EFFECTS OF COCOA ALKALINITY ON SENSORY QUALITIES IN A CHOCOLATE-FLAVORED SUPPLEMENT CONTAINING TORULA YEAST

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CHAPTER I

INTRODUCTION

Nutrition plays an important role in the health of an individual. When an illness occurs, this role is endangered due to a variety of reasons, such as anorexia due to cancer. One way to achieve optimum nutrition, even in disease states, is through the use of supplements.

Although many nutrient supplements are commercially available covering a multitude of needs and taste preferences, existing supplements may become monotonous due to a lack of variety (Aker, 1979). It has been reported by DeWys and Herbst (1977) that patients better accept supplements that taste more like regular food. They found that patients preferred milk-based products to synthetic chemically defined nutritional products.

In order to obtain a positive patient response to nutritional supplements, the patient may try and reject a number of assorted supplements before choosing a final product. Factors influencing rejection may include color, odor, viscosity, temperature, foaming, taste, and lack of variety (Aker, 1979).

Purpose and Objectives

The purpose of this research is to test a chocolate-flavored supplement in the form of a dry mix containing torula yeast for nutrient fortification. The dry mix has been developed in the Food Product Development Laboratory at Oklahoma State University and is flavored with regular Hershey's cocoa from the grocery store. The dry mix can be prepared in different forms - pudding, beverage, or ice cream - to provide variety. Since many different types of cocoa are available to the commercial food manufacturer, it is important to determine the cocoa that is most compatible with torula yeast.

The products made from the dry mix have been generally well received and are reported as better flavored than most of the supplements currently available. However, the products do have an undercurrent of "sharp" flavor attributable to the yeast. The yeast enhances certain flavors, while altering others. Also certain foods and flavors tend to emphasize rather than mask the yeast flavor.

Chocolate manufacturers produce cocoas with a range of pH from 5.2 to 8.8 depending upon the amount of alkali (Dutch-process) the product receives (Freeland-Graves and Peckham, 1987). The bitterness also varies from a strong to a mild bitter flavor. A study is needed to show which cocoa will best enhance the flavor of the dry mix. The objectives of this study are as follows:

1. To determine the acceptability of the supplement prepared with four different cocoas from a single manufacturer using a trained sensory panel. That is,
   a. To determine if an alkali treatment of the cocoa (pH level of 5.65 to 7.56) affects the overall acceptability of the torula yeast supplemented pudding.
   b. To determine if the degree of bitterness is affected by the degree of the alkali treatment of the cocoa (pH level of 5.65 to 7.56) in the torula yeast supplemented pudding.
   c. To determine if the degree of alkali treatment of the cocoas affects yeast flavor or sweetness of the torula yeast supplemented product.
2. To determine the following parameters:
   a. pH values of the prepared supplements.
   b. Nutritive value of the supplements.

Hypotheses

H1: There are no differences in the panelists' mean ratings for the perceived intensity levels for the characteristics of bitter flavor, yeast flavor, and sweetness of the chocolate-flavored dietary supplements due to the degree of alkali treatment (pH level of 5.65 to 7.56) of the cocoa used.

H2: There are no differences in the panelists' mean ratings for their preferred levels for the characteristics of bitter flavor, yeast flavor, and sweetness of the chocolate-flavored dietary supplements due to the degree of alkali treatment (pH level of 5.65 to 7.56) of the cocoa used.

H3: There are no differences in the panelists' mean ratings for the sensory evaluation for overall acceptability of the chocolate-flavored dietary supplements due to the degree of alkali treatment (pH level of 5.65 to 7.56) of the cocoa used.

Assumptions

1. The sensory evaluation panel will evaluate the product as instructed.
2. The experiments will be conducted under controlled conditions.
3. The cocoas received the same processing methods except for the degree of alkalization (pH).

Limitations

1. Sensory evaluation panel consisting of trained members only will evaluate the dietary supplements.
2. Only one level of yeast (7.98% of dry weight) will be tested.
3. Only four cocoas from one manufacturer will be tested.
4. Nutrient values used in the nutrient analysis will be

calculated using published nutrient values of the ingredients except when supplied by the manufacturer.

Definition of Terms

Acceptability: The degree of liking an individual expresses for a product (Institute of Food Technologists Sensory Evaluation Division, 1981).

Alkalization or Dutch-process: A process in which the bean, nib, liquor, or powder has been treated with an alkali solution, usually in the form of potassium or sodium carbonate (Minifie, 1980).

Cocoa Bean: The whole seed of the cocoa tree (*Theobroma cacao*) which consists of the outer shell and kernel or "nib" (Heath, 1978; Wood and Lass, 1985).

Cocoa Nib: The kernel of the cocoa bean (Heath, 1978).

Fortification: The addition of nutrients not present in the food originally (Krause and Mahan, 1984).

Sensory Evaluation: A scientific discipline used to evoke, measure, analyze, and interpret reactions to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch, and hearing (Institute of Food Technologists Sensory Evaluation Division, 1981).

<u>Single Cell Protein</u>: Dried cells of microorganisms such as algae, actinomycetes, bacteria, yeasts, molds, and higher fungi grown in large-scale culture systems for use as protein sources in human foods or animal feeds (Litchfield, 1983).

Format of Thesis

Chapters I, II, and IV follow the guidelines set in the Graduate College Style Manual. Chapter III was organized and prepared as an individual manuscript for publication in the most acceptable journal. The chapter was written according to the Publication Manual of the American Psychological Association, the American Home Economics Association, and the Home Economics Research Journal. References cited in Chapter III will also be cited in the Selected Bibliography section.

CHAPTER II

REVIEW OF LITERATURE

This study evaluated the sensory qualities of four different alkali treated cocoas in a torula yeast supplemented pudding. This review covers a brief history of cocoa production, sensory evaluation, protein sources, nutrient supplements, and single cell protein.

General History of Cocoa

Cocoa is produced from the beans of the cocoa tree (Theobroma cacao Linnaeus), which grows in countries near the equator (Wood and Lass, 1985). The main commercial crops of cocoa beans come from Ghana, Brazil, Nigeria, Dominica, Ecuador, and Venezuela, and much smaller quantities from the West Indies (Heath, 1978).

The fresh cocoa bean or nib has a strong, bitter taste and must be treated to develop the cocoa flavor, aroma, and color. The flavor developed from the cocoa been varies considerably, being influenced largely by the variety of tree and method of preparation (Wood and Lass, 1985). There are three major steps in the flavor development of cocoa: fermentation, drying, and roasting.

Fermentation, which develops the flavor precursors, lasts from five to six days, depending on the type and size of the beans. During fermentation, high temperatures of 45-50° C (113-122° F) and large quantities of liquid develop (Jay, 1986). During fermentation, several chemical reactions occur. The proteins present in the beans are degraded and the level of free amino acids rise; sucrose is inverted to fructose and glucose which are oxidized to alcohol and various acids, such as acetic acid; and some theobromine and tannins are lost (Heath, 1978). There is also a significant color change. The original bean is a slate gray and, depending on the type of bean, changes to a light brown or purple-brown during fermentation (Minifie, 1980).

After fermentation, the beans are dried. The main objective of drying is to reduce the moisture content of the bean to avoid rapid molding and spoilage during storage and shipment. The drying process is a continuation of the oxidative stage of fermentation. This stage is important in reducing bitterness and astringency as well as developing the chocolate brown color of well fermented beans (Wood and Lass, 1985). During drying, the beans lose about 65% of their beginning weight, assuming their final optimum moisture content of 6% (Minifie, 1980). Due to moisture loss, the pH of the beans rise. Volatile acids are also lost.

After drying, the beans are roasted. In the roasting process, the beans are heated to 100-120° C (212-248° F) for 45-70 minutes (Wood and Lass, 1985). The conditions vary according to the type of roaster and the requirements for the final product. Lower roasting temperatures yield milder flavors. The primary purpose of roasting is to develop the flavor precursors formed during fermentation and drying (Wood and Lass, 1985). During roasting, bitterness is further reduced, the chocolate aroma is developed, and the beans turn to a rich brown (Connell, 1985).

A flow diagram of cocoa and chocolate production is given in Figure 1. The first step in cocoa production consists of removing the beans from the mucilaginous substance in the pod. The beans are then fermented, which also aids in removing the pulp from the outside of the cocoa beans. The beans are dried. At this time, the beans develop their rich brown color from the oxidation of tannins. After drying, the beans are roasted. Roasting improves the flavor of the cocoa beans and dries the husks or shells to allow for easy removal by a winnowing machine. The winnowing machine uses the combined action of sieving and air separation to divide the kernel or "nib" from the shell.

The nibs are further roasted to enhance flavor. Next, the nibs undergo a series of grinding operations. As the grinding continues, the particle size reduces and the paste becomes more and more fluid. The grinding process ruptures

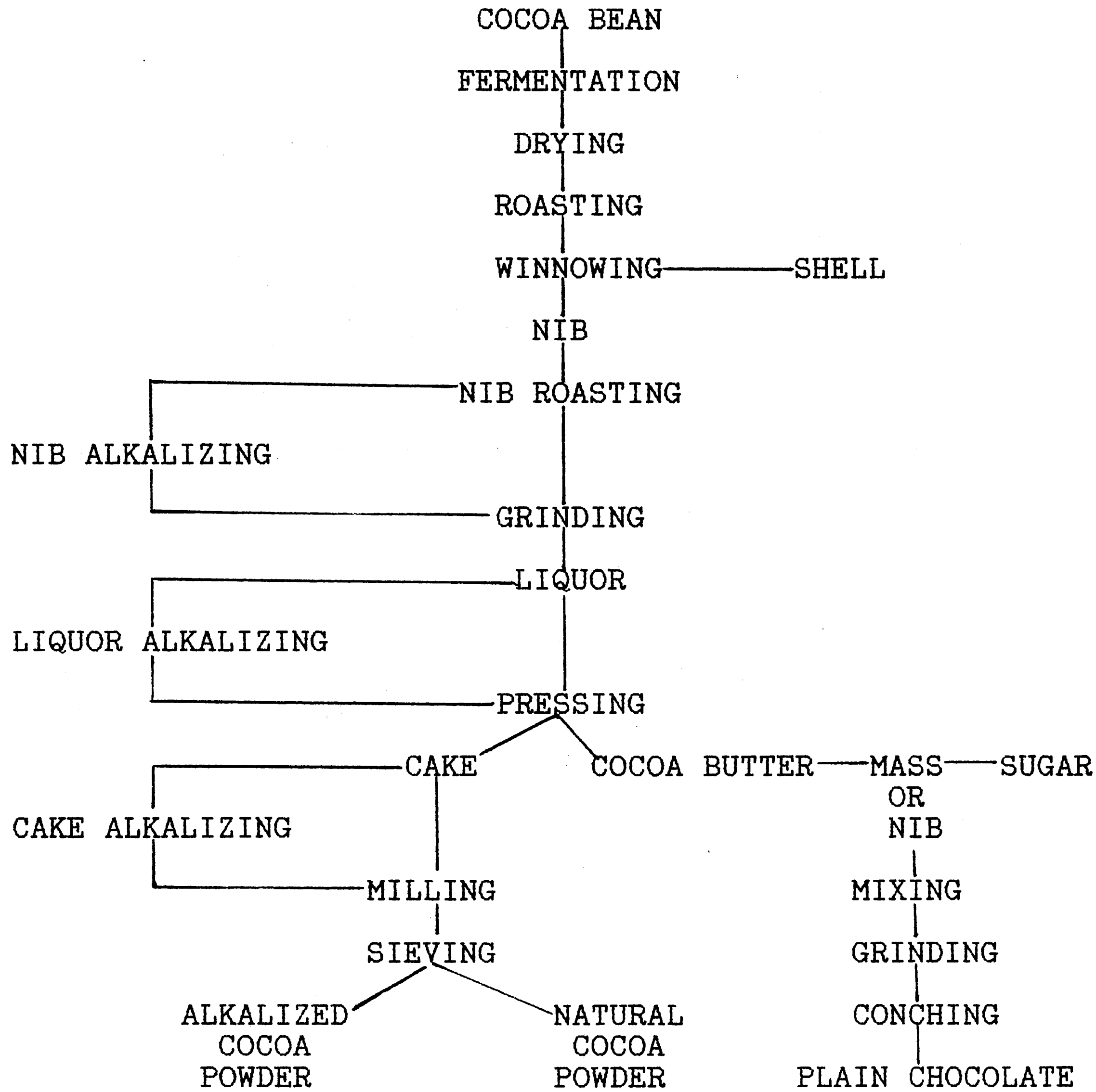

Figure 1. Production of Cocoa and Chocolate

the cell wall and produces frictional heat which liquefies the fat in the cell. The resulting paste, known as chocolate liquor, is the base of all chocolate and cocoa products.

To make cocoa powder, the chocolate liquor is put into hydraulic presses which removes most of the cocoa butter. The result is a pressed cocoa cake. The pressed cocoa cake is finely milled to produce cocoa powder.

Cocoas can be classified into two main types: breakfast or natural-process cocoa and Dutch-process cocoa. The breakfast or natural-processed cocoa has no additional treatment to the cocoa powder. The Dutch-processed cocoa involves the optional step in cocoa manufacturing, called "dutching," which was introduced in Holland in the late 1820's by Van Houten (Connell, 1985; Minifie, 1980). Dutching is a process in which the cocoa bean, nib, liquor, or powder is treated with an alkali solution. The alkali solution decreases the acidity of the cocoa from a pH of 5.2 - 6.0 to a final pH of 6.0 - 8.8 (Freeland-Graves and Peckham, 1987). The results of dutching include an alkalinity increase, a bitterness reduction, a color change from brown to a darker reddish brown color, and a slight solubility increase.

Sensory Evaluation

Sensory evaluation has been defined as "a scientific discipline used to evoke, measure, analyze, and interpret reactions to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch, and hearing" (Institute of Food Technologists [IFT] Sensory Evaluation Division, 1981). In the food industry, manufacturers use sensory evaluation as a guide in product development, quality control, and in the selection of product consumers. When used in the research and development phase, sensory evaluation can reduce the financial losses due to the failure of customer acceptance.

The major purpose of any sensory evaluation study is to provide information regarding the effect of certain experimental treatments upon a particular population (Sidel and Stone, 1976). That effect is described as changes or differences in a response that is analyzed using an appropriate statistical operation. The accuracy of the information provided by the sensory study depends upon the selection of an appropriate experimental design and the appropriate analysis of data. In most sensory tests, replications of the study are desired for both statistical and behavioral reasons. Those replications give the opportunity to study the consistency of the panel and lessen the degree of variability by both the researcher and the sensory panel.

There are two major classifications of sensory tests: analytical and affective. Analytical tests are used for laboratory evaluation of products in terms of differences or similarities and for identifying and qualifying sensory characteristics (IFT Sensory Evaluation Division, 1981). The two major types of analytical tests are discriminative and descriptive. Both employ experienced and/or trained panelists.

Potential panelists are screened for selected personal traits, interest, ability to discriminate or describe differences, and generate reproducible results. Training familiarizes the panelists with test procedures and increases their ability to recognize, identify, and recall sensory characteristics.

Affective tests are used to evaluate preference and/or acceptance of products and, generally, require a large number of respondents (IFT Sensory Evaluation Division, 1981). These panelists are not trained, but are selected to represent target or potential populations of consumers. Panel members are selected in accordance with a number of criteria, which frequently include previous use of the product, size of family or age of specific family members, occupation of head of the household, economic or social level, and geographic area (IFT Sensory Evaluation Division, 1981).

Types of Tests

There are several types of sensory testing which can be used in the evaluation of products. The type of test used depends upon the information desired. Affective or preference testing is based on a measure of preference or acceptance of a product. Preference tests include the hedonic or rating scale, paired comparison test, and ranking (IFT Sensory Evaluation Division, 1981). Little input is required by the panelist other than a statement of like or dislike.

Discriminative tests are used to determine if a difference exists between samples. Discrimination tests include the duo-trio, paired comparison, triangle, and taste threshold tests (IFT Sensory Evaluation Division, 1981). These tests indicate difference and the direction of that difference, but do not reveal the magnitude or degree of that difference. In discriminative tests, the panelist does not allow his personal likes or dislikes to influence his response.

Descriptive tests identify sensory characteristics and show the magnitude of differences. Descriptive tests include flavor and texture profiles, magnitude estimation, quantitative descriptive analysis, and ranking tests (IFT Sensory Evaluation Division, 1981). Descriptive tests provide more information on degrees of differences than discriminative tests and require a more highly trained group of panelists due to the detailed product evaluation.

Nutrient Supplements

Nutrient supplements are needed when an individual is 'at-risk' nutritionally, malnourished, or in a disease state. Before the initiation of nutritional therapy, an individual must undergo a complete nutritional assessment. After assessing the individual's needs, the best approach in restoring the health of the individual is established. The most preferred method of feeding is orally. Oral feeding is preferred, because enteral and parenteral feedings have many drawbacks and can lead to problems. These problems include catheter-related sepsis or bacteria; gastrointestinal complications, such as diarrhea, nausea, or malabsorption; electrolyte imbalance; metabolic disturbances, such as hyperglycemia or hyperammonemia; fluid and electrolyte imbalances; macronutrient or micronutrient deficiencies; and other complications, such as allergic reactions or anemia (Cataldi-Betcher, Seltzer, Slocum, Jones, 1983; Schneider, Anderson, Coursin, 1983). Also, mechanical complications can occur in the equipment. However,if the individual is unable to meet their nutritional requirements through oral intake, the individual must be fed through a tube, enterally or parenterally.

Due to gastrointestinal surgery, unconsciousness, or esophageal obstruction that prevents oral intake, some patients require liquid feedings through a tube. This type of feeding is enteral nutrition. Although most enteral feeding formulas are liquids, some pudding supplements are available. The method and route of administration and the condition of the individual will determine the type of formula to be used. The route of administration may be by nasogastric, esophagostomy, gastrostomy, or jejunostomy tube (Krause and Mahan, 1984). Continuous drip or pump administration of the feeding is the most common method of administration.

Parenteral nutrition, or intravenous feeding, by definition is the administration of nutrients by routes other than the gastrointestinal tract (Schneider et al., 1983). The administration of parenteral nutrition should be considered if the gastrointestinal tract is incapable of absorbing nutrients, taken orally or when infused through a nasogastric tube; if the individual is unable to ingest food by mouth; or when the individual might benefit from bowel rest. Generally, parenteral nutrition is not initiated unless intravenous support will continue at least five days (Grant, 1980).

Protein Sources

The two basic categories of protein sources for the animal diet are other animals (living or dead) and plants. The animal category contains terminal sources or nonreplenishing sources such as a living animal which is killed and eaten. Renewable or repeating protein sources, such as milk and eggs, come from living animals. Also included in this category are earthworms, single cell protein, and algae (Considine and Considine, 1982).

Plants also require protein to build and maintain their life processes, which, in turn, are protein sources for the animal diet. Some plants are essentially the exclusive source of proteins, energy, and other dietary factors for animals such as herbivores (Considine and Considine, 1982). Examples of plant protein sources are grains.

In terms of percentage of protein content, animal sources exceed plant sources. For example, the protein content of some typical unfortified foods range from 20 to 30% for cooked poultry and meats; 19 to 30% for cooked or canned fish; 25% for cheese; 13 to 17% for cottage cheese; 16% for nuts; 13% for whole eggs; 7 to 14% for dry cereals; 8.5 to 9% for white bread; 7 to 8% for cooked legumes; and about 2% for cooked cereals (Considine and Considine, 1982).

Protein sources used in supplements include non-fat dry milk, powdered whole milk, sodium and calcium caseinate, and soy protein isolate. Protein sources used in chemically defined formulas include hydrolyzed casein, lactalbumin, sodium caseinate, egg white solids, and amino acids (Krause and Mahan, 1984).

Single Cell Protein

The term "single cell protein" (SCP) refers to the dried cells of microorganisms such as algae, actinomycetes, bacteria, yeasts, molds, and higher fungi grown in large-scale culture systems for use as protein sources in human foods or animal feeds (Litchfield, 1983). Although these microorganisms are grown primarily for their protein contents, the microbial cells also contain carbohydrates, lipids, vitamins, minerals, and nonprotein nitrogen materials such as nucleic acids.

Four groups of microorganisms have been used for SCP production: algae, bacteria, filamentous fungi and molds, and yeasts. The substrates used for the production of these microorganisms are divided into four categories: carbohydrate-containing substances, carbon dioxide, lower alcohols and organic acids, and petroleum and related products. The first category includes starch, sugar, molasses, sulfite waste liquor, cheese whey, and cellulose; the second category, carbon dioxide, is used only for the production of algae and photosynthetic bacteria; the third category includes methanol, ethanol, isopropanol, acetate, and maleate; and the fourth category includes n-paraffins, gas-oil, natural gas, and crude oil (Chen and Peppler, 1978).

In the production of SCP, yeasts are the best choice for human nutrition. Bacteria have variable and low protein quality and digestibility. When fed relatively high doses of bacterial formulations, human subjects experienced vertigo, nausea, vomiting, diarrhea, headache, weakness, and pain in the extremities (Tuse, 1983). Bacteria is not approved by the Food and Drug Administration and is low in acceptability. Fungi and algae have low digestibility and production rates.

There are many advantages in using yeast as a protein supplement. Rapid growth rates, the ability to digest a variety of substrates, high protein content, good amino acid profiles, and high acceptance have made yeasts the prime candidates for SCP production. Yeasts are a good source of the B group vitamins and also provide small amounts of vitamin E and provitamin D, but few yeast strains contain vitamin A (Goldberg, 1985). Despite the limitation of sulfur-containing amino acids, yeast SCP is 80 to 90% digestible and the biological value is up to 70% (Tuse, 1983). The quantities of these vitamins vary according to the strain, methods of production, conditions of cultivation, and carbon source. The nutritional analysis of Provesteen-T dried yeast is shown in Appendix A.

Currently, in the United States, Food and Drug Administration regulations permit four types of yeasts for human food use. These yeasts are Saccharomyces cerevisiae (bakers' yeast), Candida utilis (torula yeast), Kluyveromyces fragilis (fragilis yeast), and bakers' yeast protein concentrate produced by extraction of protein from Saccharomyces cerevisiae (Litchfield, 1983).

The first purposeful SCP production originated in Germany during World War I when baker's yeast, Saccharomyces cerevisiae, was grown (with molasses as the carbon and energy source and ammonium salts as the nitrogen source) for consumption as a protein supplement (Litchfield, 1983). During this period, the development of the Waldhof fermentor represented a significant advance in the technology for mass cultivation of microbial cells. After World War II, torula yeast production was introduced into the United States and has continued until the present time.

Although yeast SCP can be batch produced, the most feasible process is a continuous process. The yeast, air, ethyl alcohol, and mineral nutrients are combined in a fermentor, where the pH and temperature are controlled to promote rapid cell growth and to obtain a uniform product (Schnell, Akin, and Flannery, 1976). The mixture is continuously withdrawn and pasteurized, centrifuged, and spray-dried. The resulting product is a fine powder that is cream-colored and has a slight yeasty aroma and flavor.

A recent improvement, known as Provesteen process, in the continuous process, was introduced by the Provesta Corporation, a Phillips Petroleum Company subsidiary. In this process, an extremely dense cell mass is formed in the fermentor, which is continuously withdrawn to go directly from pasteurization to spray drying. Due to this improved process, the centrifugation step is eliminated (Dziezak, 1987; Phillips, 1984).

SCP can be used in the form of whole cells or as isolated protein concentrates for human consumption. The SCP as whole cells has been used to improve the quality of cereal protein, to enrich the vitamin and mineral contents in many foods, to improve the physical properties of some processed foods, and as dietary supplements for both humans and animals (Chen and Peppler, 1978). The SCP isolated concentrate has been used in experimental bench research for flavor and texture improvement, foaming and gel formation properties, and water and fat binding properties (Chen and Peppler, 1978). Only small quantities of the SCP isolated concentrate have been produced. SCP is also used as flavor enhancers and processing enzymes. As research continues and technology expands, the sources and uses of single cell proteins will continue to rise.

CHAPTER III

EFFECTS OF COCOA ALKALINITY ON SENSORY QUALITIES IN A CHOCOLATE-FLAVORED SUPPLEMENT CONTAINING TORULA YEAST

Introduction

Nutrition plays an important role in the health of an individual. When an illness occurs, this role is endangered due to a variety of reasons, such as anorexia due to cancer. One way to achieve optimum nutrition, even in disease states, is through the use of supplements.

Although many nutrient supplements are commercially available covering a multitude of needs and taste preferences, existing supplements may become monotonous due to a lack of variety (Aker, 1979). DeWys and Herbst (1977) reported that patients are more accepting of supplements that taste like regular food products. They found that patients preferred milk-based products to synthetic chemically defined nutritional products.

The spector of a protein shortage in third world countries has urged researchers and scientists to look for new and inexpensive sources for protein. These new protein sources included microorganisms, such as yeasts. There are many advantages in using yeast as a protein supplement. Yeast protein contains a considerable amount of lysine, which is deficient in many cereal proteins; yeast is a much more efficient producer of protein; and arable land is not necessary as it is for plant and animal production (Scott, Sanderson, and Ashton, 1972). Due to these advantages, torula yeast has been included in a chocolate-flavored dry mix supplement that can be reconstituted as a beverage, pudding, or frozen dessert. However, yeast enhances certain flavors, while altering others. Also certain foods and flavors tend to emphasize rather than mask the yeast flavor. Therefore, the cocoa used in the mix must be chosen with care.

Chocolate manufacturers produce cocoas with a range of pH from 5.2 to 8.8 depending upon the amount of alkali or "dutching" treatment a cocoa receives (Freeland-Graves and Peckham, 1987). The results of dutching include an alkalinity (and pH) increase, a bitterness reduction, a color change from brown to a darker reddish-brown color, and a slight solubility increase. A study is needed to show which alkalinity or pH of cocoa will best enhance the flavor of the dry mix and will be most compatible with the flavor of the dried torula yeast.

Materials and Methods

Preparation of the Samples

The research was performed using the dry mix reconstituted as a pudding. The ingredients for the instant product were Berisford cocoa, Imperial sugar, Amaizo instant starch, Carnation instant non-fat dry milk, powdered free-flowing Butter Buds butter and Beatrice shortening, Ottens Flavors dried vanilla, Provesteen-T dried torula yeast, and water. (Provesteen-T is a human food grade dried torula yeast produced with a sucrose substrate.) The combined dry ingredients were added to the water and mixed in a blender at medium speed for 30 seconds. The mixture was stirred and then mixed for another 30 seconds. The mixture was poured into a large bowl, covered, and refrigerated approximately 12 hours before evaluation by the sensory evaluation panel to ensure all products were the same temperature.

The supplements were made using cocoa at four different pH levels (non-alkalized or natural cocoa, pH 5.65; lightly alkalized brownish-red cocoa, pH 7.02; alkalized dark red cocoa, pH 7.14; and alkalized light red cocoa, pH 7.56) giving four different products to be tested by the sensory evaluation panel. Although the cocoas were different shades of color due to the alkali treatment, there was little difference in color among the prepared puddings. The pH of the cocoas and the prepared puddings were measured using a Fischer Accumet pH meter (Model 815 MP). All cocoas were obtained from the same manufacturer.

Nutrient Analysis

Nutrient analysis was calculated using published nutrient values of the ingredients and nutrient information supplied by the Provesta Corporation for Provesteen-T dried torula yeast (Watt and Merrill, 1963).

Procedures

A trained sensory panel, consisting of 7 healthy females and 1 healthy male, was selected from the Oklahoma State University student body. A training session was held in order to familiarize the panelists with the flavors, ingredients, and evaluation forms to be used.

Panelists rated the puddings for bitter flavor, yeast flavor, sweetness, and overall acceptability. The panelists were orally instructed to evaluate each characteristic based on intensity of that characteristic and also on their (the panelists') preference for that characteristic. A scale of 0 to 100 was used with 100 being the weakest concentration and 0 being the strongest concentration for all characteristics except overall acceptability, for which 100 was the optimum value. Descriptor words for the extremes of each scale were used. (A sample score sheet used in the sensory evaluation is provided in Appendix B.)

The experimental design for this study was a randomized block design in a 4 x 4 arrangement of treatments repeated in each of the eight panelists. Product variations were randomized within each replication.

Individual pudding samples were placed in small souffle cups and presented to the panelists in a random order. The panelists sat in booths separated by dividers. Because the different color shades of the cocoas had little effect on the color of the prepared puddings, tests were conducted in a normally lighted room. The panelists were provided with water to rinse their mouths between samples. Testing sessions followed procedures described in American Society for Testing and Materials STP 434 (1968). Analysis of Variance (AOV) and Duncan's Multiple Range Test (P=0.05) were used to determine if there were significant differences in mean response ratings (Steel and Torrie, 1980).

Results and Discussion

Sensory Analysis

F-tests from the analysis of variance showed there was no interaction between the two experimental variables, day and cocoa for any of the seven characteristics tested. This shows the panelists rated the same characteristics the highest each day during the course of the experiment. (See Appendixes C - E for thesis data, analysis of variance tables, and day x cocoa means.)

The mean values for the characteristic, bitter preference, showed a difference due to days (P=0.004). The mean values for the characteristic, yeast preference, showed a difference due to days at a probability level (P=0.068) which approaches significance. The differences between these values (shown in Table I) indicate that the panelists tended to prefer a more bitter product as testing progressed. The panelists also preferred a more yeast flavored product as the testing progressed. Other characteristics tested showed no significant difference due to day.

The mean values for the characteristic, overall acceptability, showed a difference due to the cocoa used (P<0.0001). The mean values for the characteristic, yeast intensity, showed a difference due to the cocoa used at a probability level (P=0.071) which approaches significance, although the yeast level was the same in all samples. The

TABLE I

MEAN SCORES AND SIGNIFICANT DIFFERENCES FOR CHARACTERISTICS DUE TO DAY IGNORING COCOA

CHARACTERISTIC*	DAY OF COCOAS TESTED			
	1	2	3	4
BITTER INTENSITY	67.97[a]	64.78[a]	62.31[a]	60.31[a]
BITTER PREFERENCE	91.03[a]	89.12[ab]	87.06[bc]	86.16[c]
YEAST INTENSITY	54.56[a]	58.00[a]	56.59[a]	57.75[a]
YEAST PREFERENCE	90.84[a]	90.25[a]	89.69[ab]	87.44[b]
SWEET INTENSITY	49.03[a]	43.78[a]	46.62[a]	48.44[a]
SWEET PREFERENCE	43.78[a]	43.75[a]	45.12[a]	43.91[a]
OVERALL ACCEPTABILITY	58.84[a]	56.56[a]	58.66[a]	60.03[a]

* Characteristics rated on a scale of 0 to 100 with 100 being the weakest concentration and 0 being the strongest concentration except for overall acceptability for which 100 was the optimum value.

a-c Means on the same line followed by different letters are significantly different.

panelists were more accepting of the pudding supplements that were rated as having a less perceived yeast flavor. Data in Table II shows the differences in these values.

The mean ratings for the bitter flavor on all cocoas ranged from 60.66 - 65.84 on intensity and 87.19 - 89.44 for preference. As indicated by the mean ratings shown in Table II, the panelists preferred a less bitter cocoa. Much is the same for yeast flavor. The panelists preferred a milder yeast flavor than that present in the puddings tested. The panelists rated sweetness near the optimum level of 50 on both intensity and preference indicating a mid-level of sweetness was both perceived and preferred.

In overall acceptability, the cocoas were divided into two significantly different groups by the panelists: (i) the alkalized cocoa (pH 7.56) and the lightly alkalized cocoa (pH 7.02); and (ii) non-alkalized (natural) cocoa (pH 5.65) and the alkalized cocoa (pH 7.14). Within each group, there were no significant differences between the cocoas. The mean ratings for the cocoas in overall acceptability were 66.41 for the alkalized light red cocoa (pH 7.56), 65.59 for the lightly alkalized brownish-red cocoa (pH 7.02), 54.56 for the alkalized dark red cocoa (pH 7.14), and 47.53 for the natural or non-alkalized cocoa (pH 5.65) as shown in Table II.

The pH values of the prepared puddings varied less than 0.3 pH points; whereas, the pH values of the cocoas, both the values reported by the manufacturer as well as those

TABLE II

MEAN SCORES AND SIGNIFICANT DIFFERENCES FOR CHARACTERISTICS DUE TO COCOA IGNORING DAY

CHARACTERISTIC*	pH OF COCOA 7.02	7.56	5.65	7.14
BITTER INTENSITY	65.84[a]	64.47[a]	60.66[a]	64.41[a]
BITTER PREFERENCE	87.19[a]	89.31[a]	89.44[a]	87.44[a]
YEAST INTENSITY	62.97[a]	60.97[ab]	51.87[b]	51.09[b]
YEAST PREFERENCE	89.25[a]	90.31[a]	88.56[a]	90.09[a]
SWEET INTENSITY	45.59[a]	44.22[a]	49.37[a]	48.69[a]
SWEET PREFERENCE	43.84[a]	44.28[a]	44.41[a]	44.03[a]
OVERALL ACCEPTABILITY	65.59[a]	66.41[a]	47.53[b]	54.56[b]

[*] Characteristics rated on a scale of 0 to 100 with 100 being the weakest concentration and 0 being the strongest concentration for all characteristics except overall acceptability for which 100 was the optimum value.

[a-b] Means on the same line followed by different letters are significantly different.

determined by pH meter readings, varied by almost 2 pH points, as shown in Table III. This was probably due to the buffering capacity of the proteins in the puddings.

Nutrient Analysis

Figure 2 shows the nutritional analysis of the supplement prepared with whole and skim milk. As shown in Figure 2, a single 4 ounce serving prepared with whole milk provides 8 grams of protein, 210 calories, and substantial amounts of several vitamins and minerals.

TABLE III

pH COMPARISONS

COCOA	MEASURED pH	REPORTED pH	pH OF PREPARED PUDDING
N	5.65	5.7 ± 0.4	5.92
B	7.02	7.0 ± 0.25	6.06
D	7.14	7.4 ± 0.3	6.11
E	7.56	7.6 ± 0.25	6.21

Provesteen® Chocolate Flavored Mix

For: • Drink
• Pudding
• Frozen Dessert

This product combines Provesteen dried yeast and milk protein in a pleasant tasting supplement designed to be served either as a drink, pudding or a frozen dessert.

Protein levels range from 5 to 13 grams per serving depending upon the method of preparation.

Ingredients: Sugar, corn starch, non-fat dried milk, Provesteen dried yeast, cocoa, flavoring.

Nutrutional Information	Supple-ment Mix	Whole Milk	Whole Milk	Skim Milk
Serving Size	58.9 g.	4 Oz.	8 Oz.	8 Oz.
Calories	170	210	320	270
Protein(g)	5	8	13	13
Carbohydrates(g)	33	36	49	50
Fat(g)	1	3	7	1
Sodium(mg)	40	75	140	140
Percentage of US RDA				
Protein	10	15	25	25
Vitamin A	*	2	6	6
Vitamin C	*	2	4	4
Thiamine	6	10	10	10
Riboflavin	25	35	35	35
Niacin	15	15	15	15
Calcium	10	20	30	30
Iron	10	10	10	10
Vitamin D	8	15	30	30
Phosphorus	2	8	15	20
Magnesium	4	4	4	4

Apparent adding errors due to rounding.

*Value is less than 2% of US RDA

Instructions: For all versions 58.5 grams of the mix is stirred thoroughly with water or milk. For the pudding 4 ounces of liquid are used while 8 ounces are used for the drink or frozen dessert. This mixture freezes well in various ice cream machines.

For additional information, contact:

Provesta Corporation

Figure 2. Nutrient Label on Provesta Mix

Conclusions

After evaluating these products, the panelist have found cocoas that range from lightly alkalized (pH 7.02) to alkalized (pH 7.56) as more acceptable. The least favored was the natural cocoa. This was a non-alkalized product. The bitter flavor may be reacting synergistically with the yeast flavor. Further research is needed in this area and a study is needed comparing the acceptability of the prepared supplements with commercially available supplements by individuals that are ill and in need of dietary supplementation.

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CHAPTER IV

HYPOTHESES TESTING AND RECOMMENDATIONS

The purpose of this research was to determine the effects of cocoa alkalinity on sensory qualities in a chocolate-flavored supplement containing torula yeast. The variables of this study were supplements made with cocoas of different pH levels and the days the cocoas were tested. The sensory evaluation data was analyzed using analysis of variance procedure and Duncan's Multiple Range Test with a significance level of P=0.05.

Hypotheses Testing

The first hypothesis (H1) stated there are no differences in the panelists' mean ratings for the perceived intensity level of the characteristics of bitter flavor, yeast flavor, and sweetness of the chocolate-flavored dietary supplements due to the degree of alkali treatment (pH level of 5.65 to 7.56) of the cocoa used. Statistical analyses showed there were significant differences in the means of yeast intensity due to the cocoa used, so the researcher rejected H1 for this characteristic. Statistical analyses did not show any significant differences in the mean response ratings of flavor intensity for the other characteristics.

The second hypothesis (H2) stated there are no differences in the panelists' mean ratings for their preferred level for the characteristics of bitter flavor, yeast flavor, and sweetness of the chocolate-flavored dietary supplements due to the degree of alkali treatment (pH level of 5.65 to 7.56) of the cocoa used. Statistical analyses showed there were significant differences in the means of bitter preference and yeast preference due to the day, so the researcher rejected H2 for these characteristics. Statistical analyses did not show any significant differences in the mean response ratings due to preference for the other characteristic.

The third hypothesis (H3) stated there are no differences in the panelists' mean ratings for the sensory evaluation for overall acceptability of the chocolate-flavored dietary supplements due to the degree of alkali treatment (pH level of 5.65 to 7.56) of the cocoa used. Statistical analyses showed there were significant differences in the means of overall acceptability due to the cocoa, so the researcher rejected H3.

Recommendations

This study showed that cocoa made with different levels of alkalinity (pH) does affect the acceptability of a product. Additional testing of the torula yeast supplement should be conducted to evaluate the product when prepared as a beverage or ice cream. A study is needed to compare the torula yeast supplement with commercially prepared supplements currently on the market and other yeast supplements. Research should be conducted to determine the acceptability of the torula yeast supplement by hospital patients.

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APPENDICES

APPENDIX A

NUTRIENT ANALYSIS OF PROVESTEEN-T

TYPICAL COMPOSITION OF PROVESTEEN T DRIED YEAST

WEIGHT PERCENT	COMPOSITION
55.3	Crude Protein (N × 6.25)
47.0	True Protein (Biuret Analysis)
11.4	Ash
5.5	Moisture
4.6	Lipids
22.5	Carbohydrates (by Difference)

	MINERALS
0.07	Calcium
1.80	Potassium
0.35	Magnesium
0.02	Sodium
3.70	Phosphorus

ppm	TRACE ELEMENTS
36	Copper
271	Iron
19	Manganese
21	Molybdenum
203	Zinc

AMINO ACID PROFILE

g/100 g	AMINO ACID
3.4	Lysine
2.6	Arginine
2.4	Threonine
8.4	Glutamic Acid
2.3	Glycine
2.8	Valine
3.6	Leucine
2.4	Isoleucine
1.6	Tyrosine
1.0	Histidine
4.4	Aspartic Acid
2.3	Serine
1.8	Proline
3.3	Alanine
0.6	Methionine
2.1	Phenylalanine
0.2	Cystine
0.5	Tryptophan

FATTY ACID COMPOSITION

PERCENT OF TOTAL FATTY ACIDS	MAJOR FATTY ACIDS
0.2	C 14:0 Myristic
0.6	C 15:0 Pentadecanoic
14.0	C 16:0 Palmitic
5.8	C 16:1 Palmitoleic
0.6	C 17:0 Heptadecanoic
2.2	C 17:1 Heptadecenoic
1.1	C 18:0 Stearic
21.0	C 18:1 Oleic
48.4	C 18:2 Linoleic
5.6	C 18:3 Linolenic
0.5	C 20:1 Eicosenoic

VITAMIN CONTENT

mg/Kg	VITAMIN
8.8	Thiamine
50.5	Riboflavin
56.1	Pyridoxine (HCl)
0.003	B 12
0.14	Biotin
3820	Choline Chloride
21.1	Folic Acid
2980	Inositol
51.9	p-Aminobenzoic Acid
511	Niacin
194	Pantothenic Acid

APPENDIX B

SENSORY EVALUATION SCORE SHEET

SAMPLE NUMBER ___________

Rate the product on the characteristics listed below. For each characteristic, draw a straight line at the point you would rate the product.

BITTER FLAVOR

Strong bitter flavor — No bitter flavor

YEAST FLAVOR

Strong yeast flavor — No yeast flavor

SWEETNESS

Strong sweet taste — No sweet taste

OVERALL ACCEPTABILITY

Not acceptable — Acceptable

APPENDIX C

THESIS DATA

CODES USED

COCOA	pH OF COCOA	ALKALIZATION TREATMENT
N	5.65	NATURAL
B	7.02	LIGHTLY ALKALIZED
D	7.14	ALKALIZED
E	7.56	ALKALIZED

DEPENDENT VARIABLE CODES

BITTERI - BITTER INTENSITY

BITTERP - BITTER PREFERENCE

YEASTI - YEAST INTENSITY

YEASTP - YEAST PREFERENCE

SWEETI - SWEET INTENSITY

SWEETP - SWEET PREFERENCE

OVERACC - OVERALL ACCEPTABILITY

OBS	PANELIST	DAY	COCOA	BITTERI	BITTERP	YEASTI	YEASTP	SWEETI	SWEETP	OVERACC
1	TS	1	B	100	100	100	100	64	53	67
2	TS	1	D	100	100	100	100	55	55	100
3	TS	1	E	100	100	81	100	54	54	83
4	TS	1	N	100	100	100	100	52	52	100
5	BM	1	E	37	87	87	87	31	67	93
6	BM	1	D	60	86	9	86	51	68	40
7	BM	1	N	17	88	10	86	31	68	14
8	BM	1	B	63	87	68	87	51	67	85
9	TO	1	E	34	93	15	90	38	22	63
10	TO	1	B	51	90	54	89	43	23	55
11	TO	1	N	24	92	19	90	66	24	32
12	TO	1	D	15	89	11	93	89	25	12
13	MZ	1	B	78	81	44	79	68	52	38
14	MZ	1	D	78	70	54	85	78	40	26
15	MZ	1	N	73	68	67	84	70	44	33
16	MZ	1	E	77	81	85	87	56	49	56
17	KT	1	N	96	98	75	97	74	49	22
18	KT	1	D	97	97	15	88	58	52	15
19	KT	1	E	96	96	14	95	28	49	39
20	KT	1	B	86	97	83	96	52	52	60
21	CM	1	D	72	100	13	95	66	50	34
22	CM	1	B	49	100	63	95	61	50	73
23	CM	1	E	28	100	78	91	51	50	74
24	CM	1	N	8	100	35	94	60	53	48
25	LN	1	D	100	100	100	100	35	1	89
26	LN	1	B	100	100	31	99	27	0	76
27	LN	1	N	100	100	79	79	26	26	69
28	LN	1	E	99	99	98	98	7	0	100
29	JC	1	B	50	71	53	82	21	49	85
30	JC	1	E	56	91	38	88	50	52	81
31	JC	1	D	56	65	24	81	23	52	64
32	JC	1	N	75	87	43	86	33	53	57
33	JC	2	N	30	75	85	85	55	60	89
34	JC	2	E	30	80	43	75	41	45	68
35	JC	2	B	38	65	34	70	24	49	70
36	JC	2	D	23	65	21	78	51	51	46
37	TS	2	N	100	100	73	100	64	64	76
38	TS	2	E	100	100	100	100	60	60	86
39	TS	2	B	100	100	100	100	60	60	72
40	TS	2	D	100	100	85	100	66	66	66
41	BM	2	E	54	88	83	87	44	68	17
42	BM	2	N	34	88	32	87	52	68	74
43	BM	2	D	24	89	6	89	37	66	88
44	BM	2	B	13	86	76	87	32	72	34
45	KT	2	D	95	99	2	99	42	51	20
46	KT	2	N	83	99	70	100	14	43	3
47	KT	2	E	85	99	2	98	32	49	1
48	KT	2	B	97	100	32	96	45	48	48
49	MZ	2	N	74	61	26	57	73	46	10
50	MZ	2	E	76	66	46	79	70	53	26
51	MZ	2	B	70	60	74	81	80	52	66
52	MZ	2	D	79	69	79	79	56	49	45
53	TO	2	N	75	89	59	87	28	13	74
54	TO	2	B	81	88	90	93	21	15	81
55	TO	2	E	44	92	36	89	53	17	39
56	TO	2	D	23	94	20	95	52	21	46

OBS	PANELIST	DAY	COCOA	BITTERI	BITTERP	YEASTI	YEASTP	SWEETI	SWEETP	OVERACC
57	LN	2	B	100	100	98	98	1	1	100
58	LN	2	D	100	100	92	100	16	0	76
59	LN	2	N	100	100	100	100	7	0	100
60	LN	2	E	100	100	98	98	4	4	100
61	CM	2	N	22	100	19	95	65	55	16
62	CM	2	D	55	100	60	96	45	50	57
63	CM	2	E	37	100	70	95	65	53	69
64	CM	2	B	31	100	45	95	46	51	47
65	JC	3	E	66	66	87	87	54	54	93
66	JC	3	N	67	80	85	85	48	55	89
67	JC	3	B	40	40	72	72	63	63	82
68	JC	3	D	37	70	29	82	40	40	64
69	LN	3	N	100	100	100	100	2	2	93
70	LN	3	E	100	100	100	100	12	12	100
71	LN	3	D	100	100	100	100	9	0	98
72	LN	3	B	100	100	100	100	1	1	100
73	TS	3	B	100	100	83	100	65	65	69
74	TS	3	E	100	100	100	100	64	64	92
75	TS	3	N	93	100	100	100	62	62	79
76	TS	3	D	100	100	80	100	66	66	61
77	CM	3	N	28	100	27	91	50	48	26
78	CM	3	E	30	100	49	94	44	52	79
79	CM	3	D	28	100	21	89	29	52	11
80	CM	3	B	27	100	34	91	36	50	39
81	BM	3	D	27	88	47	87	49	67	57
82	BM	3	B	38	86	50	87	43	68	61
83	BM	3	N	46	87	10	88	42	67	25
84	BM	3	E	36	88	35	87	54	68	68
85	MZ	3	B	72	62	59	68	51	45	36
86	MZ	3	E	62	56	72	81	51	47	45
87	MZ	3	D	72	60	76	76	54	49	61
88	MZ	3	N	70	62	45	57	68	55	30
89	TO	3	N	26	87	24	90	86	19	29
90	TO	3	B	20	88	25	90	60	20	50
91	TO	3	E	22	88	18	90	36	15	46
92	TO	3	D	52	89	41	88	48	21	77
93	KT	3	E	94	98	39	98	41	52	42
94	KT	3	B	94	97	81	98	51	51	64
95	KT	3	N	66	98	18	97	60	51	6
96	KT	3	D	81	96	4	97	53	63	5
97	JC	4	B	35	65	39	70	38	50	84
98	JC	4	E	45	80	32	85	66	66	67
99	JC	4	D	48	48	62	62	52	52	83
100	JC	4	N	27	75	11	75	42	50	29
101	MZ	4	E	50	46	38	50	51	47	44
102	MZ	4	N	71	55	25	64	69	49	22
103	MZ	4	B	57	52	39	68	65	47	35
104	MZ	4	D	56	56	59	72	53	46	32
105	TO	4	E	26	88	30	88	48	17	64
106	TO	4	N	14	91	13	89	70	15	30
107	TO	4	B	31	90	30	87	53	15	47
108	TO	4	D	48	91	51	91	65	17	61
109	TS	4	E	100	100	87	100	61	61	85
110	TS	4	B	100	100	94	100	65	65	91
111	TS	4	N	100	100	88	100	61	61	80
112	TS	4	D	100	100	89	100	67	67	82

OBS	PANELIST	DAY	COCOA	BITTERI	BITTERP	YEASTI	YEASTP	SWEETI	SWEETP	OVERACC
113	BM	4	B	51	87	83	87	62	66	89
114	BM	4	E	36	87	81	88	48	67	83
115	BM	4	N	29	87	31	86	49	65	23
116	BM	4	D	31	87	45	87	52	68	47
117	LN	4	D	100	100	98	100	0	0	100
118	LN	4	E	100	100	96	100	6	1	91
119	LN	4	B	95	100	100	100	11	1	85
120	LN	4	N	100	100	100	100	5	5	100
121	CM	4	E	54	100	32	92	49	52	73
122	CM	4	D	28	100	63	92	52	50	42
123	CM	4	N	20	99	42	91	60	49	30
124	CM	4	B	47	100	52	93	51	50	61
125	KT	4	E	89	89	81	93	46	50	58
126	KT	4	D	76	90	79	96	49	54	41
127	KT	4	N	73	96	49	94	36	50	13
128	KT	4	B	93	98	29	98	48	52	49

APPENDIX D

CLASS LEVEL INFORMATION AND ANALYSIS OF VARIANCE

CODES USED

COCOA	pH OF COCOA	ALKALIZATION TREATMENT
N	5.65	NATURAL
B	7.02	LIGHTLY ALKALIZED
D	7.14	ALKALIZED
E	7.56	ALKALIZED

DEPENDENT VARIABLE CODES

BITTERI - BITTER INTENSITY

BITTERP - BITTER PREFERENCE

YEASTI - YEAST INTENSITY

YEASTP - YEAST PREFERENCE

SWEETI - SWEET INTENSITY

SWEETP - SWEET PREFERENCE

OVERACC - OVERALL ACCEPTABILITY

CLASS LEVEL INFORMATION

CLASS	LEVELS	VALUES
PANELIST	8	BM CM JC KT LN MZ TO TS
DAY	4	1 2 3 4
COCOA	4	B D E N

Number of observations in data set = 128

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: BITTERI

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
TOTAL	127	111632.8750			
PANELIST	7	92265.6250	13180.8036		
DAY	3	1046.6875	348.8958	2.13	0.1002
COCOA	3	475.7500	158.5833	0.97	0.4097
DAY X COCOA	9	684.4375	76.0486	0.47	0.8948
ERROR	105	17160.3750	163.4321		

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: BITTERP

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
TOTAL	127	27510.8750			
PANELIST	7	23352.7500	3336.1071		
DAY	3	456.3125	152.1042	4.73	0.0039
COCOA	3	137.3750	45.7917	1.42	0.2403
DAY X COCOA	9	184.6875	20.5208	0.64	0.7627
ERROR	105	3379.7500	32.1881		

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: YEASTI

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
TOTAL	127	118269.4297			
PANELIST	7	57874.1172	8267.7310		
DAY	3	235.8359	78.6119	0.16	0.9241
COCOA	3	3591.2734	1197.0911	2.41	0.0710
DAY X COCOA	9	4441.4453	493.4939	0.99	0.4496
ERROR	105	52126.7578	496.4453		

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: YEASTP

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
TOTAL	127	13601.6172			
PANELIST	7	10192.9297	1456.1328		
DAY	3	212.6484	70.8828	2.44	0.0686
COCOA	3	62.1484	20.7161	0.71	0.5465
DAY X COCOA	9	82.1953	9.1328	0.31	0.9688
ERROR	105	3051.6953	29.0638		

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: SWEETI

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
TOTAL	127	47627.8750			
PANELIST	7	30210.6250	4315.8036		
DAY	3	534.0625	178.0208	1.25	0.2941
COCOA	3	582.3125	194.1041	1.37	0.2569
DAY X COCOA	9	1394.5000	154.9444	1.09	0.3755
ERROR	105	14906.3750	141.9655		

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: SWEETP

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
TOTAL	127	55487.4688			
PANELIST	7	53080.7188	7582.9598		
DAY	3	41.7813	13.9271	0.64	0.5895
COCOA	3	6.0938	2.0312	0.09	0.9634
DAY X COCOA	9	82.0938	9.1215	0.42	0.9215
ERROR	105	2276.7813	21.6836		

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: OVERACC

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	Pr > F
TOTAL	127	94313.9297			
PANELIST	7	51160.4922	7308.6417		
DAY	3	199.6484	66.5495	0.23	0.8776
COCOA	3	7956.6484	2652.2161	9.03	0.0001
DAY X COCOA	9	4171.7578	463.5286	1.58	0.1310
ERROR	105	30825.3828	293.5751		

APPENDIX E

DAY X COCOA MEANS

CODES USED

COCOA	pH OF COCOA	ALKALIZATION TREATMENT
N	5.65	NATURAL
B	7.02	LIGHTLY ALKALIZED
D	7.14	ALKALIZED
E	7.56	ALKALIZED

DEPENDENT VARIABLE CODES

BITTERI - BITTER INTENSITY

BITTERP - BITTER PREFERENCE

YEASTI - YEAST INTENSITY

YEASTP - YEAST PREFERENCE

SWEETI - SWEET INTENSITY

SWEETP - SWEET PREFERENCE

OVERACC - OVERALL ACCEPTABILITY

DAY=1 COCOA=B

N Obs	Variable	N	Mean
8	BITTERI	8	72.12
	BITTERP	8	90.75
	YEASTI	8	62.00
	YEASTP	8	90.87
	SWEETI	8	48.37
	SWEETP	8	43.25
	OVERACC	8	67.37

DAY=1 COCOA=D

N Obs	Variable	N	Mean
8	BITTERI	8	72.25
	BITTERP	8	88.37
	YEASTI	8	40.75
	YEASTP	8	91.00
	SWEETI	8	56.87
	SWEETP	8	42.87
	OVERACC	8	47.50

DAY=1 COCOA=E

N Obs	Variable	N	Mean
8	BITTERI	8	65.87
	BITTERP	8	93.37
	YEASTI	8	62.00
	YEASTP	8	92.00
	SWEETI	8	39.37
	SWEETP	8	42.87
	OVERACC	8	73.62

DAY=1 COCOA=N

N Obs	Variable	N	Mean
8	BITTERI	8	61.62
	BITTERP	8	91.62
	YEASTI	8	53.50
	YEASTP	8	89.50
	SWEETI	8	51.50
	SWEETP	8	46.12
	OVERACC	8	46.88

DAY=2 COCOA=B

N Obs	Variable	N	Mean
8	BITTERI	8	66.25
	BITTERP	8	87.37
	YEASTI	8	68.62
	YEASTP	8	90.00
	SWEETI	8	38.62
	SWEETP	8	43.50
	OVERACC	8	64.75

DAY=2 COCOA=D

N Obs	Variable	N	Mean
8	BITTERI	8	62.37
	BITTERP	8	89.50
	YEASTI	8	45.62
	YEASTP	8	92.00
	SWEETI	8	45.62
	SWEETP	8	44.25
	OVERACC	8	55.50

DAY=2 COCOA=E

N Obs	Variable	N	Mean
8	BITTERI	8	65.75
	BITTERP	8	90.63
	YEASTI	8	59.75
	YEASTP	8	90.12
	SWEETI	8	46.12
	SWEETP	8	43.62
	OVERACC	8	50.75

DAY=2 COCOA=N

N Obs	Variable	N	Mean
8	BITTERI	8	64.75
	BITTERP	8	89.00
	YEASTI	8	58.00
	YEASTP	8	88.87
	SWEETI	8	44.75
	SWEETP	8	43.62
	OVERACC	8	55.25

DAY=3 COCOA=B

N Obs	Variable	N	Mean
8	BITTERI	8	61.37
	BITTERP	8	84.12
	YEASTI	8	63.00
	YEASTP	8	88.25
	SWEETI	8	46.25
	SWEETP	8	45.37
	OVERACC	8	62.62

DAY=3 COCOA=D

N Obs	Variable	N	Mean
8	BITTERI	8	62.12
	BITTERP	8	87.87
	YEASTI	8	49.75
	YEASTP	8	89.87
	SWEETI	8	43.50
	SWEETP	8	44.75
	OVERACC	8	54.25

DAY=3 COCOA=E

N Obs	Variable	N	Mean
8	BITTERI	8	63.75
	BITTERP	8	87.00
	YEASTI	8	62.50
	YEASTP	8	92.12
	SWEETI	8	44.50
	SWEETP	8	45.50
	OVERACC	8	70.62

DAY=3 COCOA=N

N Obs	Variable	N	Mean
8	BITTERI	8	62.00
	BITTERP	8	89.25
	YEASTI	8	51.12
	YEASTP	8	88.50
	SWEETI	8	52.25
	SWEETP	8	44.87
	OVERACC	8	47.12

-- DAY=4 COCOA=B --

N Obs	Variable	N	Mean
8	BITTERI	8	63.62
	BITTERP	8	86.50
	YEASTI	8	58.25
	YEASTP	8	87.87
	SWEETI	8	49.12
	SWEETP	8	43.25
	OVERACC	8	67.62

-- DAY=4 COCOA=D --

N Obs	Variable	N	Mean
8	BITTERI	8	60.87
	BITTERP	8	84.00
	YEASTI	8	68.25
	YEASTP	8	87.50
	SWEETI	8	48.75
	SWEETP	8	44.25
	OVERACC	8	61.00

-- DAY=4 COCOA=E --

N Obs	Variable	N	Mean
8	BITTERI	8	62.50
	BITTERP	8	86.25
	YEASTI	8	59.62
	YEASTP	8	87.00
	SWEETI	8	46.38
	SWEETP	8	45.12
	OVERACC	8	70.62

-- DAY=4 COCOA=N --

N Obs	Variable	N	Mean
8	BITTERI	8	54.25
	BITTERP	8	87.87
	YEASTI	8	44.87
	YEASTP	8	87.37
	SWEETI	8	49.00
	SWEETP	8	43.00
	OVERACC	8	40.87

VITA 2

Michell DeAnn Solomon James

Candidate for the Degree of

Master of Science

Thesis: EFFECTS OF COCOA ALKALINITY ON SENSORY QUALITIES IN A CHOCOLATE-FLAVORED SUPPLEMENT CONTAINING TORULA YEAST

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