. The vegetable soup was added after the pilot test to replace the stir fry of bitter melon. It was chosen because it had similar ingredients and taste to the chili and tomato sauce, but a different texture due to diced bitter melon versus a purée of bitter melon. The curry recipe included only bitter melon and spices and was chosen to act as a negative control for bitterness. All dishes were representative of foods that would be consumed by one or more ethnic groups in Hawaii.

Food was prepared seven days prior to the sensory evaluation and frozen (0°F) until the day before the study when they were placed under refrigeration (39°F) to thaw. This was done in anticipation of future clinical trials that likely will require subjects to freeze several days worth of food because they will most likely be given food only once each week. In this study, food dishes were removed from refrigeration and reheated to 165°F the morning prior of the sensory evaluation. They were kept warm (≥140°F) using electric crockery pots and served warm throughout the study. The chili and curry were each served with rice and the tomato sauce was served with pasta. All samples were served in small paper cups in the order they were to be tasted.

Survey Development

A draft sensory form (see Appendix C, pp. 66-69) was pilot-tested prior to the study. Based on pilot test results, several changes were made to the final survey form used in this study. Demographic data and more specific tasting instructions and warnings

were incorporated into the sensory form design. Open-ended questions followed each sample evaluation to allow participants to comment on factors that would make each dish better. A question was added to assess whether the subject typically would eat the food dish even in the absence of bitter melon. Also, the answer choices for questions on willingness to consume each dish were modified to make the interval equal (i.e., 0,1,2,3, or 4 times). Questions aimed at ranking samples were removed from the pilot form in an effort to focus more on acceptance of each individual dish rather than preference among the dishes. Additional questions on the importance of cost, health, and ease of preparation were also omitted to keep the survey as short as possible with an emphasis on current and future consumption intentions.

A total of eight final versions of the complete survey were developed and each consisted of two basic parts: 1) the sensory evaluation form followed by 2) a series of questions to determine current consumption and future intentions to consume bitter melon. The eight versions of the form differed only in terms of which dish was sampled first and the order of bitter melon health information provided. Table 2 summarizes the eight versions of the survey. An example of "version 1a" of the survey is also provided (see Appendix D, pp. 70-74).

Table 2: Summary of the Eight Final Survey Versions

Version	Dish Sampled 1st	1st Set of Information	2nd Set of Information
1a	Chili	Attribute-specific	Consequence-Specific
1c	Chili	Consequence-Specific	Attribute-specific
2a	Tomato Sauce	Attribute-specific	Consequence-Specific
2c	Tomato Sauce	Consequence-Specific	Attribute-specific
3a	Curry	Attribute-specific	Consequence-Specific
3c	Curry	Consequence-Specific	Attribute-specific
4a	Soup	Attribute-specific	Consequence-Specific
4c	Soup	Consequence-Specific	Attribute-specific

Data Collection

Each subject was asked to read and sign an informed consent form (See Appendix E, pp. 75-76). Subjects were then randomly assigned to one of four sensory evaluation stations based on the order in which they arrived for the study. The first food to be sampled differed at each of the four stations, however the order was always the same (chili, tomato sauce, curry, soup). At each station the sensory survey form was given to the participant along with an overview of the general directions. Each participant was given approximately 1 tablespoon of each of the 4 different mixed food dishes, each prepared with at least 50 grams of bitter melon per usual serving. Participants were instructed to sample the food dishes from left to right in the order provided on their sample plate after providing demographic data and reading the evaluation instructions. Subjects were not required to finish all food provided and they were given both water and saltine crackers

to cleanse their palates if desired during sampling. Upon tasting each sample, participants completed the sensory evaluation designed to determine acceptability of each dish. A 9-point hedonic scale (1=dislike extremely; 9=like extremely), initially developed by Peryam and Pilgrim (71), was used to evaluate sensory attributes of each dish. This scale is balanced with respect to degrees of liking and is often used to determine consumer acceptability. It can be used by all individuals even if they are untrained in sensory evaluation, thus making it ideal for studying a representative sample within a specific population (72). Attributes deemed important to bitter melon acceptability included texture, bitterness, smell, and overall liking (taste).

Participants were asked to list factors that would improve acceptability and increase consumption frequency for each dish. Food was provided to the participants in sampling order on a paper plate. However, the dish with which each participant started was randomly stratified among the population. This was to reduce the possibility that an additive effect of bitterness from the previous samples would skew the acceptability data of the first compared to last dish sampled. Sensory evaluations took approximately 10 minutes to complete. Upon completion, participants continued to answer questions related to their current consumption, knowledge, and attitudes, as well as to their intentions to consume bitter melon in the future. The methodology for this section of the survey was not developed in time for the initial pilot testing, and therefore was not tested prior to the actual study.

Stages of Change Determination

Individuals were placed in one of the five stages of change applicable to dietary studies based on their answers to questions provided in an algorithm format. This format was

adapted from previous research that assessed stage movement of individuals in a community-based diabetes program (69). The specific questions and subsequent stage assignment for this study are summarized in Table 3. After subjects were provided health information on bitter melon, participants classified in the pre-action stages (precontemplation, contemplation, or preparation) were asked again whether they were "not thinking," "thinking," or "planning" to consume bitter melon in the future. This was included to determine whether the information had an impact on stage movement among pre-action subjects, despite palatability of bitter melon. Determination of stage movement was used to assess consumption intentions of bitter melon, in general, versus the specific dishes tasted in this study.

Table 3: Bitter Melon Stages of Change Algorithm*

Question	Answer	Stage
Do you currently consume bitter melon at least once every 2 months?	Yes	Action or Maintenance
	No	Pre-action
Which of the following best describes how long you have consumed bitter melon at least once every 2 months?	<6 months	Action
	≥6 months	Maintenance
I am NOT thinking of consuming bitter melon in the future.	Yes	Precontemplation
I am thinking of consuming bitter melon in the future.	Yes	Contemplation
I am planning to consume bitter melon in the future.	Yes	Preparation

*Adapted from Chapman-Novakofski (69)

Health Information and Consumption Intentions Survey

The last part of the survey provided examples of attribute- and consequence-specific health information, as described by Wansink, *et al.*,(63) tailored specifically to bitter melon. Attribute-specific information provided information on bitter melon traits or characteristics of action. For example, "bitter melon has been shown in animal studies to increase good blood cholesterol" provides information on a bitter melon attribute or quality. The consequences of such attributes were provided separately. An example of consequence-specific information included in the survey was "eating bitter melon may help lower your risk for type 2 diabetes or heart disease." Surveys were randomized such that half of the participants read the attribute-specific information first while the other half read the consequence-specific information first. Individuals were asked how many times they would be willing to consume each dish in a 2-week period before being provided health information and after each section of information. This was designed to assess changes in willingness to consume each dish given varying levels of knowledge on bitter melon. Additionally, individuals initially classified in the pre-action stages (precontemplation, contemplation, preparation) were asked after each set of information to check one of three boxes to indicate that they were either "not thinking," "thinking," or "planning" on consuming bitter melon in the future. This was included to determine if providing health information affected stage movement for these subjects despite palatability of bitter melon.

Statistical Analysis

Survey data were entered into a database constructed in Filemaker Pro and analyzed using SAS (version 9) and Microsoft Excel 2003. Frequency distributions among the

hedonic scale categories were determined for each of the three sample attributes (texture, bitterness, and smell) as well as the overall sample rating. Mean hedonic scores and standard deviation (SD) were also calculated for all attributes. Comparisons of statistically significant differences of means for each attribute were calculated using the Student's t-test. Paired t-tests were conducted to determine if participant consumption intentions for each sample were affected by subjects receiving attribute-specific, consequence-specific, or both types of information about bitter melon compared to receiving no information. Stage distribution prior to receiving health information was also determined for all participants and again after they received each of the two sets of health information for individuals initially in the pre-action stages. Chi-square (χ^2) analyses were conducted to determine if there were statistically significant differences in stage distribution before and after receiving health information. A significance level of $p<0.05$ was used to determine statistical significance for all analyses.

Results

Subject Demographics

A total of 50 subjects participated in this study and completed all or part of the survey. One survey was excluded from the analysis due to unreliable demographic responses in which the individual clearly did not fit the demographic profile provided. Table 4 shows demographic characteristics of the remaining subjects (n=49). There was a nearly equal distribution of female (53%) and male (47%) participants. Most participants (47%) identified with one of the nine major Asian ethnic or racial groups in Hawaii, especially Chinese (18%) or Japanese (14%). Forty-one percent identified themselves as "White Other" and wrote in numerous responses including Caucasian, Croatian, Dutch,

European, French, Georgian, German, Irish, Italian, Russian, or some combination of these.

Table 4: Demographic Characteristics of Study Participants (n=49)

Characteristic	n	%
Gender		
Male	23	47%
Female	26	53%
Ethnicity		
Asian	**23**	**47%**
Cambodian	0	0%
Chinese	9	18%
Filipino	2	4%
Indian (India)	2	4%
Japanese	7	14%
Korean	2	4%
Thai	0	0%
Vietnamese	0	0%
Other (Afghan)	1	2%
Hawaiian/Pacific Islander	**4**	**8%**
Guamanian/Chamorro	0	0%
Hawaiian/Part-Hawaiian	3	6%
Samoan	1	2%
Tongan	0	0%
Other	0	0%
Hispanic	**2**	**4%**
Cuban	0	0%
Mexican	1	2%
Puerto Rican	0	0%
Other (Brazilian)	1	2%
Native American	**0**	**0%**
American Indian	0	0%
Alaskan Native	0	0%
White	**20**	**41%**
Portuguese	0	0%
Other	20	41%

One of the 49 participants included in the subject demographics and analysis did not provide their age. Of the 48 individuals that did provide their age, the age of participants was 31.8 ± 12.5 (mean ± SD) years with ages ranging from 20 to 65 years. Table 5 provides additional information on the categorical age distribution of participants.

Table 5: Age Distribution of Study Participants (n=48)

Age	% of Subjects
18-24	35%
25-29	27%
30-39	13%
40-49	10%
50-59	10%
60-65	4%

Hedonic Evaluation of Food Samples

Overall acceptability and liking of specific attributes varied among the four food samples. Mean hedonic scores for both attributes and overall liking are presented in Table 6.

Table 6: Hedonic Scores for Food Samples (mean ± SD)[1,2]

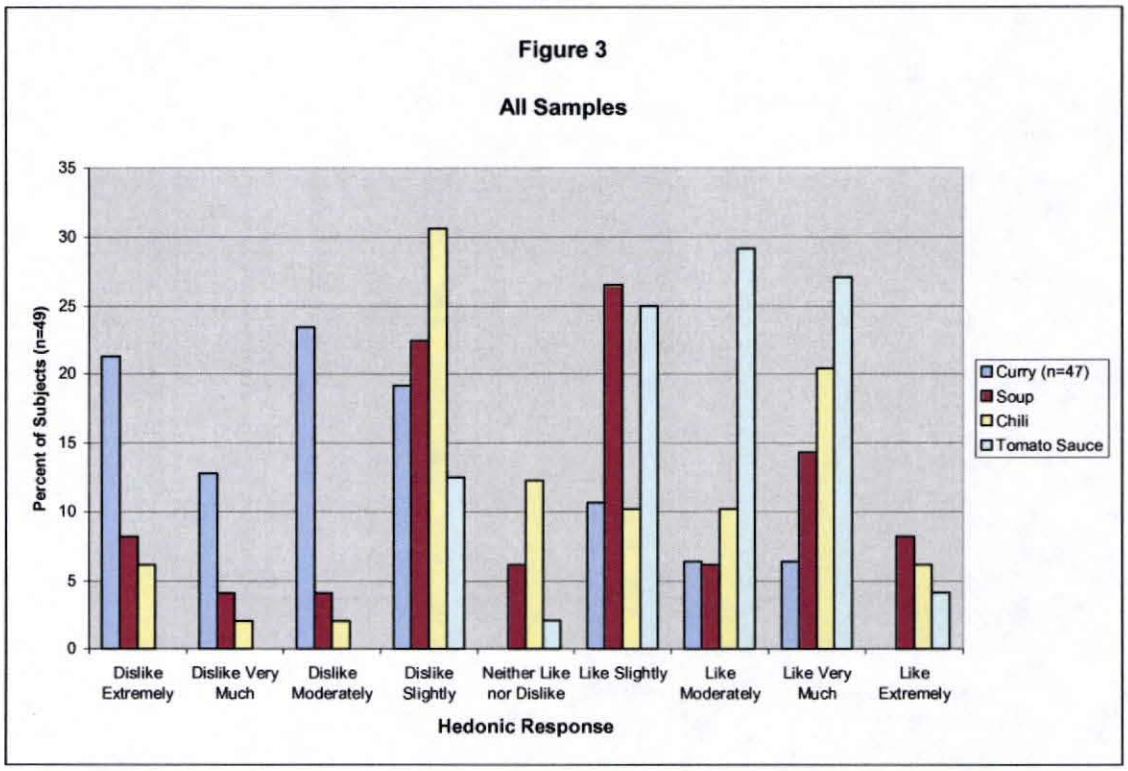
	Texture	Bitterness	Smell	Overall
Curry	5.55^{a} ± 1.87	3.27^{a} ± 2.22	5.51^{c} ± 2.13	3.53^{c} ± 2.14
Soup	6.22^{b} ± 1.68	$5.06^{b,c}$ ± 2.31	$6.27^{b,c}$ ± 1.80	5.39^{b} ± 2.26
Chili	6.63^{b} ± 1.62	4.98^{b} ± 2.17	$6.53^{a,b}$ ± 1.65	5.51^{b} ± 2.17
Tomato Sauce	6.96^{b} ± 1.41	5.88^{c} ± 2.00	7.20^{a} ± 1.08	6.69^{a} ± 1.36

[1]Means within attribute (columns) followed by the same superscript are not different ($p<0.05$)
[2]Scoring Scale: 1= Extremely Dislike; 5= Neither Like Nor Dislike; 9= Extremely Like

The possible range of scores spanned from 1 (Extremely Dislike) to 9 (Extremely Like) with a midpoint of 5 (Neither Like nor Dislike). Mean hedonic scores greater than

5 were considered acceptable while those less than 5 were deemed unacceptable. Except for the bitter melon curry, all samples were considered acceptable overall to some degree. However, the bitterness of both the curry and the chili was considered unacceptable and only slightly acceptable for the soup. The tomato sauce received the highest overall mean hedonic scores, followed by the chili, soup, and curry, respectively. However, overall mean hedonic scores for the soup and chili were not significantly different ($p<0.05$). The curry received significantly lower mean hedonic scores for all attributes except smell. The distribution of overall liking scores for all samples is shown in Figure 3.

Figure: 3: Frequency Distribution of Overall Liking Scores for All Samples



Although there was a range of responses for each dish, it is evident that most people largely disliked the curry to some degree while most liked the tomato sauce. Responses for the chili and soup were mixed and more difficult to determine acceptability from the distribution of responses alone. Over 30% of subjects indicated they "dislike slightly" the chili while another 20% said they liked it very much. Similarly, 23% of subjects indicated they "dislike slightly" the soup, yet 27% said they liked it slightly. The rest of the subject responses were near evenly split between the degrees of liking or were neutral as indicated by a "neither like nor dislike" response. Overall mean hedonic scores for the chili (5.51 ± 2.17) and soup (5.39 ± 2.26) were just above a score of 5 and therefore considered acceptable.

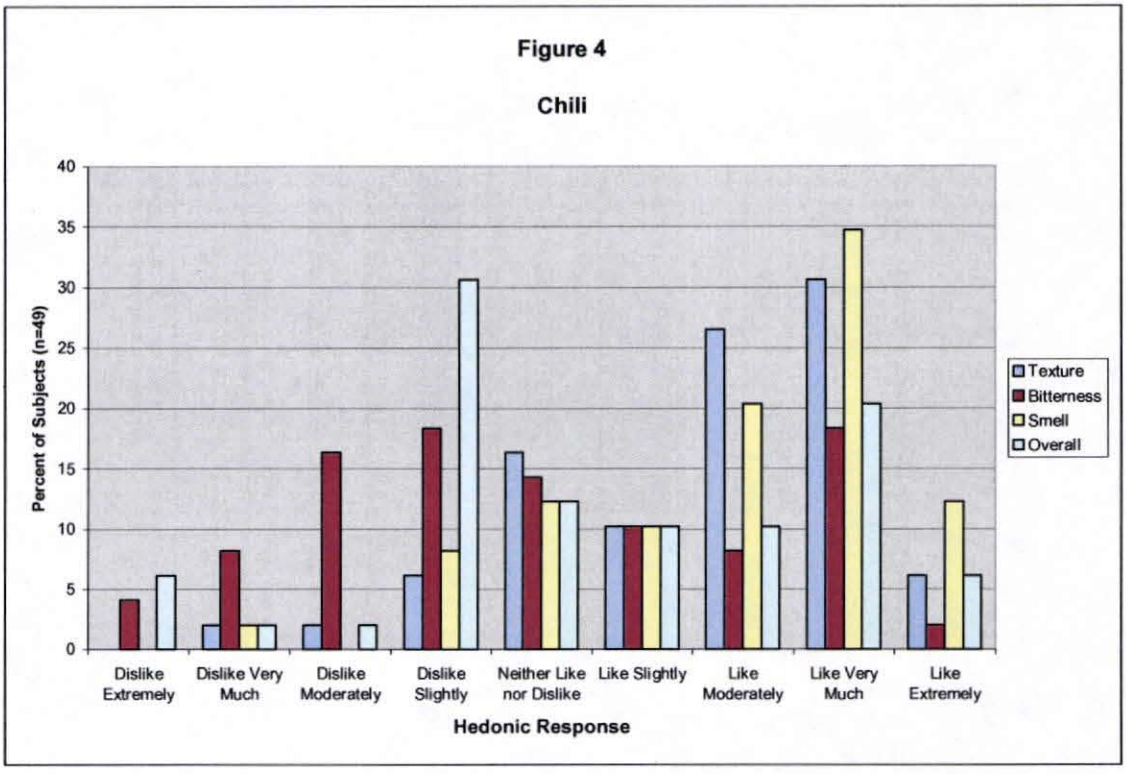
The percentage of subjects that typically do not liked chili, curry, soup, or tomato sauce varied from 0% to 17%. The primary theme of comments on how to make each dish better was to decrease or somehow mask the bitter taste or aftertaste (see Appendix F, pp. 77-80). However, the distribution of scores for bitterness and the other attributes varied by dish.

Chili

Out of 49 surveys included in the analysis, there were 2 subjects (4%) who indicated that they typically do not like chili. There was a full range of responses for the acceptability of the individual chili attributes and overall liking. Figure 4 shows the frequency distribution of hedonic scores for the chili. Over 30% of subjects (n=15) indicated that overall they "dislike slightly" this sample. The most disliked attribute was the bitterness for which the mean hedonic score (4.98 ± 2.17) indicated this attribute was slightly unacceptable. On the other end of the spectrum, over 65% of respondents (n=33) liked

the smell at least moderately. Subjects largely felt that this dish could be better with "more spice" and less bitterness, especially less bitter aftertaste. Other common suggestions for how to make the dish more appealing were to add more beans, meat, and/or vegetables. A complete list of the participants' comments about the chili is also provided (See Appendix F, p.77).

Figure 4: Frequency Distribution of Chili Hedonic Scores

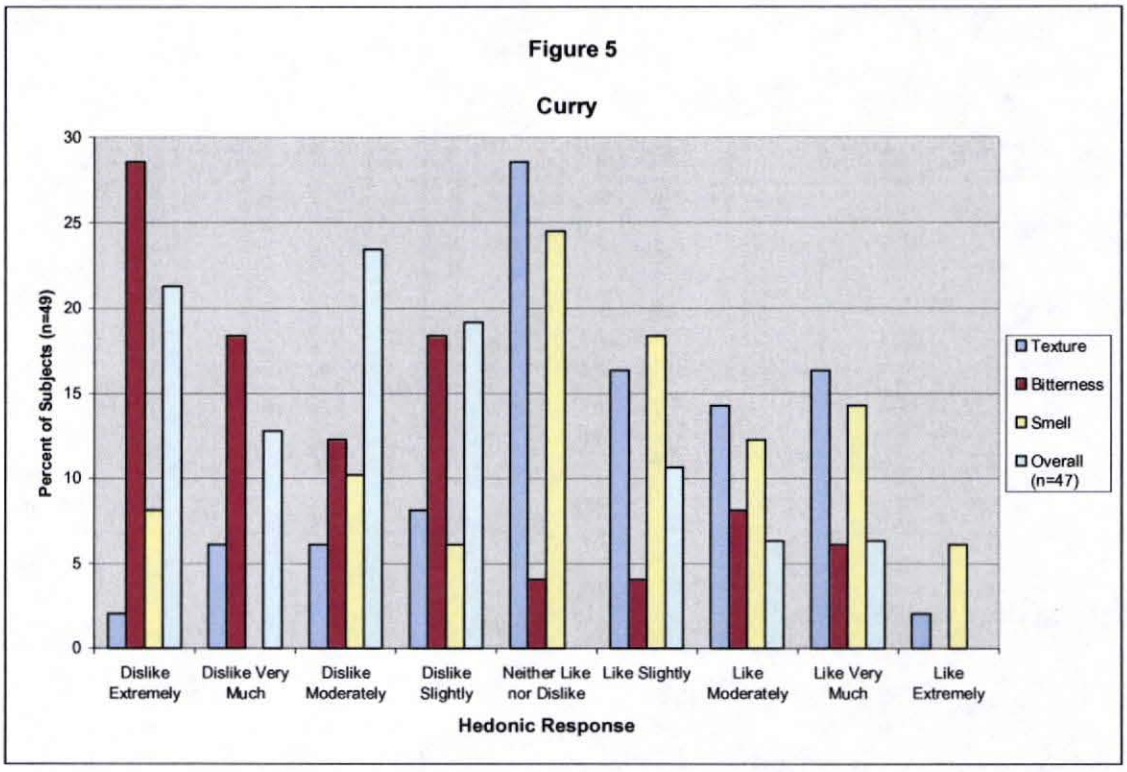


Curry

Out of 48 responses, 8 participants (17%) indicated that they typically do not like curry. Figure 5 shows the frequency distribution of hedonic scores for this dish. Based on the

distribution of hedonic responses, most subjects were indifferent to or liked the smell (n=37) and texture (n=38). However, almost 30% (n=14) of the participants extremely disliked the bitterness and nearly another 20% (n=9) disliked it very much. It received the lowest mean score of all the samples for bitterness (3.27 ± 2.22) and overall (3.53 ± 2.14). Specific comments were mostly that it was "very bitter" and needed "more curry flavor."

Figure 5: Frequency Distribution of Curry Hedonic Scores

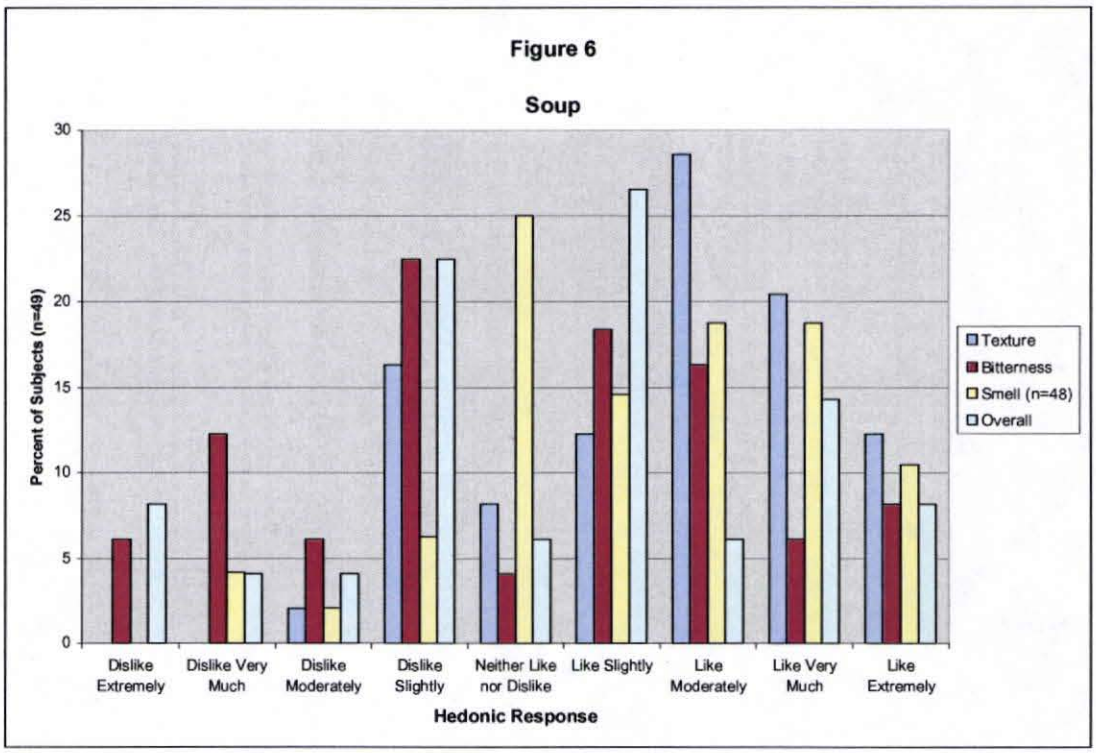


Soup

All 49 subjects included in the analysis indicated that they typically like soup. Figure 6 shows the frequency distribution of hedonic scores for this dish. Over 60% of subjects

(n=30) liked the smell to some degree and nearly three-fourths (n=36) liked the texture. However, the overall mean hedonic score was just above acceptable (5.39 ± 2.26). As with the other dishes, bitterness received the lowest mean hedonic score with over 40% of subjects (n=23) disliking this attribute. However, over one-third of subjects (n=24) liked the bitterness and several (n=4) even extremely liked it. Most comments on the soup were mixed, but texture and bitterness were common topics (See Appendix F, p 79). The diced bitter melon was an undesirable texture for some individuals and they recommended either a smaller dice or a purée.

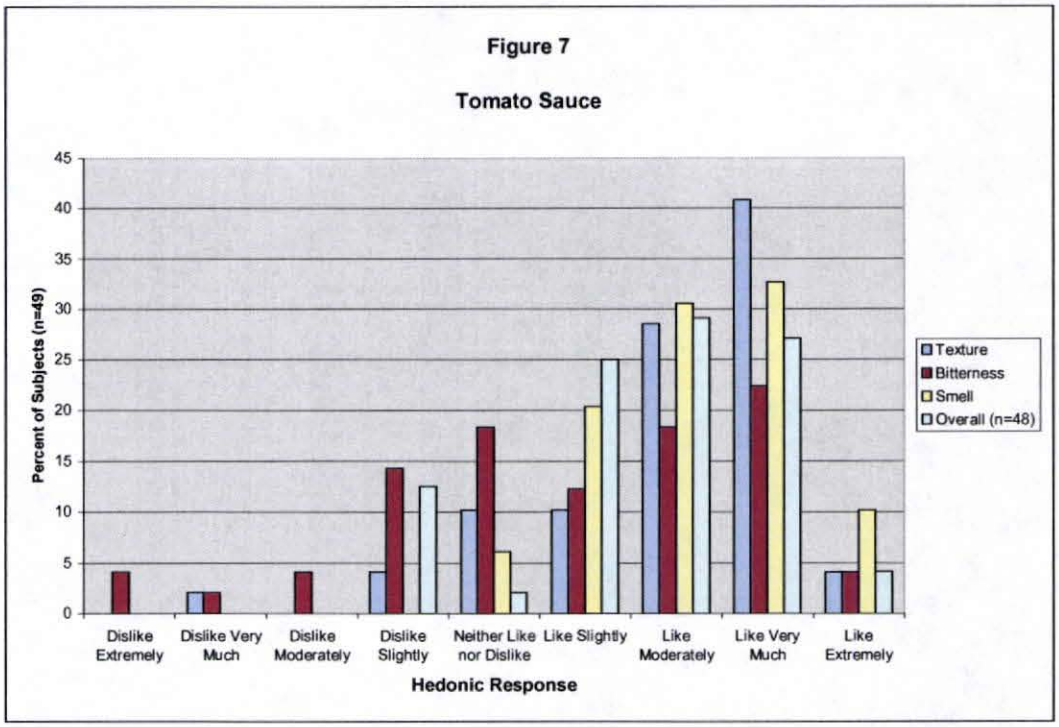
Figure 6: Frequency Distribution of Soup HedonicScores



Tomato Sauce

Out of 49 responses, 4 participants (8%) indicated that they typically do not like tomato sauce. One of these individuals made a note that they do eat it, but prefer "white sauce." Figure 7 shows the frequency distribution of hedonic scores for the tomato sauce.

Figure 7: Frequency Distribution of Tomato Sauce Hedonic Scores



Other than bitterness, nearly all responses were positive. This dish received the highest mean hedonic scores for all attributes, including bitterness (5.88 ± 2.00). Over one-third of subjects (n=20) moderately to extremely liked the bitterness. The mean score for smell (7.20 ± 1.08) was the highest of any attribute among all samples. Over 40% of subjects (n=21) indicated that they "like very much" or "like extremely" the smell. Some people indicated that the sample could be better if less bitter, but there were many that

indicated liking it as is or that they would add more garlic, onion, or other spice (see Appendix F, p. 80).

Consumption Intentions

Table 7 shows number of times (mean ± SD) subjects indicated that they would be willing to consume each dish in a 2-week period both before and after receiving health information on bitter melon. Consumption intentions were significantly lower for the curry than all other dishes both before and after health information was provided. Consumption intentions were not significantly different among the other three dishes (chili, soup, and tomato sauce) at any point in the survey.

Table 7: Number of Times Subjects Would Be Willing to Consume Each Dish in 2-Weeks Before and After Receiving Health Information (mean ± SD).[1]

	Chili	Curry	Soup	Tomato Sauce
No Information	$1.57^{a} \pm 1.50$	$0.56^{b} \pm 1.03$	$1.58^{a} \pm 1.41$	$1.94^{a} \pm 1.41$
Post Attribute Information	$1.85^{a} \pm 1.50$	$0.65^{b} \pm 1.23$	$1.70^{a} \pm 1.47$	$2.20^{a} \pm 1.47$
Post Consequence Information	$1.92^{a} \pm 1.58$	$0.67^{b} \pm 1.17$	$1.75^{a} \pm 1.47$	$2.08^{a} \pm 1.53$

[1]Means within rows followed by the same superscript are not different ($p<0.05$)

The frequency distribution of consumption intention responses prior to receiving health information, after receiving attribute-specific information, and after receiving consequence-specific information for all samples is shown in Figures 8, 9, and 10, respectively. Although there were no significant differences in the mean values for consumption intentions among the chili, tomato sauce, and chili, the actual distribution of responses varied among these dishes.

Figure 8: Frequency Distribution of Consumption Intentions Pre-Health Information

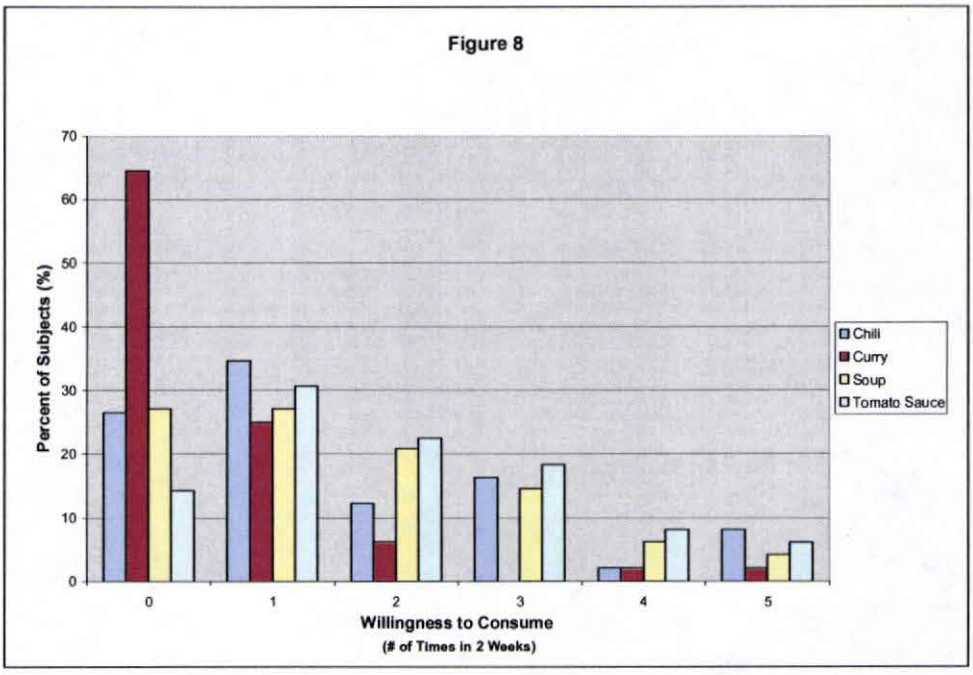


Figure 9: Frequency Distribution of Consumption Intentions Post-Attribute Health Information

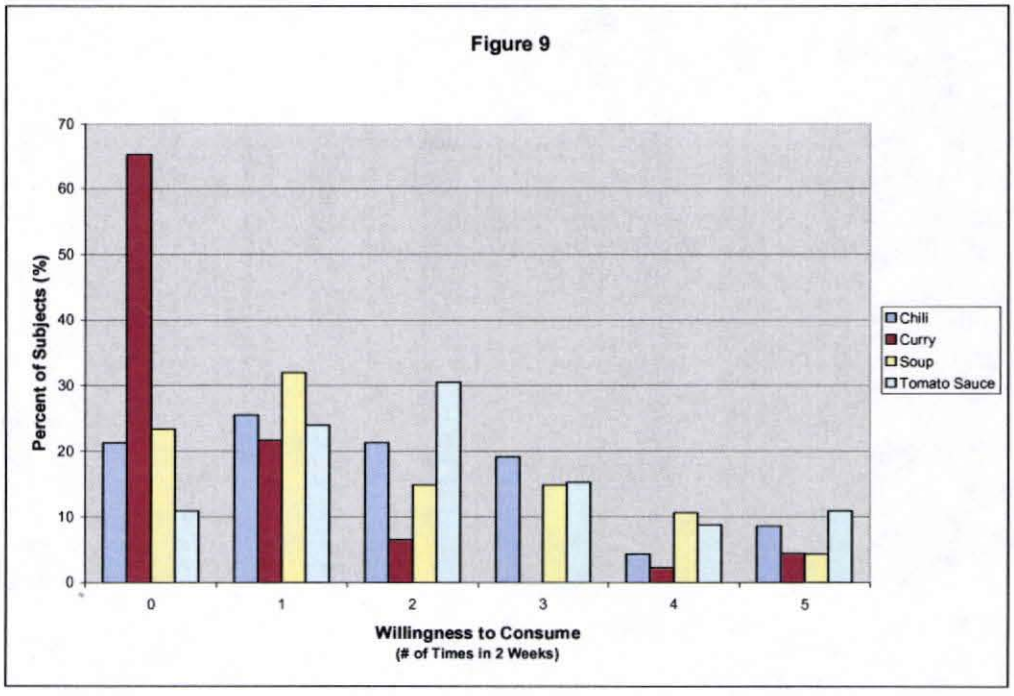
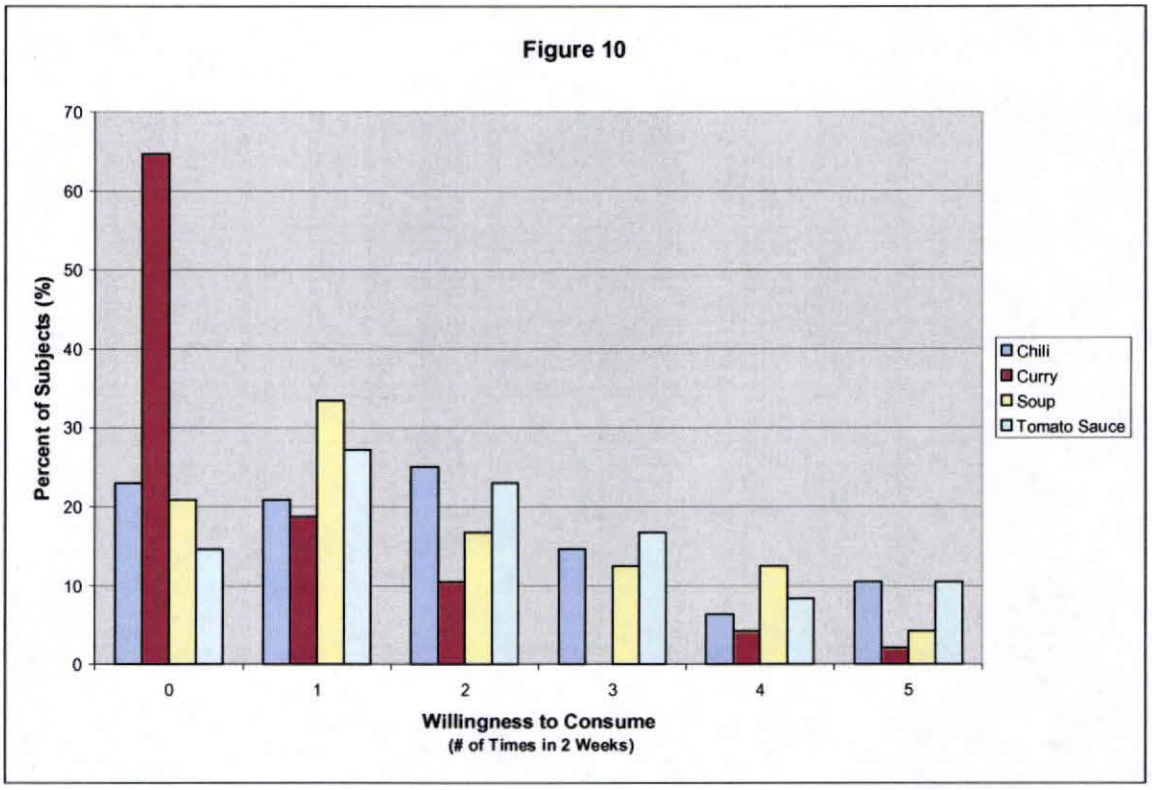


Figure 10: Frequency Distribution of Consumption Intentions Post-Consequence-Specific Health Information



Over 25% of subjects (n=13) indicated that they would not be willing to consume the soup at all in a 2-week period before receiving health information. However, only 14% of subjects (n=7) indicated that they would not be willing to eat the tomato sauce in a 2-week period prior to receiving health information. After receiving consequence-specific health information, the percentage of people who indicated that they would not be willing to consume the soup in the future dropped to 20% (n=10), whereas the number not willing to consume tomato sauce stayed the same as before health information was provided.

Results from paired t-tests of consumption intention responses after subjects received attribute-specific and consequence-specific health information about bitter

melon are shown in Tables 8 and 9, respectively. The degrees of freedom (df) was equal to the number of paired responses minus one (n-1). This varied by sample due to incomplete surveys in which paired responses were not completed for every dish by every subject. Differences between consumption intention responses before and after receiving attribute-specific and consequence-specific information were only significant ($p<0.05$) for the chili sample. Therefore, health information did not have an effect on increasing consumption intentions for the foods tasted in this study except for the chili sample. All other changes in consumption intention responses were not significantly different.

Table 8: Paired t-Test Parameters and Results for Consumption Intention Responses After Viewing Attribute-Specific Information.

	Mean ± SD[1]	df	t value	p value
Chili	0.32 ± 0.73	46	3.02	0.004[2]
Curry	0.22 ± 0.50	44	0.30	0.77
Soup	0.13 ± 0.78	45	1.14	0.26
Tomato Sauce	0.20 ± 0.81	45	1.65	0.11

[1] Mean ± SD = Mean of pair differences ± standard deviation
[2] $p<0.05$ compared with no information

Table 9: Paired t-Test Parameters and Results for Consumption Intention Responses After Viewing Consequence-Specific Information.

	Mean ± SD[1]	df	t value	p value
Chili	0.35 ± 0.84	47	2.93	0.005[2]
Curry	0.04 ± 0.46	46	0.63	0.53
Soup	0.15 ± 0.75	46	1.36	0.18
Tomato Sauce	0.15 ± 0.92	47	1.10	0.28

[1] Mean ± SD = Mean of pair differences ± standard deviation
[2] $p<0.05$ compared with no information

Stages of Change Distribution

Of the 49 participants, 69% (n=34) indicated they had tried bitter melon before while 31% (n=15) had not. However, only 13 of the 34 subjects (38%) that had tried bitter melon previously indicated that they consume bitter melon at least once every 2 months. Consumption at least once every 2 months was used as the means to classify an individual in the "action stages" according to the Stages of Change algorithm shown in Table 3. Based on responses to the questions in Table 3, the stage distribution of participants was determined after they evaluated each sample, but prior to receiving health information on bitter melon. Table 10 shows the number of individuals classified in the pre-action and action stages prior to receiving health information and the respective percentages of the total number of subjects ($\%_{total\ n}$). Also shown is the percentage of pre-action subjects ($\%_{preaction}$) in each of the pre-action stages (precontemplation, contemplation, and preparation) as well as the number of action subjects ($\%_{action}$) in each of the action stages (action, maintenance).

Table 10: Stage Distribution Pre-Health Information

Stages	n	n_{total}	$\%_{total\ n}$	$n_{pre\text{-}action}$	$\%_{pre\text{-}action}$	n_{action}	$\%_{action}$
Pre-action	**36**	**49**	**74%**				
precontemplation	19	49	39%	36	53%		
contemplation	15	49	31%	36	42%		
preparation	2	49	4%	36	5%		
Action	**13**	**49**	**27%**				
action	3	49	6%			13	23%
maintenance	10	49	20%			13	77%

The 13 subjects classified in the action stages all specified one or more reasons why they consume bitter melon (Table 11). Several subjects indicated that they eat bitter melon for multiple reasons. One person said that the "other" reason for eating it was that friends will sometimes prepare food for them that contains bitter melon.

Table 11: Major Reasons for Eating Bitter Melon Among "Action" Subjects (n=13)

	Number of subjects
I Like the Taste	8
I Grew Up Eating It	9
Health	6
Other	1

After receiving health information about bitter melon, stage distribution shifted for those subjects initially classified in the pre-action stages. Table 12 depicts the number of subjects in the various pre-action stages before receiving information, after receiving attribute-specific information, and after receiving consequence-specific information. Figure 11 is a graphic depiction of this information.

Table 12: Number and Percentage of Respondents in Pre-action Stages Before and After Receiving Health Information

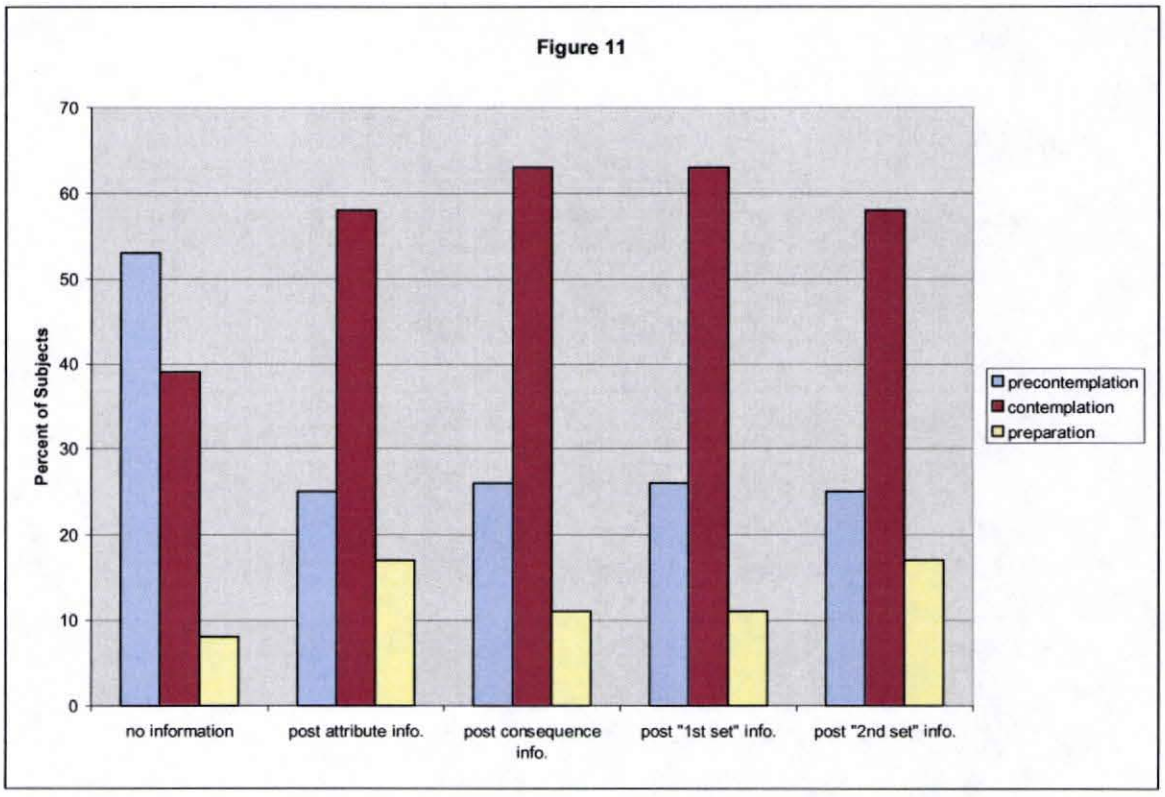
	n	pre-contemplation	%	contemplation	%	preparation	%
No information	36	19	53%	14	39%	3	8%
Post attribute	36	9*	25%	21*	58%	6	17%
Post-consequence	35	9*	26%	22*	63%	4	11%
No information	36	19	53%	14	39%	3	8%
After first set	35	9*	26%	22*	63%	4	11%
After 2nd set	36	9*	25%	21*	58%	6	17%

*Significantly different from no information at a level of $p<0.05$

Because half of the subjects received attribute-specific information first while the other half received consequence-specific information first, the stage distribution after receiving the first and second sets of information is also provided. The number of subjects that answered the questions used to assess stage distribution varied. Some subjects did not complete all questions related to stage distribution and consumption intentions.

The number of individuals in the precontemplation stage decreased by more than half from 53% to 25% and 26% after individuals received attribute and consequence-specific health information about bitter melon, respectively.

Figure 11: Percentage of Subjects in Pre-action Stages Pre- and Post-Health Information



Meanwhile, the number of subjects increased in the contemplation and preparation stages. The number of people in the contemplation stage increased by 19% after subjects received attribute-specific information and increased by 24% after they received consequence-specific information. A similar stage shift was seen after subjects received the first set of information, regardless of whether or not it was attribute- or consequence-specific in nature. Stage distribution in the precontemplation and contemplation stages was significantly different from before receiving health information after receiving attribute and consequence-specific information based on chi-square (χ^2) analysis at the level of $p<0.05$. Likewise the stage distribution was significantly different from pre-health information after receiving the 1st set of information and the second set of information. Thirty-eight percent (n=13) of all pre-action subjects shifted stages. However, only 3 subjects indicated an additional stage change after reading the second set of information compared to the first set of information. The majority of individuals who moved among the stages (77%) did so after receiving the first set of information and those who shifted stages did not shift more than once. Subjects who started out in the precontemplation stage never shifted to the preparation stage. However, those in the precontemplation stage sometimes shifted to the contemplation stage and those in the contemplation stage sometimes moved to the preparation stage. Subjects who started out in the preparation stage (n=3) prior to receiving health information were unable to shift to the action stages based on the questions used to assess stage change. If those subjects are excluded then 38% (n=13) of the pre-action subjects that were able to shift stages (n=34) did so as indicated by their survey responses.

Discussion

Hedonic Evaluation

Results from this study indicate that three of the four bitter melon-containing dishes (chili, soup, and tomato sauce) were considered palatable or acceptable by study participants. Only the curry was considered unacceptable as indicated by an overall mean hedonic score less than 5. Bitterness received the lowest mean hedonic scores of all attributes for every dish. A selection and sampling bias likely existed solely by use of the name "bitter melon." Participants were recruited using signs that specifically stated that the study was an acceptability study of bitter melon and they likely had an expectation that the food would be bitter. This bias could have been reduced partially by using recruitment materials that did not expressly say "bitter melon." The use of general terms, such as "food tasting" and "tasting study," as seen in Appendix A, Sign 2 (p. 60), should have solely been used in recruitment. Additionally, one of the main attributes scored for each dish was bitterness so there was attention given to this potentially negative food trait even after participants began tasting. However, it was necessary to include "bitterness" in order to understand how acceptable this attribute was for each dish. To date there are no published acceptability studies of food dishes prepared with bitter melon in English language journals. Stein, *et al.*, used bitter melon as a control bitter stimulus in evaluating exposure and health effects on a bittersweet beverage (56). Subjects received a bite-sized sample (1.8 grams) of *karela* (bitter melon) along with six other flavor stimuli and rated them for pleasantness, intensity, and familiarity on a 9-point scale (1 = extremely unpleasant to 9 = extremely pleasant). Subjects were also asked to identify "taste notes" (percent bitter, sweet, sour, etc.) for each stimuli. However, specific

preparation of the bitter melon sample (raw, blanched, stir fried, etc.) was not indicated. Mean hedonic scores for bitter melon "pleasantness" were 2.9 and 3.2 before and after exposure to a bitter beverage, respectively. These values were similar to "pleasantness" hedonic ratings of 3.2 and 3.4 for low- and high-exposure groups, respectively, obtained by Mattes (55). Values from both studies are lower than all samples, except the curry, evaluated in this study. The mean hedonic curry scores for bitterness (3.27 ± 2.22) and overall (3.53 ± 2.14) were similar to those previously reported. The next lowest mean score for all attributes of all samples was 4.98 ± 2.17 (chili bitterness). Curry was typically liked the least of all four dishes, even without bitter melon. Almost all subjects indicated they typically liked the other dishes and 100% of participants said that they "typically like soup." More subjects may have answered "no" to this question had it stated "Do you typically like vegetable soup?" The word "vegetable" was intentionally not included because it may have elicited more negative responses for typical consumption of soup.

The curry was essentially a negative control because the recipe was comprised primarily of bitter melon, some spices, and few other ingredients. Therefore, there is little else to offset or mask the bitterness which is the predominant overall taste. The other three samples (chili, soup, tomato sauce) all included several other ingredients that likely distracted from the bitterness. Various spices were incorporated into each recipe, especially salt, pepper, garlic, and basil. The amount of salt in each recipe may have had an effect on perceived bitterness. Several studies have shown that various sodium salts, including sodium chloride (NaCl), are effective at suppressing the bitterness of certain bitter compounds (73-75). Except for the curry, the recipes in this study were made with

tomato-based products that are higher in sodium. The acidity and sourness of the tomato products may have complemented the bitterness of the bitter melon.

Sucrose and various artificial sweeteners have also been evaluated for their ability to curb bitterness. Nakamura, *et al.*, found that in addition to NaCl, sucrose, and aspartame were also effective at bitterness suppression (74). Natural sweeteners and sugar alcohols, such as sucrose and sorbitol, have been shown to be more effective at reducing perceived bitterness when compared with artificial sweeteners, such as aspartame and sodium saccharin (76). The addition of sweeteners, including no-calorie sweeteners, to recipes in this study may render them more palatable and increase feasibility of compliance in future clinical trials. Drewnowski and Gomez-Carneros also suggest that bitterness can be masked by the addition of fat or cooking techniques such as pickling, caramelizing, or braising (61). In this study, cooking methods that increased the fat content or sugar content of the dish were intentionally limited because the intended population for future clinical trials will be adults with diabetes. Other bitter melon recipes made with tomato-based products, such as pizza, pasta marinara, or casseroles may be well accepted and should be developed for diabetics. As previously discussed, general dietary recommendations for diabetics include optimal carbohydrate consumption for blood glucose control and no more than 30% of calories from fat daily due to increased risk for heart disease.

Effects of Health Information on Consumption Intentions

Previous research has shown that consumption intentions decreased as the amount of bitter compounds increased, but health information increased liking (62). The population for this study was a convenience sample that was not representative of the entire

population in the state of Hawaii. Demographic variables likely influenced acceptability and consumption intentions, as well as outcomes in the presence of health information. Although this study included subjects with ages ranging from 20 to 65 years old, most (35%) were in the 18-24 years age group and nearly two-thirds (62%) were less than 30 years old. This factor may have limited the effect of health information on the ability to change both bitter melon consumption intentions and stage distribution in this population. Caltabiano and Shellshear previously found that in young adults (mean age of 22 years) healthiness was less important than taste or palatability in determining food preferences (77). In general, the importance of the type of health information has been demonstrated in previous studies (56, 62, 63). Information that provides not only qualities of a food, but also the consequences of ingestion is more likely to correspond to consumption (63). Stein, *et al.*, suggested that information that focuses on specific prevention benefits versus just good qualities may increase liking of bitter foods (56). This study investigated hedonic ratings and "taste notes" for bitter foods, including bitter melon, but did not specifically determine consumption intentions. Additionally, Stein, *et al.*, evaluated post-exposure hedonic scores after health information was provided about a bitter beverage, but no specific information was provided about bitter melon

Tailoring messages to a specific population is an important concept in any type of nutrition education. Information pertaining to the participants' health status or history was not collected. Additionally, individual health beliefs were not assessed. Such factors may have an effect on bitter melon acceptability and consumption intentions, especially in the presence of health information on bitter melon. The health information provided in this study was very general and may or may not have applied to the convenience sample

assessed. Most of the information focused on attributes and consequences of bitter melon consumption that would be beneficial to those at risk of heart disease or diabetes. For the younger participants, if they did not have a family history or other risk factor for these diseases then it would be difficult to internalize a general risk and personal benefit of consumption. This type of health message may have even had a negative effect by giving bitter melon a "healthy" label. Previous research using reduced fat foods as an example has shown that such labels can affect sensory perceptions depending on individual beliefs about the specific label (78). For older subjects, a lack of interest in overall health, the specific health benefits of bitter melon, or long-term eating patterns/habits may all have affected the ability of health information to change future consumption intentions. The effect of age on palatability of food dishes made with bitter melon was not investigated in this study, but will be further analyzed in future publications of this data. Previous studies have shown a decrease in sensitivity to some bitter compounds with aging (79). This could translate into greater acceptance, but not necessarily consumption, of bitter tasting foods, such as bitter melon, with age.

Although four major ethnic categories (Asian, Hispanic, Hawaiian/Pacific Islander, and White) and at least 10 more specific groups within these categories were represented in this population sample, it was not representative of the population of Hawaii as a whole. According to the 2000 U.S. Census Bureau data, the major ethnicities in Hawaii are Asian (42%), White (24%), Native Hawaiian/Other Pacific Islander (9.4%), Hispanic (7.2%), Black/African American (1.8%), and American Indian/Alaskan Native (0.3%). Twenty-one percent of the population is classified as "two or more races" (80). This study over-represented Asians (47%) and Whites (41%) and under-represented

Blacks/African Americans (0%), Native Americans (0%), Hispanics (4%), and Native Hawaiians/Other Pacific Islanders (8%). Participants were asked to choose only the ethnic/racial category that they most identified with so it was not possible to compare how many individuals would normally be classified as "two or more races." This was part of the study design because it allowed for separation and the potential to analyze the impact of certain ethnic groups that traditionally consume bitter melon. For example, bitter melon is commonly cultivated and consumed in Brazil, China, India, and the Philippines (30). Hawaii is has a diverse population and individuals that most identify with one of these groups were more likely to have been exposed previously to bitter melon and may have even grown up eating it.

Future willingness to eat the various dishes in this study ranged from a mean of less than once to more than 2 times in two weeks. The mean number of times subject would be willing to consume each dish increased with increasing information, however, further analysis revealed that the change was not significant, except for the chili, when looking specifically at the overall difference between individual responses. Sensory scores for the chili showed that it was considered more acceptable than the curry and soup, but less acceptable than the tomato sauce. The mean number of times subjects were willing to consume the chili in 2 weeks varied from 1.57 ± 1.50 with no information up to 1.92 ± 1.58 with consequence-specific information. Compared with the tomato sauce which had the highest hedonic scores and 2-week consumption scores, the chili was well liked but still had room to improve. Prior to receiving health information, nearly 30% of subjects (n=13) initially said they would not consume the chili again whereas approximately half that many (n=7) said they would not be willing to eat the tomato

sauce. Thus, among two dishes with the highest mean hedonic scores, there was more room for people to change their initial response in the chili category. Individuals may have been reluctant to increase the number of times they would be willing to eat the tomato sauce because the average consumption willingness at baseline (before health information was provided) was already close to 2 or more times on average.

Some participants indicated they were unwilling to eat any of the dishes again. This may have been purely due to an aversion to the sensory characteristics, especially bitterness, or to a general reluctance to try new foods. Investigations into the latter, food neophobia, have found that reluctance to try new foods can affect the amount, type, and liking of foods (81, 82). Personality traits, including neophobia, were not investigated in this study.

Stages of Change Distribution

Although 69% of participants (n=34)) had tried bitter melon previously, only 27% (n=13) of all participants indicated that they eat it at least once every 2 months and therefore were classified in the "action" stage for consumption behavior. The "action" classification cutoff of once every 2 months was somewhat arbitrary since no previous definition has been established for bitter melon consumption behavior. This classification was based on the reasonable expectation that regular consumption of a food likely occurs in a 2 month period. However, "active" consumption would probably be defined as more frequent than once every 2 months if the definition were based on certain benefits, such as lower blood glucose or blood lipids. Of the nearly three-fourths of subjects (n=37) initially classified in one of the three pre-action stages, most (51%) were "not thinking" of consuming bitter melon in the future. Many factors determine food

choice and the complexity of these factors makes it difficult to precisely describe these results. Taste is widely considered the most important factor in food preference (58, 61, 83). Although mean hedonic scores suggested that all dishes except the curry were acceptable, the frequency distribution of individual responses was largely mixed for all four samples. A number of subjects rated specific attributes of the tomato sauce, chili, and soup as unacceptable to some degree. Negative taste perception could have persuaded those who had not tried bitter melon before to indicate that they were not thinking of trying it again in the future. For individuals who had previously tried bitter melon, their past experiences together with their sensory judgments in this study most likely combined to guide their future consumption intentions. A negative sensory experience with bitter melon could have biased their willingness to accept the current preparation or future consumption intentions. Likewise, some subjects may have previously consumed bitter melon that was prepared by blanching or other means to reduce bitterness and therefore were willing to consume it in general in the future. There are currently no published studies in English language literature using the stages of change to classify bitter melon consumption behavior or even behaviors related to consumption of novel or functional foods. Most applications of this model have been directed toward general eating behaviors to reduce risk of chronic disease, such as heart disease and diabetes, including higher consumption of grains, fruits, and vegetables and lower consumption of fat and saturated fat (67).

Stage changes after subjects received health information were mostly between the precontemplation and contemplation stages although some movement occurred between the contemplation and preparation stages. Movement across more than one stage was not

observed in this study. These results are expected based on the nature of individual behaviors within each stage. Sigman-Grant suggests that individuals in the pre-action stages can be motivated to change by cognitive strategies aimed at helping someone to start a behavior (68). Thus, providing health information, as was done in this study, could potentially increase awareness to someone in the precontemplation stage to think about consuming bitter melon for its potential health benefits. The most evident stage change seen here was a decrease in the number of subjects in the precontemplation stage and subsequent increase in the contemplation stage by 19% and 24% after viewing "attribute-" and "consequence-specific" information, respectively. Greater stage movement was seen after the consequences were presented which is not unexpected since this level of information provides more insight into the benefits to the person versus just the good qualities of bitter melon. Those in the contemplation stage are less likely to move stages because of some obstacle to completing the desired behavior. For example, an individual may be thinking of eating bitter melon in the future because they are aware of its health benefits, but are unwilling to move into the preparation and action stages due to the undesirable bitter taste (68). There were three individuals who did change from the contemplation to the preparation stage. The health information provided may have been directly applicable to their current health, health risks, or health beliefs. Interestingly, these three subjects varied in age from 26 to 56. Whether they generally found the samples acceptable was not investigated nor was a correlation made between hedonic scores and stage change.

Conclusions/Implications

The acceptability of bitter melon varies depending on preparation, regardless of previous exposure and knowledge of its health benefits. Among the attributes investigated, bitterness was the least liked and was the factor most often pinpointed as to how the dish could be better. Willingness to consume these dishes varied from less than once to more than twice per 2 weeks. These results suggest a need for development of additional recipes with bitter melon or changes to the present ones in order to increase feasibility of compliance in future clinical trials. Health information did not have a significant effect on willingness to consume all, but one dish in the present study. However, the effect of information may have been inhibited by sampling bias. Similar health information provided to individuals with diabetes or pre-diabetes or to those at risk for diabetes or heart disease may increase consumption intentions and help promote compliance in a clinical trial. In this study, health information positively affected stages of change classification for more than one-third of all pre-action subjects. The primary effect was the movement of more than 25% of those in the precontemplation stage to the contemplation stage. There was little difference between the stage distribution after subjects were provided attribute-specific information and consequence-specific information. This suggests that positive health information in general can elicit a change in consumption intentions of bitter melon despite mixed palatability results.

Implications

Many people assume that bitter melon is not palatable just based on its name. However, this study demonstrated that masking the bitterness caused by the presence of bitter melon increases palatability among a mixed ethnic and age group. Specifically, the use

of tomato-based recipes and various spices in conjunction with bitter melon may be a successful way to mask bitterness. Additional recipe development aimed at using the whole bitter melon without the addition of sugar or fat is warranted for its use in clinical trials with diabetics and those with risk factors for heart disease. The present study also suggests that health information on bitter melon presented in such a way to increase awareness can help move people to initiate behaviors they may have been unwilling to start after initial sensory judgments. It also demonstrates the usefulness of the stages of change construct in evaluating interventions with novel or functional foods. The potential benefits associated with many bitter fruits and vegetables, such as bitter melon, may warrant the development of stages of change protocol for use in nutrition interventions aimed at increasing consumption of these foods.

Appendix A –

Sign 1

Bitter melon

Bitter melon

Palatability Study

Thursday, April 27th

11:00 a.m. - 2:30 p.m.

AgSci 319

Appendix A –

Sign 2

WANT TO BE PART OF A RESEARCH STUDY?

Food Tasting!

THURSDAY, APRIL 27TH
11 A.M. UNTIL 2:30 PM

UNIVERSITY OF HAWAII MANOA CAMPUS
AGRICULTURAL SCIENCES BLDG ROOM 219

PALATABILITY STUDY OF BITTER MELON
APPROX. TIME: 15 MINUTES

Appendix B – Recipes

Chili

Vegetable Chili with Bitter Melon

1 Tbsp olive oil
1/3 large onion (~2.5 oz), diced
2 garlic cloves, minced
14.5 oz. can petite diced tomatoes
1.25 oz. mild green chiles, diced
1 Tbsp chili powder
1 tsp. ground cumin
1 tsp oregano
6 oz. kidney beans
1/2 c. green pepper, diced
1/2 c. corn
225g (~ 2c.) bitter melon, seeds removed, puréed
1c. tomato sauce
salt and pepper (to taste)

1. Heat oil in large saucepan over medium heat.
2. Add onions, garlic, and green peppers
3. Cook, stirring, until onions are clear, about 10-15 minutes
4. Add chiles, chili powder, cumin, tomatoes, and tomato sauce
5. Cook, stirring, for about 2 minutes
6. Add kidney beans, corn, and bitter melon. Allow to simmer for 5 minutes.
7. Stir in oregano.
8. Optional: add extra tomato sauce to taste

Nutrition Analysis:*
Serving Size: 1 cup; Calories: 95 kilocalories; Carbohydrates: 16g; Protein: 4g; Total Fat: 2g; Dietary Fiber: 4g

*Nutrition information approximated using Genesis SQL software

Appendix B – Recipes

Curry

Bitter Melon Curry

1 tsp. olive oil
¼ tsp. mustard seeds
¼ tsp. turmeric powder
5 ½ c. (675g) bitter melon, seeds removed, chopped
1c. water
4 tbsp. dry coconut (unsweetened)
½ tbsp. peanut butter
1 tsp. curry powder
¼ tsp. chili powder
½ tsp. sugar
Coriander leaves, chopped

1. Heat oil over medium heat and add mustard seeds and turmeric powder.
2. Add bitter melon, water, and coconut, peanut butter, curry powder, chili powder, and sugar.
3. Bring to a boil and then cook at medium heat until water evaporates (Approx. 20-25 minutes).
4. Garnish with coriander leaves.

Nutrition Analysis:*
Serving Size: 1 cup; Calories: 82 kilocalories; Carbohydrates: 8g; Protein: 2g; Total Fat: 8g; Dietary Fiber: 5g

*Nutrition information approximated using Genesis SQL software

Appendix B – Recipes

Soup

Vegetable Soup with Bitter Melon

17 oz. chicken broth
1 c. baking potatoes, diced
1/2 c. carrots, diced
1/2 c. plain tomato sauce
2 c. bitter melon, seeds removed, finely diced (~200g)
1/2 c. yellow corn
2 1/2 tsp. dried basil
1/4 tsp salt
3/4 tsp black pepper
1/2 tsp oregano

1. Bring chicken broth to boil in large saucepan over high heat
2. Once to a boil, add potatoes and carrots, then reduce heat to medium-high until vegetables are tender (~20 minutes).
3. Add tomato sauce, corn, and bitter melon. Reduce heat to medium low and allow to simmer for 5-10 minutes
4. Add salt, pepper, oregano, and dried basil to taste.

Nutrition Analysis:*
Serving Size: 1 cup; Calories: 93 kilocalories; Carbohydrates: 20g; Protein: 3g; Total Fat: <1g; Dietary Fiber: 4g

*Nutrition information approximated using Genesis SQL software

Appendix B- Recipes

Tomato Sauce

Tomato Sauce with Bitter Melon

2- 15oz. cans tomato sauce
1/2 medium onion, chopped
4 cloves garlic
1 Tbsp olive oil
3 Tbsp fresh basil
1 Tbsp oregano
1 tsp. black pepper
1 tsp salt
1/4 c. tomato paste
300g (~3 c.) bitter melon, seeds removed, puréed

1. Heat oil, garlic, and onion in large saucepan over medium heat
2. Add tomato sauce and bitter melon, stirring for 2 minutes
3. Add oregano, basil, pepper, and salt. Allow to simmer for 5-10 minutes
4. Add tomato paste as needed to thicken the sauce.

Nutrition Analysis:*
Serving Size: 1 cup; Calories: 93 kilocalories; Carbohydrates: 17g; Protein: 3g; Total Fat: 3g; Dietary Fiber: 5g

*Nutrition information approximated using Genesis SQL software

Appendix C- Pilot Study Survey Form

Bittermelon Questionnaire – DRAFT

Gender:
Circle one: M F

Ethnicity:_____

*****Important Information*****

- The following samples are made with bittermelon.
- If you are pregnant or think you may be pregnant or have hypoglycemia (low blood glucose) please let it be known and do not begin sampling
- Listed below are potentially allergenic sample ingredients. Please **read completely** and let it be known if you are allergic to any of these ingredients.
- If you do have an allergy, do **not** begin tasting the samples. If you have a known allergy to any food/food ingredient please check with a survey administrator to ensure it is not contained within any of the following samples.

Ingredients:
Peanuts?, OTHER?

General Directions: Taste each of the following samples one at a time. Once you have tasted each sample and completed the corresponding questions feel free to go back and taste previous samples as many times as you would like.

Directions: Evaluate each dish by looking at it and tasting it. Considering all characteristics (appearance, texture, flavor) indicate your overall opinion by [√] one box below.

Sample #478

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

What did you like/dislike about Sample #478? (Use Words not Sentences)

Liked:

_____
_____
_____
_____
_____

Disliked:

_____
_____
_____
_____
_____

Would you eat Sample #478 again as part of your diet? Check Yes or No:

Yes ☐ No ☐

If Yes, how many times would you be willing to eat this as a meal over a period 2 weeks? Check one:

Once ☐ 2-3 times ☐ 4 or more times ☐

How many times would you be willing to eat this in 2 weeks if you knew it had potential health benefits?

Once ☐ 2-3 times ☐ 4 or more times ☐

Sample #296

Directions: Evaluate the dish in front of you by looking at it and tasting it. Considering all characteristics (appearance, texture, flavor) indicate your overall opinion by [√] one box below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

What did you like/dislike about Sample #296? (Use Words not Sentences)

Liked: _____ _____ _____ _____ _____

Disliked: _____ _____ _____ _____ _____

Would you eat Sample #296 again as part of your diet? Check Yes or No:

Yes ☐ No ☐

If Yes, how many times would you be willing to eat this as a meal in 2 weeks? Check one:

Once ☐ 2-3 times ☐ 4 or more times ☐

How many times would you be willing to eat this in 2 weeks if you knew it had potential health benefits?

Once ☐ 2-3 times ☐ 4 or more times ☐

Sample #913

Directions: Evaluate the dish in front of you by looking at it and tasting it. Considering all characteristics (appearance, texture, flavor) indicate your overall opinion by [√] one box below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

What did you like/dislike about Sample #913? (Use Words not Sentences)

Liked: _____ _____ _____ _____ _____

Disliked: _____ _____ _____ _____ _____

Would you eat Sample #913 again as part of your diet? Check Yes or No:

Yes ☐ No ☐

If you Yes, how many times would you be willing to eat this as a meal in 2 weeks? Check one:

Once ☐ 2-3 times ☐ 4 or more times ☐

How many times would you be willing to eat this in 2 weeks if you knew it had potential health benefits?

Once ☐ 2-3 times ☐ 4 or more times ☐

Sampe #374

Directions: Evaluate the dish in front of you by looking at it and tasting it. Considering all characteristics (appearance, texture, flavor) indicate your overall opinion by [√] one box below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

What did you like/dislike about Sample #374? (Use Words not Sentences)

Liked: _____ _____ _____ _____ _____

Disliked: _____ _____ _____ _____ _____

Would you eat Sample #374 again as part of your diet? Check Yes or No:

Yes ☐ No ☐

If Yes, how many times would you be willing to eat this as a meal in 2 weeks? Check one:

Once ☐ 2-3 times ☐ 4 or more times ☐

How many times would you be willing to eat this in 2 weeks if you knew it had potential health benefits?

Once ☐ 2-3 times ☐ 4 or more times ☐

Sample #571

Directions: Evaluate the dish in front of you by looking at it and tasting it. Considering all characteristics (appearance, texture, flavor) indicate your overall opinion by [√] one box below.

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

What did you like/dislike about Sample #571? (Use Words not Sentences)

Liked: _____ _____ _____ _____ _____

Disliked: _____ _____ _____ _____ _____

Would you eat Sample #571 again as part of your diet? Check Yes or No:

Yes ☐ No ☐

If Yes, how many times would you be willing to eat this as a meal in 2 weeks? Check One:

Once ☐ 2-3 times ☐ 4 or more times ☐

How many times would you be willing to eat this in 2 weeks if you knew it had potential health benefits?

Once ☐ 2-3 times ☐ 4 or more times ☐

Please rank from 1-5 the samples according to your preference. Please assign each number only once.

1= Liked the Most 5= Liked the Least

___Sample #478
___Sample #296
___Sample #913
___Sample #374
___Sample #571

Would you be willing to eat any of these samples as a meal, once per day, on an alternating basis for 2 weeks? Check Yes or No.

Yes ☐ No ☐

If Yes, which ones? Circle any of the following that apply:

Sample #478 Sample #296 Sample #913 Sample #374 Sample #571

Would you be willing to eat any of these samples as a meal, once per day, on an alternating basis for 2 weeks if you knew it would have potential health benefits? Check Yes or No.

Yes ☐ No ☐

If Yes, which ones? Circle any of the following that apply:

Sample #478 Sample #296 Sample #913 Sample #374 Sample #571

Please rank the following from 1-3 in terms of importance to you when considering foods to prepare/eat:

1= Most important 3= Least Important

__Cost
__Ease of Preparation
__Taste

If a food had potential health benefits but was more expensive, would you pay extra in order to include it in your diet? Check Yes or No.

Yes ☐ No ☐

If a food had potential health benefits but was time consuming to prepare, would you spend extra time preparing it in order to include it in your diet? Check Yes or No.

Yes ☐ No ☐

Appendix D- Survey Form "Version 1a"

Bitter Melon Sensory Evaluation and Questionnaire

Gender:

☐Male

☐ Female

Age:_____

Which ethnic or racial group below do you most identify with? Check only one.

Asian

☐Cambodian

☐Chinese

☐Filipino

☐Indian (from India)

☐Japanese

☐Korean

☐Thai

☐Vietnamese

☐Other (Write in)_____

Black

☐African American

☐Other (Write in)_____

Hispanic

☐Cuban

☐Mexican

☐Puerto Rican

☐Other (Write in)_____

Native American

☐American Indian

☐Alaskan Native

Native Hawaiian or Other Pacific Islander

☐Guamanian/Chamorro

☐Hawaiian/Part-Hawaiian

☐Samoan

☐Tongan

☐Other (Write in)_____

White

☐Portuguese

☐Other (Write in)_____

*****Important Information*****PLEASE Read

- The following samples are made with bitter melon.
- If you are pregnant or think you may be pregnant, breastfeeding, have problems with low blood sugar, or are taking medications for diabetes, please let it be known and do not begin sampling.
- If you have any food allergies or sensitivities to any food/food ingredient, do not begin tasting the samples. Please check with a survey administrator to ensure the food/food ingredient is not contained within any of the following samples.

Directions: Taste each of the following samples one at a time in the order on this form. First evaluate each dish by considering how much you like or dislike individual and then overall characteristics (texture, flavor, smell, etc.). Indicate your opinion by placing a [√] in one box below for each row. Then, answer the questions for each sample.

SAMPLE #1: Chili

	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
Texture									
Bitterness									
Smell									
Overall									

How could this dish be better so that you would consider eating it?

Do you typically like chili? Yes ☐ No ☐

How many times would you be willing to eat Sample #1 as a meal in 2 weeks. Check one:
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times ☐

SAMPLE #2: Tomato Sauce

	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
Texture									
Bitterness									
Smell									
Overall									

How could this dish be better so that you would consider eating it?

Do you typically like tomato sauce? Yes ☐ No ☐

Indicate how many times would you be willing to eat Sample #2 as a meal in 2 weeks. Check one:
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times ☐

SAMPLE #3: Curry

	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
Texture									
Bitterness									
Smell									
Overall									

How could this dish be better so that you would consider eating it?

Do you typically like curry? Yes ☐ No ☐

How many times would you be willing to eat Sample #3 as a meal in 2 weeks. Check one:
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times ☐

SAMPLE #4: Soup

	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
Texture									
Bitterness									
Smell									
Overall									

How could this dish be better so that you would consider eating it?

Do you typically like soup? Yes ☐ No ☐

How many times would you be willing to eat Sample #4 as a meal in 2 weeks. Check one:
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times ☐

1. Have you ever tried bitter melon before?
☐Yes ☐No

2. Do you currently consume bitter melon at least once every 2 months? If yes, how many times in 2 months do you typically consume bitter melon?
☐Yes_____times per 2 months ☐No

If you answered "Yes" to question #2 above, please answer questions #3 and #4 below

If you answered "No" to question #2 above, please skip questions #3 and #4 and answer question #5 below.

3. Which of the following best describes how long have you consumed bitter melon at least once every 2 months?
☐ <6 months
☐ ≥6 months

4. Why do you consume bitter melon? Check any of the following that apply then **skip Question #5.**

☐I like the taste
☐Health reasons
☐I grew up eating it
☐Other (please specify)_____

5. Which of the following best describes you:

☐I am NOT thinking of consuming bitter melon in the future
☐I AM thinking of consuming bitter melon in the future
☐I am planning to consume bitter melon in the future

Please read the following information about bitter melon and answer Questions #6 and #7 below

- Research with animals and human have shown that bitter melon can lower high blood sugar.
- Feeding bitter melon to rats and mice on a high fat diet lowered body weight and fat-like components in the blood and liver.
- Bitter melon has also been shown in animal studies to increase "good" blood cholesterol (HDL).

6. Was this new information to you?

☐Yes ☐No

7. Given this information, indicate how many times you would be willing to eat each dish as a meal in a 2-week period. Check only one box for each sample below.

Sample - Chili
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times ☐

Sample - Tomato Sauce
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times ☐

Sample - Curry
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times ☐

Sample - Soup
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times ☐

If you answered "No" to question #2, please answer question #8:

8. Given the information on bitter melon above, which of the following best describes you:

☐I am NOT thinking of consuming bitter melon in the future
☐I AM thinking of consuming bitter melon in the future
☐I am planning to consume bitter melon in the future

Please read the following information about bitter melon and answer Questions #9 and #10 below.

- Eating bitter melon may help lower your risk for type 2 diabetes or heart disease.
- Eating bitter melon may provide another treatment if you have type 2 diabetes.

9. Was this new information to you?

☐Yes ☐No

10. Given this information, indicate how many times you would be willing to eat each dish as a
meal in a 2-week period? Check only one box for each sample below.

Sample - Chili
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times

Sample - Tomato Sauce
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times

Sample - Curry
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times

Sample - Soup
None ☐ 1 time ☐ 2 times ☐ 3 times ☐ 4 times ☐ 5 times

If you answered "No" to question #2, please answer question #11:

11. Given the information on bitter melon above, which of the following best describes you:

☐I am NOT thinking of consuming bitter melon in the future
☐I AM thinking of consuming bitter melon in the future
☐I am planning to consume bitter melon in the future

IMPORTANT NOTE – please read:

- Children under the age of 18 and pregnant or breastfeeding women should not consume bitter melon because of potential negative side effects.
- In some people, excessive consumption of bitter melon may cause diarrhea due to irritation of the stomach and intestines.

Appendix E- Informed Consent Form

Agreement to Participate in
Bitter Melon Acceptability & Feasibility Study

Pratibha Nerurkar
Primary Investigator
956-9195

This research project is being conducted as a component of a graduate thesis. The purpose of the project is to learn the acceptability of traditional food dishes prepared with the vegetable bitter melon and the effects of varying levels of nutrition and health knowledge on willingness and intent to consume these dishes. You are being asked to participate because you are a healthy adult on the UH campus.

Participation in the project will consist of tasting several traditional mixed food dishes and filling out an evaluation form consisting of questions about each dish, your willingness to consume these dishes given information about bitter melon, and your consumption, if any, of bitter melon. Questions will focus on how much you like or dislike each food dish. Data from the questions will be summarized to determine overall acceptability of each dish. No personal identifying information will be included in the research results. Completion of the evaluation form should take no more than 15-20 minutes. Approximately 35 people will participate in the study.

The investigator believes there is little or no risk to participating in this research project. However, food allergies/sensitivities are common in some people so there may be a small risk that you will have a food allergy/sensitivity to one or more components of the food dishes. Please notify investigators if you have any known food allergies/sensitivities. Also, notify the investigators if you have problems with low blood sugar.

Participating in this research may be of no direct benefit to you. It is believed that the results from this project will help determine the acceptability of bitter melon in traditional food dishes and feasibility of bitter melon consumption in future clinical trials. There is no compensation for time spent participating in this research project.

Research data will be confidential to the extent allowed by law. Agencies with research oversight, such as the UH Committee on Human Studies, have the authority to review research data. All research records will be stored in a locked file in the primary investigators office for the duration of the research project. All other research records will be destroyed upon completion of the project.

Participation in this research project is completely voluntary. You are free to withdraw from participation at any time during the duration of the project with no penalty, or loss of benefit to which you would otherwise be entitled.

If you have any questions regarding this research project, please contact the researcher, Pratibha Nerurkar, at (808) 956-9195.

If you have any questions regarding your rights as a research participant, please contact the UH Committee on Human Studies at (808) 956-5007.

Participant:
I have read and understand the above information, and agree to participate in this research project.

_____
Name (printed)

_____ _____
Signature Date

Appendix F- Comments on Food Samples

Answers to the question "How could this dish be better so that you would consider eating it?"

Chili

- "More sweet"
- "I do not like bitter food; needs meat"
- "It would be better with beans"
- "Fine"
- "Use more beans, they help temper the bitterness; needs stronger flavor (try adding chipotle pepper)"
- "There is a flavor aside from the bitter that I do not like in this preparation. Other qualities mentioned [in the hedonic evaluation] were okay."
- "Add meat and maybe extra spices to cover up the after taste. Maybe add something spicier to see if spice lingers longer than the bitter melon."
- "If it were a bit spicier; also a thicker texture would be preferable. It seemed a bit watery."
- "It was *ono*."
- "Less rice, more chili"
- "I think this is a great way to incorporate bitter melon."
- "Onions and garlic"
- "Somewhat of a metal taste"
- "Hotter spice; more onion; less bitter"
- "Less bitter; spicier"
- "Adding more sweetner"
- "Dilute the bitter melon; maybe make it sweeter"
- "More 'tomatoey' flavor"
- "[Add] meat"
- "More rice"
- "Bitter melon sautéed longer with salt before added to chili components"
- "Add salt"
- "Needs more spices; I like spicy chili"
- "I think meat could overpower the bitterness"
- "More sauce"
- "Hide bitterness more"
- "More beans"
- "It tastes like the [soup]; awful!!!"
- "More flavor; more balance"
- "By complementing or highlighting the flavor of the melon more; maybe a white chili instead"
- "Less bitter"
- "Maybe add more chili spices; still taste pretty bitter; the rice helps to make it less bitter"

Appendix F

Curry

- "The taste is awful to me, like burning"
- "Way too bitter; needs meat"
- "It would be better with more gravy"
- "Less bitter"
- "This was awful. It needs much stronger flavors from other spices and more salt. Add some spicy heat to it."
- "Less oil"
- "Less spice taste"
- "It still had that bitter after taste. The smell makes it seem like it will taste good, then the after taste makes it terrible."
- "Very bitter to me; somehow lessen it; was too wet; more appealing color needed"
- "Add tomato juice, or purée to reduce the bitterness"
- "No curry; don't like curry. Also doesn't taste like there is salt/pepper (seasoning)"
- "Melon was over-cooked; too soft"
- "I'm not sure. The bitter melon was very noticeable."
- "Maybe add other veggies; it was really bitter."
- "No taste; metal taste; needs flavor"
- "Could have more curry and spices"
- "Too bitter; more curry"
- "Make this [a little more] sweet"
- "Too astringent; too much green curry flavor"
- "Much more spice"
- "Tastes like dish soap"
- "More salt and spice; too plain"
- "Stronger curry spice; garlic would help; and spice peppers"
- "I just would not eat this one."
- "Maybe cook it with chicken to distract from the bitterness"
- "I don't think it can [be better]."
- "Take the bitter melon out."
- "The bitter melon taste is a tad strong, especially the after taste"
- "The bitterness was very strong. Perhaps more veggies to diversify the taste a bit more."
- "Seems so bland; combine with other vegetables in mixed vegetable dish."
- "More flavor"
- "I bet that if there were more liquid or if it were more sauce-like it would add flavor and enhance this dish slightly."
- "More garlic"
- "Change whatever ingredient you put in that green stuff."
- "More sugar or [I would] eat it when I'm sick."

Appendix F

Soup

- "Make it more sweet or salty to cover up the bitter after taste."
- "This would actually be a really good dish with a little more garlic and salt."
- "Try smaller chunks of [bitter melon], maybe grate it; it may affect the way bitterness is perceived"
- "The bitter melon seemed raw; cooking it a little bit more would be more appealing to me. The taste of this soup is strong (bitter and pepper). I like the taste, but only in small amounts at a meal; like as a condiment. Actually, it tastes like a natural medicine."
- "Once again, find a way to mask the bitter after taste. It lingers in your mouth."
- "How come this sample didn't have rice? I'd like rice; more vegetable or meat"
- "Less pepper taste; love the veggies (carrot & corn)"
- "Good"
- "The spices really contribute a lot to this dish and bitter melon taste is minimal; maybe more spices or tomato flavoring?"
- "It was good."
- "Not sure"
- "More spice"
- "Could be more flavorful, but overall [was] good"
- "A little less salt"
- "Too chunky; not enough flavor"
- "Less salty, but maybe that is the bitter part"
- "The best dish of the four; no recommendations available"
- "Not so spicy and bitter"
- "It was pretty good. The random bits of bitter melon [were] a little strong, but not terrible."
- "Add meat"
- "Try to hide bitterness more"
- "More herbs and seasoning"
- "There was a little bit too much bitterness so cutting down on the bitter melon would be nice."
- "Sugar; take out the bitter melon"
- "Better balance; bitterness a little overwhelming"
- "I liked that it was flavored well and that the bitter melon flavor was pretty well balanced. I wouldn't change it."
- "Less bitter"
- "It was too bitter; maybe use less bitter melon. More garlic might be good."
- "Good as it is"
- "Cover the bitterness more; the soup without the [bitter melon] pieces tastes very good."
- "Remove the bitterness"
- "Spice in this soup doesn't go well with the bitterness"

Appendix F

Tomato Sauce

- "Less bitter, less hard chunks"
- "Don't like bitter food; needs meat"
- "It could be better with more sugar."
- "This was very good! It would be very good with scallops, as they have a nice contrasting 'sweetness'."
- "Less onion. I could not taste the bitter flavor much. I like bitter flavor better than onion flavor. I liked crunchy texture."
- "Terrible after taste. I eat a lot of pastas and tomato sauces and none of them have that after taste."
- "More fragrant ingredients; richer flavor"
- "Cook the macaroni with the sauce; like simmer it into it."
- "Good dish"
- "Maybe a little more spices"
- "Too much herb maybe"
- "More garlic"
- "A little too bitter; needs more tomato"
- "Too bitter; not soupy enough"
- "This sample better than the [chili]; spice helps"
- "Again, too bitter and spicy"
- "I don't know; it was pretty good; tasted a lot like the chili."
- "Possibly use less bitter melon to take away the strong taste of bitterness"
- "Unaccustomed to eating [bitter melon] prepared this way (with pasta)."
- "The additional spices compensated for the bitterness. Perhaps a little more spice would be nice, but that could be because I like spicy food."
- "Somehow mask the after taste"
- "More ingredients; better balance"
- "I thought the flavor, texture, & seasoning were all pretty good. Maybe if some cheese were added it would make it more appealing."
- "Different [pasta] noodle"
- "Pasta should be cooked in the sauce"
- "Still quite bitter, but the spices actually cover it well. The spiciness is quite strong."
- "Personally, I like cheese sauces better than tomato [sauces], but I would eat it."
- "Less carbohydrates and [I] would eat when I have nasal congestion"

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