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A Research Paper

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for HUEC 3012

of

The University of the West Indies

Title: Consumer acceptance of Chataigne Patty (*Artocarpus Camansis*) using two different binding agents; Xanthan Gum and Eggs

Student Name: Hana Hosein

Project Supervisor: Neela Badrie

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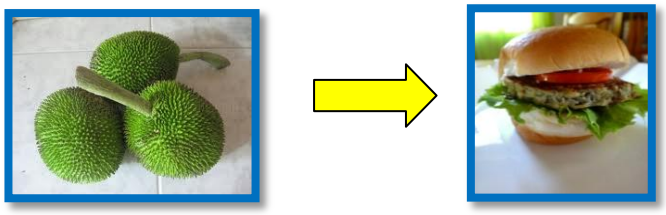
Department of Agricultural Economics & Extension
Faulty of Food and Agricultural

CONSUMER ACCEPTANCE OF CHATAIGNE PATTY(*Artocarpus Camansis)*

USING TWO DIFFERENT BINDING AGENTS;

XANTHAN GUM AND EGGS.



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HANA HOSEIN

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SUPERVISOR: PROFESSOR NEELA BADRIE

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ABSTRACT

*Breadnut (*Artocarpus camansis*) is a seeded variety of breadfruit and is commonly known as chataigne in Trinidad and Tobago. The main objectives of this study were to assess the consumer acceptability of the breadnut/chataigne patty with variable binding agents: xanthan gum and eggs in addition to comparing its compositional proximate and physicochemical properties. This study was a cross sectional study which compared chataigne patties with variable binding agents. Sensory evaluation consisted of 53 panellists who volunteered to take part in the study. The chataigne was cleaned, washed and then boiled for 10minutes at 215°F. After boiling, the chataigne was drained and added to the food processor for 3 minutes. Spices/herbs were added to the mixture and then each patty was pan seared at 130°F for 3 minutes on either side. Proximate analysis results for sample X for moisture, ash, crude protein, crude fat were 4.01 ± 0.81%, 11.05 ± 0.58%, 14.63 ± 0.92%, 53.78 ± 3.66% respectively. The results ascertained for sample E were as follows, 5.44 ± 0.01% moisture, 9.87% ash, 28.48 ± 0.38% crude protein and 55.97 ± 1.94% crude fat. Texture properties showed that sample E was firmer than sample X while sample X was stickier than sample E. The hue angle for sample X and E were 92.40 ± 1.99° and 94.24 ± 3.75° respectively which represented a yellow colour of the product. The chroma values were 14.99 ± 0.38 for sample X and 16.05 ± 0.20 for sample E showing there was more colour saturation in sample E. Sensory evaluation showed a high sample preference (86.8%) to sample E which contained eggs when compared to sample X containing xanthan gum (13.2%). A large proportion of 64.2% indicated they would choose this patty in preference of a meat patty.*

INTRODUCTION

Background

Breadnut (*Artocarpus camansis*) is a seeded variety of breadfruit and is commonly known as chataigne in Trinidad and Tobago. Breadnut was introduced into the Caribbean region in the year1782. It took some time before the local inhabitants acquired a taste for the fruit on the islands, before it became a part of their diet (Powell, 1973). Breadnut is seasonal with a shelf-life of 2-3 days after which they ripen and deteriorate rapidly (Thompson 1974; Maharaj and Sankat 1993) . The breadnut fruit is covered in spiny, conical protrusions which are 5-12mm long. The number of seeds in the fruit varies from as little as 12 to as many as 150 per fruit and are embedded in the fleshy pulp. Each seed is encased in a fairly rigid membrane (the aril) and an inner fragile paper-like membrane which encapsulates the fleshy, white edible portion of the seed. Breadnut seeds are thin walled and have a thickness of 1-2cm. Breadnut is most popularly cooked in Trinidad with curry or the mature seeds are often boiled in salted water with the shell(aril). (DeBravo, Graham & Padovani, 1983)

The term “burgers” originated from the word “hamburger” which presumably is a product which was conceived in the country Hamburg. Most of the European countries regulated that burgers should contain at least 80% meat and 20-30% of fat content. Burgers are also referred to as “patties” (Al –Mrazeeq *et al*., 2008; Ranken, 2000). A patty is a flattened, usually disc-shaped

serving of ground meat or meat alternatives. The meat alternative/meat is usually minced/finely chopped, compacted, shaped and cooked. Substitution of some ingredients with meat substitutes has been practiced among processed meat industries. This replacement is done due to several relationships such as for quality, health, economic or preferential purposes. Many food industries have replaced ingredients of animal origins with that of plants (Egbert and Payne, 2009).

The combination of these two terms chataigne and burger essentially describes this project, as the fruit chataigne is being utilized in the form of a burger or patty. This meat substitute burger is described as a healthier alternative since it provides less fat when compared to a traditional meat burger as research from proximate analysis shows. Chataigne is often underutilized because of the lack of knowledge surrounding its nutritional potential. Chataigne is an excellent source of fiber, carbohydrates, protein, potassium, and calcium (Ragone, 1997). According to Magnus (2005), breadfruit is named one of the top 25 superfoods and can be useful in the management of prevalent diet related diseases such as diabetes and hypertension, in the Caribbean.

One of the ways to encourage better care for health is by providing options which are tasty but at the same time affordable and healthy to consumers. Many consumers perceive that foods with reduced fat or those are categorized as healthier are less desirable (McEwan and Sharp 2000; Hamilton *et al*. 2000) resulting in foods which are healthier having lower sensory acceptance to those with full fat content.

In order to meet consumer acceptability and choices, quality was an important aspect evaluated. This chataigne burger was also evaluated with several tests to analyze its nutritional composition and food safety of the patty after the proportions of ingredients were formulated. Meeting consumer demands may sometimes be difficult since there are many choices available to them

and they can be very selective about the products they purchase. Some demands of customers in products include high quality, safe food, highly nutritious, tasty and those which offer value for money. This study therefore seeked to promote a healthier alternative to a meat burger and at the same time, utilize a local fruit and to also investigate its consumer acceptability by varying binders. This product does not contain any harmful additives as many other products do.

Rationale

The purpose of this study was twofold. Firstly, this study seeked to utilize a local commodity breadnut to create a vegetable patty which would provide similar properties as a meat patty would. Secondly, the study assessed the consumer acceptability of this vegetable patty being a healthier alternative to a meat patty through sensory evaluation at the University of the West Indies.

Problem Statement

Exploring the consumer acceptability of a chataigne patty using variable binding agents; xanthan gum and egg and investigating and comparing its nutritional composition, textural properties, colour properties and microbial analysis.

Objectives

- To assess the consumer acceptability of a breadnut/chataigne patty with variable binding agents.

- To conduct compositional proximate analysis, microbial analysis and physicochemical analysis to evaluate quality of the patties.
- To investigate the differences in physicochemical qualities between the addition of two different binding agents in chataigne patties.

- To investigate the differences in sensory qualities between the addition of two different binding agents in chataigne patties.
- To determine if consumers will choose this chataigne patty over a meat patty.

Hypotheses

- Eggs is a better binding agent in Chataigne patties compared to using xanthan gum as a binding agent.
- The patty containing eggs is preferred by consumers as opposed to the patty containing xanthan gum based on the properties and overall taste.

Scope

This study is limited to students and staff across all faculties at the University of the West Indies, St. Augustine, Trinidad. Data to be collected will be done in a day through the administration of sensory evaluation questionnaires.

Key Terms

Binding agent - A binding agent is any ingredient that helps keeps a mixture combined throughout the cooking process and service. Typical binding agents include eggs, flour and breadcrumbs. (CNN, 2010)

Xanthan gum - Xanthan Gum is a plant-based thickening and stabilizing agent. It is named for the bacteria, Xanthomonas campestris, which plays a crucial role in this description. Xanthan gum has a number of powerful properties. First, it works as an emulsifier, encouraging liquids that normally don't like one another to mix together. Second, it works as thickener, increasing the viscosity of liquids and batters. Third, it can create a creamy texture. (Bob's Red Mill, 2014)

Organoleptic properties - relating to qualities (as taste, color, odor, and feel) of a substance (as a food or drug) that stimulate the sense organs. (Merriam Webster Dictionary, 2014)

Sensory Evaluation - Sensory Evaluation is defined as "A scientific discipline used to evoke, measure, analyze, and interpret those responses to products that are perceived by the senses of sight, smell, touch, taste, and hearing (Stone and Sidel 1993)."

LITERATURE REVIEW

The quality of a product is a key aspect when introducing any new product into the market place. Some factors which influence the quality of a product includes the binding properties, the overall appearance, the nutritional composition, the shelf life as well microbial analysis to ensure food safety. After all these qualities have been achieved, it is important to then let consumers evaluate the product to provide feedback on whether the product is successful or not acceptable.

In recent studies conducted by Jones, Lane *et al* (2011) it was discovered that breadfruit was a staple food and traditional crop in the Pacific for more than 3000 years and it is widely cultivated in the Caribbean and other tropical regions. Its distribution began in the late 1790s under the leadership of Captain Bligh. His voyages began with the Bounty and lead to the successful transportation of 678 plants to Vincent and Jamaica. Within recent years methods have been developed to maintain the production of the breadfruit throughout the region and even internationally (Jones, Lane *et al*, 2011). These breadfruit plants have been found to be free of bacterial, fungal, or virus contamination, and are vigorous and rapidly growing. The distribution of these plants provides the first opportunity for large-scale development of the crop for food security and commercial products which aids in enhancing the economic status of the Caribbean. (Jones, Lane *et al*, 2011).

A binding agent can be defined as any ingredient that helps keep a mixture cohesive throughout the cooking process (CNN, 2010). Typical binding agents include eggs, flour and breadcrumbs. Based on findings, one of the main functional qualities of eggs included thermal coagulation. Thermal coagulation is the process whereby protein molecules of the egg are converted from a fluid to semi- solid (Cooper, 1999). It usually occurs due heating, application of salt and

whipping of the egg. Another binding agent which was explored was xanthan gum. Binding agents are very important in the industry since without it, the organoleptic properties can be detrimentally diminished.

A similar study to this project was conducted to investigate the consumer acceptability of a low-fat pigeon pea patty (*Cajanus cajan*) consisting of the binding agent xanthan gum (Pierre, Badrie 2004). The effects of xanthan gum on the physicochemical and sensory qualities were evaluated. The formulation of the pigeon pea patties was guided by a pretested questionnaire which was used to evaluate consumer preferences. Approximately 50% of the respondents were influenced by the nutritional composition which comprised of 13.8-14.6g protein/100g and 3.5-3.9g fat/100g. The addition of xanthan gum resulted in more red and softer textured product. Overall, the products were liked slightly to neither liked nor disliked.

The nutritional composition of the food consumed is the most important aspect of choosing food to ensure daily recommended intake levels are being met as well as making food choices that will be beneficial to one's health. The following studies looked at the nutritional composition as well as beneficial uses of the fruit chataigne.

Research conducted by Badrie and Broomes(2010) showed some beneficial uses of breadnut in terms of nutritional and medicinal properties. The findings proved that the fruit and its seeds are an excellent source of the macronutrients proteins, carbohydrates, dietary fiber and fatty acids. It also provides many micronutrients such as pro-vitamin A, potassium, calcium along with some significant amounts of ascorbic acid, niacin and iron (Ragone, 1997). The nutritional composition however varies depending on the ripeness of the fruit and research has showed that the riper the fruit the higher the nutrient content. Breadfruit is also an intermediate GI food (60 $\pm$

9.0) (Ramdath *et al*, 2004). It is very useful medicinally since it contains phenolic compounds, artocarpins and lectins which carry out very important applications such as inflammatory activities, anti-platelet effects, reductase inhibitory effects, and antifungal activity. Overall breadfruit has many benefits nutritionally and medically (Koshihara *et al*, 1988, Patil *et al*, 2002, Pitaksuteepong *et al*, 2007, Selitrennikoff *et al*, 2001, Shangraw, 1992, Shimizu *et al*, 2000, Wei *et al*, 2005).

In another study conducted by Williams and Badrie (2005) investigated the utilization, nutritional composition and sensory acceptance of boiled breadnut seeds. The involved nutrient analysis for sampled of fresh and boiled breadnut seeds. A serving size of 30g of boiled breadnut seeds provided 202kJ (50kCal) of total energy based on an 837 (2000kCal) diet. These values were compared to daily reference values and proved to be a good source of dietary fiber. The most common methods of preparation for utilization were boiling (90.2%) and currying (74.8%). Overall, the sensory acceptance was significantly higher for Trinidadian panelists compared to panelists from other Caribbean countries. However, both groups showed high intent to purchase.

Shelf life studies are another crucial area of research since it provides details on how long a product can remain on the shelf without the deterioration of its quality. Every product on the market requires a shelf life study in order to provide an expiry date on the packaging. Harrynanan (2008) investigated the preservation of breadnut/chataigne through refrigeration and dehydration. It was critical to investigate preservation properties for shelf life studies to ensure the optimum quality is delivered. The fruits were packaged and sealed in polyethylene bags. Harrynanan's (2008) study showed that a storage life up to 25 days was achieved for the packaged fruit held at 16°C. Another method used was waxing of the fruit; however this was not successful and did not increase shelf life. The fruit was also stored packaged in polyethylene

bags at ambient conditions (28°C) which extended post harvest life from 3-4 days to 9 days. This information about storage at ambient conditions can be helpful when there is storage of the actual fruit before production.

Although this project did not explore shelf life testing Mukhopadhyay, Sudarsan et al (2012) found that altering the temperature, change of pH and storage conditions can be used as control factors for the survival and growth of *Salmonella Enterica Serovar Enteritidis.* The study showed that at 10°C the population was greater, but no major outgrowth was observed and that temperature had a greater influence on Salmonella reduction than did pH. The maximum reduction of Salmonella and background microflora in liquid egg white by microfiltration membrane process was observed at 40°C and pH 8 and 9. This study may indicate the burgers may also have an extended shelf life but investigations will need to be conducted to determine the actual shelf life of our burgers.

Other studies explored the consumer acceptability of meat substitutes since burgers are commonly made of meat. A meat substitute is an imitation meat that approximates certain aesthetic qualities or chemical characteristics of specific types of meats. (Elzerman, 2011) Many meat substitutes can be gluten or soy based but in this case it is vegetable based. In the food industry today many consumers are looking for an alternative to meat and the market is growing in demand.

In a study conducted by Ramadhan, Huda and Ahmad (2011) ten brands of commercial chicken burgers were selected and analysed for their physicochemical and sensory properties. The areas investigated were proximate composition, texture profiles, colour and sensory properties. Results showed the moisture, protein, fat and ash of commercial burgers ranging from 46.72-69.37%,

11.08-18.77%, 9.08-20.54% and 1.50-2.96% respectively. The texture profile tested hardness, chewiness, cohesiveness and springiness. The most preferred texture was the one with a medium hardness value of 12590g, high chewiness value of 1195.42g, high cohesiveness value of 0.371, and medium springiness value of 0.254. Consumers also showed preference to the chicken burger which had the medium lightness (L) with a value of 63.96, medium redness(a) with the value of 7.00 and the highest yellowness(b) intensity value of 12590g. It was concluded that the Malaysian commercial chicken burgers upheld their standards and conformed to the Food Act of Malaysia even though it contained different levels of chemical compositions, colour properties and textural characteristics.

The study by Ramadhan, Huda and Ahmad (2011) also showed that weight losses and diameter shrinkages of cooked burgers were present. The degrees of shrinkages ranged from about 2-10%. Research has explained this shrinkage as meat protein denaturation and fluid (moisture and fat) loss when cooked. The weight losses can however range from about 5-25% due to moisture evaporation and drip of melted fat (Mansour and Khalil, 1997: Alakali *et al*., 2010).

This study in particular explored consumer-oriented product development of environmentally more sustainable meat substitutes. It describes the production and consumption of meat substitutes as more environmentally sustainable products (Aiking et al., Apaiah, Helms, 2006). Elzerman (2013) described meat substitutes (also called “novel protein foods”) generally based on plant proteins, which are developed to replace meat in the diet. The approach taken was in the form of focus group discussions on meat substitutes, the appropriateness of the use of meat substitutes as ingredients by using photos and finally a taste session with two meat substitute dishes. The study found that consumers regarded health aspects as easy and similar preparation to meat as positive attributes however lack of information on the label and high prices as

negative attributes. The sensory aspects were reported to be both negative and some positive. Sensory aspects such as neutral taste or tastiness, crispiness, chicken-like texture, or granular texture were seen as positive attributes. Negative sensory aspects that were mentioned were uniform taste, compactness, dryness and softness. Most consumers found the use of meat substitutes appropriate in the dishes that were presented in the taste session.

Another similar study carried out by Elzerman (2011) investigated the role of meal context on the acceptance of meat substitutes. The study involved 93 participants rating the different aspects of meat substitutes such as the appearance, taste, shape, product liking, appropriateness, intention to use and overall liking of the product. Appropriateness seemed to be influenced by the appearance of the meat substitute-meal combination, and less by flavour and texture, therefore when considering new products the appearance must be the key factor in mind.

The provision of healthier options is a key aspect of promoting healthier lifestyles. A study conducted by Rohall *et al* (2009) tested three healthier alternatives of burgers; low fat beef, turkey and soy/rice burgers against a full fat hamburger patty. Sensory evaluation of the four patties was conducted with 48 untrained panelists. A 9 point scale hedonic test was used to measure consumer acceptance as well as Quality Description Analysis (QDA) to evaluate the intensity of sensory properties. Consumer acceptance mean scores showed that the full fat beef, lean beef, turkey and soy/rice patties were 5.98, 6.68, 5.50, and 5.56 respectively with no preference of the control patty over turkey or soy/rice. There was however a significant preference of the lean beef over turkey and soy/rice. Quality Descriptive analysis showed spiciness, elasticity and flavor significantly varied across the treatments. Panelists also rated the lean beef burger as significantly more elastic compared to other burgers. Even though there was no evidence to support that sensory attributes contributed to the consumer acceptance, the

research indicated that the healthier substitutes were accepted in comparison to the full fat beef patties.

METHODOLOGY

Chataigne Patty Preparation

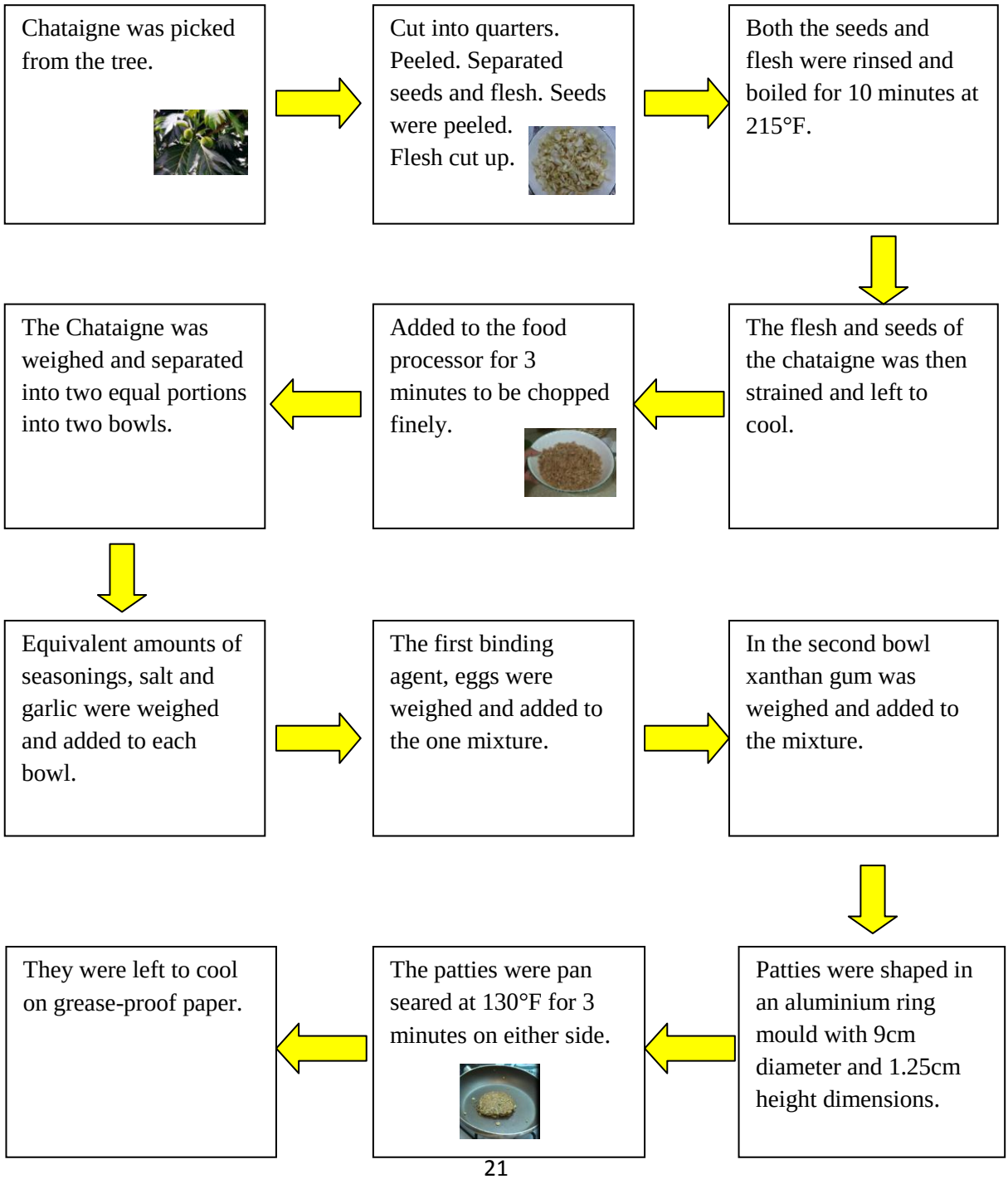
The fruit Chataigne (*Artocarpus camansis*) was obtained from a tree in Central, Trinidad. It was rinsed, cut into quarters and then peeled. It was then washed with distilled water. The seeds were separated from the fleshy part since the outer shells of the seeds had to be removed. The peeled seeds and flesh of the Chataigne were weighed and rinsed again.

Both the seeds and flesh were boiled for 10 minutes at 215°F. When it was finished boiling, it was transferred to a colander for draining and left to cool. The peeled seeds and fleshy parts were added to the food processor (FP1445, Black and Decker, Maryland) for 3 minutes to be chopped, in order to achieve coarse, grainy sized particles that would enhance the organoleptic properties of the patty. Chataigne was weighed and divided into equal portions and placed into two bowls. The binding agents were varied in both mixtures. Xanthan gum (0.3g) was added to the first mixture and eggs (24g) were added to the other mixture. Equivalent amounts of each ingredient in grams; seasonings, salt, garlic and seasoned biscuit crumbs were also added into both mixtures. All ingredients were weighed before being added to mixtures. Chataigne patty mixtures were shaped into patties using an aluminium ring mould with a 9cm diameter and 1.25cm height. They were pan seared at 130°F for 3 minutes on either side to obtain a desirable colour and ensure they were cooked well done and left to cool on greaseproof paper.

Chataigne patties containing eggs as a binding agent were prepared as follows: 71.4% Chataigne with 28.6% eggs (Sample E). The patties which contained xanthan gum as its binding agent were prepared as follows: 99.5% Chataigne with 0.5% xanthan gum (Sample X). The following

herbs/spices (24.05%) were added to the chataigne patty mixture: salt (1.3%), chive (10.1%), culantro (5.1%), garlic (6.3%) and celery (1.3%).

Flow Chart 1 showing the process of Chataigne patty preparation.



Microbial Analysis

The two samples of Chataigne Patties (Sample X and Sample E) were analysed for total aerobic counts on Plate Count Agar (Difco, Detroit; Michigan), yeast and molds on Potato Dextrose Agar (Oxoid, Lenexa) and Mannitol Salt Agar (Neogen, Miami) which is a selective medium for pathogenic *Staphylococci*.

This procedure involved the enumeration of bacteria which is to spread a known volume of sample on the surface of a laboratory medium or place sample onto a petri dish and pour the medium and allow to solidify followed by counting the number of visible colonies that develop after a period of time.

The initial steps of this procedure was to create various dilutions of the sample which is discussed in the following steps.10g of sample X was liquefied in 90ml sterile water using a stomacher producing a 10^{-1} dilution. 1ml of sample X was aseptically added using a sterile pipette into a screw cap test tube containing 9ml sterile water. This test tube was vortexed using a vortex mixer to ensure the dilution was thoroughly mixed (10^{-2} dilution). The next step created a 10^{-3} dilution, 1ml of the 10^{-2} dilution was aseptically transferred to another test tube containing 9ml sterile water and vortexed.

For the pour plate technique (PDA and PCA), 1ml of samples 10^{-1}, 10^{-2}, 10^{-3} dilutions were transferred into corresponding labeled petri-dishes. This was done in duplicate. The molten

nutrient agar (40-45°C) was poured into the petri-dishes and mixed by swirling gently. The agar was allowed to solidify and incubated at 35°C in an inverted position for 48 hours.

For the spread plate technique (MSA), 0.1ml of sample from the 10^{-2} dilution was transferred to labeled petri-dishes. This was also done in duplicate.

The entire procedure was repeated for sample E.

After 48 hours the petri-dishes were removed from the incubator and examined for significant colour changes which would indicate microbial growth.

Proximate Analysis

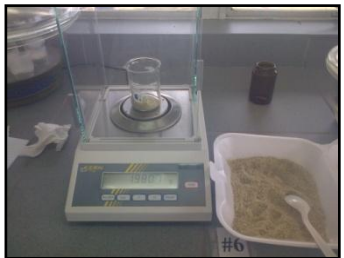
Proximate analysis was performed on the both samples of Chataigne patties containing eggs and xanthan gum on a dry matter basis. Analyses were performed in duplicate according to AOAC (2000) for moisture, ether extract, ash, crude fiber and crude protein using the nitrogen factor x6.25. The procedure used for each is as follows.

Sample X- Patty containing xanthan gum. (Duplicate X_1 and X_2)

Sample E- Patty containing eggs. (Duplicate E_1 and E_2)

- Determination of Dry Matter (AOAC, 934.01)

Two cooled containers were labeled X & E and weighed (Weight A). 1.5-2.0 grams of the samples were weighed accurately in each of the containers (Weight B). Both containers containing the samples were placed in the oven overnight at 105°C. The containers and samples were removed from the oven and placed in a dessicator to cool at room temperature. The two dried samples were weighed (Weight C).



Pictures illustrating the equipment used in the process of determining dry matter.

- Determination of Ash Content (AOAC, 942.05)

The crucibles were weighed for both samples (Weight A). 1.5 – 2.0 grams of the sample was weighed in each of the crucible (Weight B).

The crucibles and samples were placed in a muffle furnace and ashed at 600°C for 6 hours. When the furnace was cooled to about 150°C, the crucibles were transferred to a dessicator to cool at room temperature. The crucibles containing the ashed samples were weighed (Weight D).

- Determination of Ether Extract (AOAC, 920.39)

A sheet of filter paper was weighed (Weight A). 2.0 grams of sample X was weighed on sheets of paper. This was done in duplicate for samples. The paper was carefully folded around the sample and placed into the extraction thimble. The extraction flasks were dried and the extraction thimble and contents were in an oven overnight at 105°C. The dried flasks were cooled to room temperature in a dessicator and weighed (Weight D).

The extraction thimble was plugged lightly with cotton wool and placed in the extractor. The extractor was connected to the flask. Petroleum Ether was added to the extractor unit it siphoned once. More ether was added until the barrel of the unit was almost full.

The extractor and flask were connected into the heater and condenser. The water was added to the condenser and turned on. The heater was also turned on and adjusted to ensure the ether boiled gently. This was refluxed for 16 hours.

When the extract process was completed, the flask was removed and evaporated until dry. The flask was dried in an oven overnight at 105°C and cooled to room temperature in the dessicator. It was then weighed (Weight E).This process was done in duplicate for both samples X and E.

- Determination of Nitrogen and Crude Protein (AOAC, 976.05)

Samples X and E were done in duplicate (X_1, X_2, E_1, E_2). 2.0g of each sample were weighed on transparent paper on an electronic balance. The transparent paper was folded and the sample was introduced into a flask. Two catalyst tablets followed by 25ml concentrated sulphuric acid were added to each flask. The flasks were placed on a digestion rack. The heater was turned on and the temperature was regulated to prevent frothing. When the charred material was dissolved and the digestion cleared, the flasks were boiled for one hour.

After boiling, the flasks were allowed to cool. 100ml of distilled water was added to each of the flasks. The diluted digest was transferred quantitatively to 250ml volumetric flasks. The flask was made up to the 250ml mark using distilled water and the contents were mixed well. The contents were allowed to cool.

5ml of the diluted digest sample and 5ml of concentrated Sodium Hydroxide was added to a flask which was connected to the Kjelflex (K-360, BUTCHI, Switzerland). The Kjelflex was calibrated and the distillate was poured from the machine into a beaker. The solution in the beaker was titrated with Hydrochloric Acid until the solution turned pink. The nitrogen conversion factor used to calculate crude protein was x 6.25.

Picture showing the Kjelflex automated machine used for the extraction of crude protein from sample.

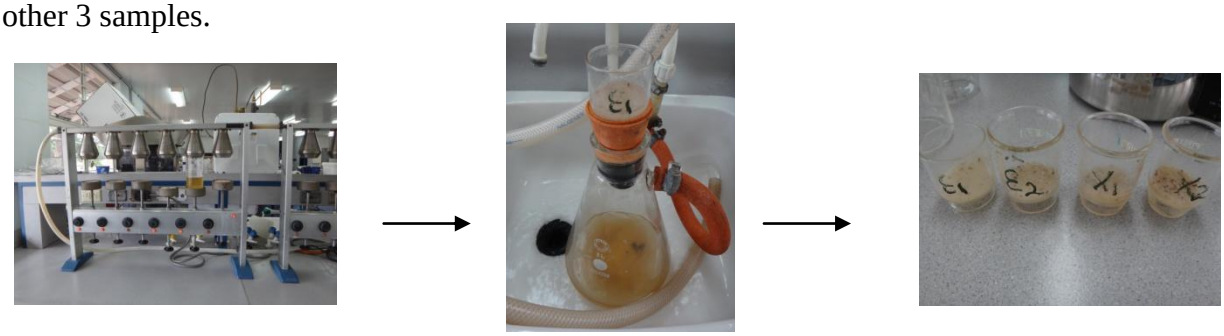
- Determination of Crude Fiber (AOAC, 988.05)

The ether extract residue for all four samples from Experiment 3: Determination of Ether Extract was transferred into four 600ml beakers. 200ml of sulphuric acid solution was added to each of the four beakers. The four beakers were placed on an extraction heater and connected to condensers on the Crude Fiber apparatus. The samples were left to boil and refluxed for exactly 30 minutes. The contents of the beakers were gently rotated at 5-minute intervals to prevent foaming and to ensure thorough wetting of the samples. The beakers were removed after 30 minutes from the extraction rack.

Each sample was filtered into a Buchner funnel using light suction and washed with boiling water until the washings were no longer acid. The samples were washed back into the beaker using exactly 200ml of sodium hydroxide solution. This was repeated for the three other samples.

All four samples were placed on the extraction rack again and refluxed for 30 minutes from the onset of boiling. The contents of the beakers were gently rotated at 5 minute intervals. After exactly 30 minutes the beakers and its contents were removed and the contents were filtered into

a gooch crucible with light suction using hot water (about 200ml). This was repeated for the other 3 samples.



Pictures showing the equipment used to extract fiber and the gooch crucible used to filter and collect sample.

Physicochemical Analysis

- Colour Measurement

Colour was taken three times on two sample patties for xanthan gum and eggs using the Konica Minolta Chroma Meter (Cr400, Konica Minolta, New Jersey). The 8mm measuring port on the chroma meter was placed on the surface of the patties. The readings were taken as "L", "a" and "b" values.

Picture showing instrument Konica Minolta, CR400 used for colour measurements.

Hue (h°) and chroma (C) was calculated using the 'a' and 'b' coordinates. The hue angle (h°) and chroma (C) are values which can be calculated from the 'a' and 'b' coordinate values. A hue angle of 0° was used in the calculations meaning 0° values indicated purplish-red, 45° indicates

orange, yellow is 90°, 180° is green and 270° is blue. Chroma values were also calculated by finding the square root of ($a^2 + b^2$).

- Texture Measurement

The texture of the patty was measured on the Texture Analyser (TA.XT plus, Stable Micro Systems, Surrey) using a half inch stainless spherical probe. Since there were no programs specifically designed for patties, the 'cheese spread triangles' program was used to obtain measurements. The objective of this application was to compare the firmness and stickiness of the patties. The instrument was calibrated using the computer program and the sample was positioned under the spherical probe and the test was commenced. This was done three times on different areas of each sample of patty.

Picture 2 showing the Texture Analyser, TA.XT plus used for texture analysis of the patty.

Sensory Analysis/ Purchase Intent

Sensory evaluation was done using a questionnaire (Appendix 1) at the University of the West Indies, St. Augustine campus. The two types of Chataigne patties were assigned random 2-digit codes (17 and 28). Fifty-three untrained panelists were served with quarter parts of the patty in bread. They were required to try both types of patties. Panelists were required to score the two types of patties using the 9-point hedonic scale as outlined by Lawless and Heymann (1998): 1=

dislike extremely; 2= dislike very much; 3= dislike moderately; 4= dislike slightly; 5= neither like nor dislike; 6= like slightly; 7= like moderately; 8= like very much; 9= like extremely on shape, colour of surface, flavor, aroma, texture, appearance and overall taste. Panelists were encouraged to rinse their mouths with water to clear their palette before proceeding to the second sample. The panelists were also asked about their patty preference and if they would be willing to purchase a vegetarian patty as a healthier choice as opposed to a meat patty.

Statistical Analysis

SPSS 12.0 for Windows (2003) statistical package was used for data analysis. Data from 53 sensory evaluation forms which were coded were entered into the database. A paired t-test was used to assess the differences in sensory attributes (shape, colour of surface, flavor, aroma, texture, appearance, overall taste) between the two types of patties, based on the panelists' responses from the sensory analysis. A paired t-test was also done to evaluate differences in composition based on proximate analyses (dry matter, ash, ether extract, crude protein and crude fiber) and texture (firmness and stickiness) and colour differences ("L", "a", "b", chroma and hue) based on physicochemical tests performed. The level of significance for all tests was set at $P < 0.05$.

RESULTS

Proximate Composition

Sample X- Patty containing xanthan gum. (Duplicate X_1 and X_2)

Sample E- Patty containing eggs. (Duplicate E_1 and E_2)

Table 1 showing paired sample test values for Sample X and Sample E on as is basis from proximate analysis.

Variable	Sample X Mean Difference ± Standard Error	Sample E Mean Difference± Standard Error	t	Significance
Dry Matter (as is basis)	959.96 ± 5.72	945.63 ± 0.10	2.551	0.000
Ash (as is basis)	105.54 ± 4.49	93.78 ± 0.02	2.631	0.000
Ether Extract (as is basis)	588.30 ± 24.69	559.85 ± 13.62	0.743	0.000
Crude Fiber (as is basis)	74.67 ± 0.68	81.90 ± 0.91	-31.435	0.000
Nitrogen Content (as is basis)	22.41 ± 0.04	45.57 ± 0.44	-48.747	0.000
Nitrogen Protein Content (as is basis)	146.31 ± 6.52	284.81 ± 2.72	-14.998	0.000

Table 2 showing proximate nutritive compostition percentages of two types of chataigne patties.

Variable	Sample X Mean Difference ± Standard Error	Sample E Mean Difference± Standard Error	t	Significance
Moisture/%	4.01 ± 0.81	5.44 ± 0.01	-2.54	0.24
Ash Content/ %	11.05 ± 0.58	9.87	2.88	0.21
Fat Content/ %	53.78 ± 3.66	55.97 ± 1.94	-1.81	0.32
Protein Content/ %	14.63 ± 0.92	28.48 ± 0.38	-15.05	0.04

Physicochemical Analysis

Colour Measurement

Table 3 showing values obtained for "L", "a" and "b" using a Chroma Meter for Samples X & E and the Chroma and Hue values calculated.

	L	A	B	Chroma (C)	Hue°
Sample X	50.75	-0.53	14.35	14.34	92.12
	49.28	-1.56	15.03	14.95	95.99
	44.99	0.25	15.67	15.67	89.09
Sample E	52.56	-1.65	16.34	16.26	95.82
	48.74	0.82	16.21	16.23	87.10
	50.07	-2.66	15.87	15.65	99.79

Table 4 showing paired sample values for L, a, b, Chroma and Hue for Samples X and E.

Variables	Sample X Mean Difference ± Standard Error	Sample E Mean Difference ± Standard Error	t	Significance
L	48.34 ± 1.73	50.46 ± 1.12	-1.299	0.732
A	-0.61 ± 0.52	-1.16 ± 1.03	0.354	0.101
B	15.02 ± 0.38	16.14 ± 0.14	-2.171	0.172
Chroma	14.99 ± 0.38	16.05 ± 0.20	-1.857	0.275
Hue	92.40 ± 1.99	94.24 ± 3.75	-0.320	0.091

Texture Measurement

Table 5 showing values obtained for firmness and stickiness for both Samples X and E.

	Firmness/g	**Stickiness/g**
Sample X	183.704	-8.697
	166.096	-7.913
	180.639	-7.841
Sample E	344.739	-7.20
	397.990	-3.350
	376.533	-5.703

Table 6 showing paired sample test values for firmness and stickiness for both Sample X and E.

	Sample X Mean Difference ± Standard Error	**Sample E Mean Difference ± Standard Error**	**t**	**Significance**
Firmness	176.81± 5.43	373.09 ± 15.47	-9.595	0.300
Stickiness	-8.15 ± 0.27	-5.41 ± 1.12	-2.927	0.463

Microbial Analysis

After a period of 48 hours, the petri-dishes were removed from the incubator and examined for significant colour changes which would indicate microbial growth. There was no observable colour change indicating that there were no colony forming units (CFU) formed on any of the samples for the three analyses executed (PDA, PCA and MSA). Colony forming units are used as a measure of the number of microorganisms present in or on the surface of a sample.

Sensory Analysis

Table 7 showing frequencies for demographic data collected from sensory analysis.

DEMOGRAPHIC	CATEGORY	Frequency	%
Gender	Male	15	28.3
	Female	38	71.7
Age	18-24 years	29	54.7
	25-34 years	13	24.5
	35-54 years	7	13.2
	55 + years	4	7.5
Race	African	10	18.9
	East Indian	34	64.2
	Chinese	2	3.8
	Caucasian	3	5.7
	Other	4	7.5

Table 8 showing paired sample test values for the characteristics of Sample X and E evaluated in sensory analysis using the 9 point hedonic scale.

Characteristics	Sample X Mean Difference ± Standard Error	Sample E Mean Difference ± Standard Error	t	Significance
Shape	7.77 ± 0.21	8.23 ± 0.14	2.437	0.000
Colour of Surface	7.00 ± 0.27	7.87 ± 0.18	3.770	0.000
Flavour	6.00 ± 0.27	8.28 ± 0.19	7.451	0.327
Aroma	6.47 ± 0.27	7.39 ± 0.21	4.262	0.000
Texture	5.34 ± 0.33	7.89 ± 0.20	7.605	0.048
Appearance	6.72 ± 0.27	7.55 ± 0.23	2.793	0.032
Overall Taste	5.51 ± 0.34	8.45 ± 0.12	8.850	0.067

Table 9 showing the preferred sample between Sample X and E by consumers from sensory analysis.

	Frequency	Percent (%)
Sample E (17)	46	86.8
Sample X (28)	7	13.2
Total	53	100.0

Pie Chart illustrating the sample preference between Sample X and E chosen by consumers from sensory analysis.

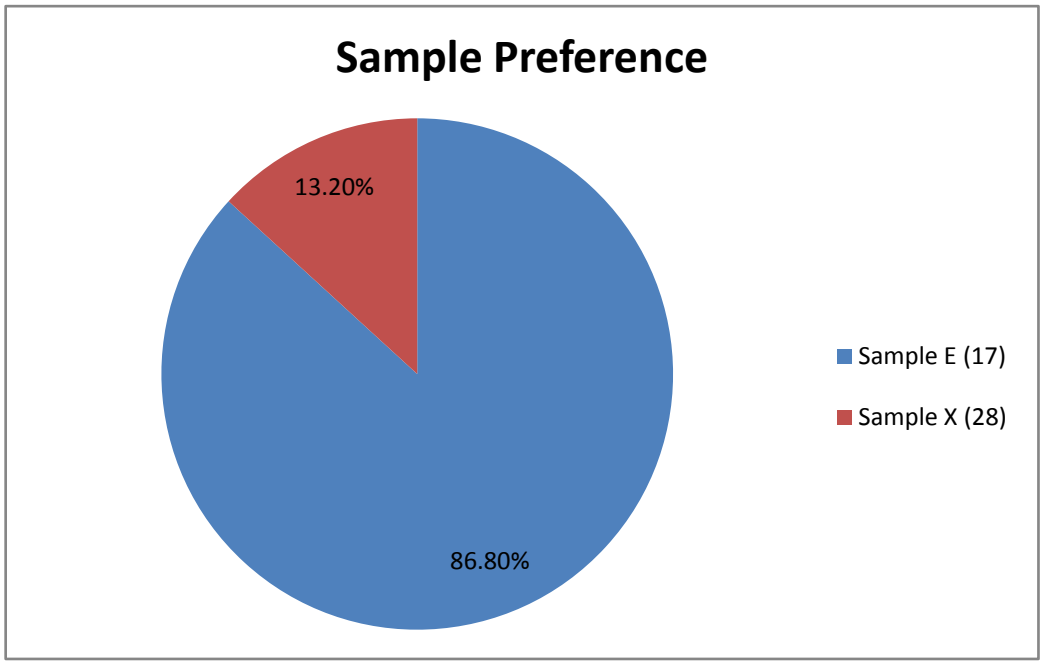


Table 10 showing consumer's willingness to choose a chataigne patty as a healthier alternative as opposed to a meat burger. (Refer to Appendix 1- Question 17 of Sensory Evaluation Form)

Responses	**Frequency**	**Percent (%)**
Yes	34	64.2
No	19	35.8
Total	53	100.0

Question 17-

Would you choose your preferred vegetable patty over a meat patty as a healthier choice?

Yes ( ) No ( )

DISCUSSION

In the preliminary stages of research and formulation of the product it was critical to investigate the availability of the key ingredient needed for production. Upon investigations, a study conducted by A.M.P. Jones *et al* (2011) explained that the breadfruit and by extension trees belonging to its family only bear fruit seasonally. As a result the raw materials for these patties can only be acquired when the fruit is available. However, further research can be done to allow for availability of this product throughout the year so that production could be increased.

The aspect of storage properties of the product was relevant to investigate since there is the option of packaging and storing the product in the freezer for later use. This was also important to determine an expiration date or best before date for the product. From the study conducted by Harrynanan (2000) which investigated the refrigeration properties of breadnut, it was found that breadnut stayed for 25 days at 16°C. This information assisted in guidance of choosing a best before date and also the temperature which it should be stored at in the freezer.

The binding agent used in Sample E was eggs which therefore made it necessary to review research which investigated the survival and growth of *Salmonella Enterica*. A study conducted by Mukhopadhyay Sundarsun(2012) showed that altering the pH and temperature of the product can decrease hazardous factors. This study however did not have sufficient time to explore the conditions on the product. Microbial analyses were however conducted on the yeast and mold growth, total aerobic counts as well as tests for *Staphylococci.* From these tests performed on samples, the results after incubation showed no colony forming units making this product a safe product for consumption.

One of the key factors of food production is its nutritional content. Therefore it was absolutely necessary to obtain information on the nutritional content of the breadnut patty. A study conducted by Badrie and Broomes (2010) at the University of the West Indies provides information that breadnut is a good source of the macronutrients: carbohydrates, protein, dietary fiber, fatty acids and micronutrients: pro-vitamin A, potassium, and calcium with significant amounts of ascorbic acid, niacin, and iron as well as its anti inflammatory properties. It reveals the fleshy parts of the fruit is rich is provitamin A carotenoids. Provitamin A carotenoids are precursors to vitamin A and the content varies with the degree of ripeness of the fruit. The study also states that two cups of ripe, seeded breadfruit provides 100% of the estimated daily requirements.

Chataigne seeds are known for its excellent source of fiber and protein. The chataigne seeds were also utilized in the patty and would definitely contribute and assist in increasing the protein content. From proximate analysis, crude protein results were 14.63 $\pm$ 0.92 in sample X and 28.48 $\pm$ 0.38 in sample E. This shows that sample E definitely contained a higher protein content compared to sample X. This difference in protein content can be accounted for in sample E by the eggs which were used as the binding agent and would have contributed significantly to the protein content. The study by Ramadhan e*t al* (2011) gave protein content findings of 12.71-18.77% contained in chicken burgers. The Sample E containing eggs even had a higher protein content that the chicken burgers. Another study by Badrie and Broomes (2010) showed a fat content of 2.5-4.9g/100g fat in breadnut seeds compared to the fat content 9.08- 17.53% contained in a chicken burger. The table below shows the macronutrient composition of fresh breadnut seeds and boiled breadnut seeds.

Table showing Nutritive Composition:Macronutrient Content of fresh and boiled breadnut seeds.

Nutrients	Fresh Breadnut Seeds	Boiled Breadnut Seeds
Macronutrients mg/100g n=8		
Moisture	60.15 ± 0.75	61.59 ± 1.41
Crude Protein	6.92 ± 0.06	6.89 ± 0.09
Crude Fat	3.65 ± 0.08	4.20 ± 0.08
Ash	3.62 ± 0.28	3.42 ± 0.20
Total Dietary Fiber	10.99 ± 0.37	8.30 ± 0.65
Total Carbohydrate by difference	25.67 ± 0.30	23.90 ± 0.35

The crude fat content was ununsually high in the Chataigne patties with values for sample X and E, 53.78 ± 3.66% and 55.97 ± 1.94% respectively. These results were not expected since other studies did not show such a high fat content. Another study showed that the fat content of the seeds in the chataigne was listed as low (3-5%) when compared to other nuts such as peanuts or almonds that contain 50-60% fat. The only other reason present that could contribute to high crude fat content values being this high could be as a result of oil used for pan searing. These high values can also be a result of a lab error and may need to be repeated to check for accuracy. However due to time constraints, these tests weren't repeated to get confirmation if these figures were correct or incorrect.

Consumers in society today are very health conscious and more vigilant with reading product labels. This information provided nutritional components which can be used to promote the product and increase its consumer acceptability.

An understanding of the elements of colour makes the replication process easy as well as communicating and comparing colour standards less complicated. The colour property of a product is also a factor that assists in making a product attractive to consumers. From observations when formulating the patty, the colour was not similar to a traditional meat patty even though there was slight browning. The 'a' and 'b' values obtained from the Konica Minolta instrument are chromaticity coordinates and represent directions away from the center of the colour sphere. The 'a' coordinate values signify redness when it is positive and green when negative meanwhile 'b' connotes yellow when positive and blue when negative. The hue angle (h°) and chroma (C) are values which can be calculated from the 'a' and 'b' coordinate values. A hue angle of 0° was used in the calculations meaning 0° values indicated purplish-red, 45° indicates orange, yellow is 90°, 180° is green and 270° is blue. Chroma values which are also calculated using the 'a' and 'b' coordinates represent the colour saturation of the sample. The calculations for these values are in Appendix II.

The 'L', 'a', 'b' values for sample E were as follows 50.46 $\pm$ 1.12, -1.16 $\pm$ 1.03 and 16.14 $\pm$ 0.14 respectively while the 'L', 'a', 'b' values for Sample X were 48.34 $\pm$ 1.73, -0.61 $\pm$ 0.52 and 15.02 $\pm$ 0.38 respectively. Sample E was significantly darker than Sample X according to the 'L' value. The eggs in sample E can be associated to the darkness since that was only difference in the patty as the ingredients; cooking method and cooking time were consistent. The 'a' values indicated both patties had shades of greenness with sample E having an increased amount of greenness. This can be accounted for by the actual colour of the fruit and the seasonings which were added to the product. The 'b' values however indicated yellowness for both patties, with sample E having more yellow when compared to sample X. The hue angle for sample X and E were 92.40 $\pm$ 1.99 and 94.24 $\pm$ 3.75 respectively which represented a yellow colour of the

product. The chroma values were 14.99 $\pm$ 0.38 for sample X and 16.05 $\pm$ 0.20 for sample E showing there was more colour saturation in sample E.

In comparison to a study conducted by Ramadhan *et al* (2011) which also tested colour properties on meat burgers showed values similar to the 'L' in this project. The 'a' values however were positive and leaned to redness because the patty comprised of meat. The 'b' values were also very similar in the respect of having related levels of yellowness. The study also commented on the use of colouring agent additives which are added by industries. From the sensory evaluation conducted, panelists indicated that the color was 'liked moderately' as the mean difference showed values of 7.00 $\pm$ 0.27 7.87 $\pm$ 0.18 for sample X and sample E respectively.

The second part of physicochemical analysis investigated was textural properties. The areas evaluated were stickiness and firmness of the patty. From the results sample E resulted in a firmer patty when compared to the patty containing xanthan gum. Sample E patty was however less stickier than Sample X. This was also observed from sensory evaluation as panelists commented that sample X was 'sticky' which could be attributed to the xanthan gum binding agent.

The last section investigated was sensory evaluation and consumer acceptability of the two types of Chataigne patties. This was regard to the marketing of the product is exploring the consumer acceptance of meat substitute products to find out if the product can survive in the market. Essentially, a product must be highly liked by consumers for it to become successful on the market. The studies found were conducted in the Netherlands and investigated the different aspects of consumer acceptance of meat substitutes (Elzerman *et al*, 2011). In Trinidad, a large

population is familiar with breadnut/ breadfruit since it is grown locally. When compared to Trinidad, it is observed that more meat is consumed in the Netherlands. The consumption patterns in a great portion of the population in Trinidad are influenced by religion. Therefore this product may be more acceptable to consumers in Trinidad. There has been a rising demand for meat in Trinidad as the meat consumption increases. However with the increase of health related non communicable diseases certain populations are becoming aware and are altering their diets to low fat diets and making healthier food choices. One of the ways to encourage better care for health is by providing options which are tasty but at the same time affordable and healthy to consumers.

Overall customers rated the shape as 7.77$\pm$ 0.21 - 8.23 $\pm$ 0.14, the flavor as 6.00 $\pm$ 0.27 - 8.28 $\pm$ 0.19, the aroma as 6.47 $\pm$ 0.27 - 7.39 $\pm$ 0.21, texture as 5.34 $\pm$ 0.33 - 7.89 $\pm$ 0.20, appearance as 6.72 $\pm$ 0.27 - 7.55 $\pm$ 0.23 and the overall taste 5.51 $\pm$ 0.34 - 8.45 $\pm$ 0.12 (Refer to Table 8 in Results). Using SPSS, the standard mean of ratings of the 9 point Hedonic Scale from sensory evaluation forms were calculated. Panelists gave higher ratings to all attributes of sample E and the overall taste was 'liked very much'. Sample X was 'neither liked nor disliked'. A greater proportion of 86.80% showed preference to sample E and 13.20% to sample X. When enquired about whether panelists will choose this patty over a meat patty, 64.2% responded yes they will while 35.8% responded no.

RECOMMENDATIONS

Some recommendations which can be used to improve this study are as follows:

- Exploration of new ingredients which can be added to this product to improve the nutritional value. For example, the addition of a protein enhancer to give similar protein content of a meat burger. However, the taste or flavor of the vegetable should not be altered.

- Exploration of more binding agents to convert this current product into a vegan product, that is, the elimination of eggs. Even though xanthan gum was used as a binding agent making it a vegan product, the mouth feel was slightly changed based on feedback of panelists. Panelists described the taste as ‘slimey’. The mouth feel of the product must be taken into account when trying new binding agents.

- Investigation of processes which can be used to increase the shelf life of the product however keeping the quality and taste at its optimum. For example, altering the pH and conditions the product can undergo to have a longer shelf life based on research from other studies.

- The use of other cooking methods may decrease the fat content. Grilling or baking as opposed to pan searing can be used to make this product even healthier.

- Conducting more tests to determine the dietary fiber for this product in particular since the dietary fiber values were from the actual fruit chataigne. Due to time constraints these tests weren't performed.

LIMITATIONS

Some limitations in the production of this product included:

- Chataigne is a seasonal vegetable therefore making the acquisition of this fruit slightly challenging for year round production of patties.
- Developing the formulation of the ingredients was very time consuming as it was done via trial and error method.
- Finding a suitable package for the patty which provides conditions to increase the shelf life was a challenge and more research has to be conducted to assist in this aspect.
- Obtaining a binding agent that vegetarians can use. Consumer acceptability of the product containing xanthan gum was not as acceptable as the patty containing eggs as a binding agent. Panelists described the patty with xanthan gum as 'slimey'.
- There was a time constraint which prevented specific tests from being carried out such as dietary fiber which is an important factor to consider when looking at nutritional composition.

CONCLUSION

In conclusion this project seeked to produce a tasty, healthy burger patty using a meat substitute which would give similar attributes to a meat patty. The meat substitute chosen was a local vegetable chataigne/breadnut since it mimicked the properties of meat as discussed in the discussion. From the findings chataigne as a meat substitute is a sustainable alternative since it provides a high protein content (breadnut seeds are included also adding to protein content). Information was gathered from many journal articles which enlightened us on different aspects of making a high quality chataigne/breadnut patty. Articles were found on the binding agents, nutritional composition, shelf life studies and acceptability of different meat substitutes which were used to compare studies.

Additionally, laboratory work was also conducted on the product to evaluate its nutritional composition, textural and colour properties and food safety by microbial tests. Proximate analysis results for sample X for moisture, ash, crude protein, crude fat were 4.01 $\pm$ 0.81, 11.05 $\pm$ 0.58, 14.63 $\pm$ 0.92, 53.78 $\pm$ 3.66 respectively. The results ascertained for sample E were as follows, 5.44 $\pm$ 0.01% moisture, 9.87% ash, 28.48 $\pm$ 0.38 crude protein and 55.97 $\pm$ 1.94% crude fat. Texture properties showed that sample E was firmer than sample X while sample X was stickier than sample E. The hue angle for sample X and E were 92.40 $\pm$ 1.99 and 94.24 $\pm$ 3.75 respectively which represented a yellow colour of the product. The chroma values were 14.99 $\pm$ 0.38 for sample X and 16.05 $\pm$ 0.20 for sample E showing there was more colour saturation in sample E.

Sensory evaluation showed a high sample preference (86.8%) to sample E which contained eggs when compared to sample X containing xanthan gum (13.2%). A large proportion of 64.2% indicated they would choose this patty in preference of a meat patty.

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APPENDICES

APPENDIX 1: Calculations for Physicochemical Analysis.

Physicochemical Analysis

Colour Measurement

	L	a	b
Sample X	50.75	-0.53	14.35
	49.28	-1.56	15.03
	44.99	0.25	15.67
Average	**48.34**	**-0.613**	**15.016**
Sample E	52.56	-1.65	16.34
	48.74	0.82	16.21
	50.07	-2.66	15.87
Average	**50.456**	**-1.163**	**16.14**

Chroma (C) for Sample X = $(a^2 + b^2)^{½}$

$= (-0.613^2 + 15.016^2)^{½}$

$= \sqrt{(-0.613^2 + 15.016^2}$

= **15.00**

hue° for Sample X = $\cos^{-1}\frac{a}{\sqrt{a^2+b^2}}$

$= \cos^{-1}\frac{(-0.613)}{15.00}$

= 92.34213976°

Chroma (C) for Sample E = $(a^2 + b^2)^{½}$

$= (-0.163^2 + 16.14^2)^{½}$

$= \sqrt{(-0.163^2 + 16.14^2)}$

= **16.14**

hue° for Sample E = $\cos^{-1}\frac{a}{\sqrt{a^2+b^2}}$

$= \cos^{-1}\frac{(-1.163)}{16.14}$

= 94.13214316°

APPENDIX 2: Calculations for Proximate Analysis.

➢ DETERMINATION OF DRY MATTER

SAMPLE X_1

Weight of Crucible **(Weight A)**: 69.4019g

Weight of Crucible and Sample **(Weight B)**: 71.3887g

Weight of Sample (B - A): (71.3887g – 69.4019g) = 1.9868g

Weight of Crucible and Dry Sample **(Weight C)**: 71.3205g

Weight of Dry Sample (C –A): (71.3205g – 69.4019g) = 1.9186g

$$\text{Dry Matter Content (\%)} = \frac{Weight\ C - Weight\ A}{Weight\ B - Weight\ A} \times 100$$

$$= \frac{1.9186}{1.9868} \times 100$$

$$= 96.57\%$$

$$\text{Dry Matter Content (g/kg)} = \frac{Weight\ C - Weight\ A}{Weight\ B - Weight\ A} \times 1000$$

$$= \frac{1.9186g}{1.9868g} \times 1000$$

$$= 965.67 g/kg$$

SAMPLE X_2

Weight of Crucible **(Weight A)**: 71.6035g

Weight of Crucible and Sample **(Weight B)**: 73.5965g

Weight of Sample (B - A): (73.5965g – 71.6035g) = 1.9930g

Weight of Crucible and Dry Sample **(Weight C)**: 73.5053g

Weight of Dry Sample (C –A): (73.5053g – 71.6035g) = 1.9018g

$$\text{Dry Matter Content (\%)} = \frac{Weight\ C - Weight\ A}{Weight\ B - Weight\ A} \times 100$$

$$= \frac{1.9018g}{1.9930g} \times 100$$

$$= 95.42\%$$

Dry Matter Content (g/kg) = $\frac{Weight\ C - Weight\ A}{Weight\ B - Weight\ A} \times 1000$

= $\frac{1.9018g}{1.9930g} \times 1000$

= 954.24g/kg

SAMPLE E_1

Weight of Crucible **(Weight A)**: 72.6246g

Weight of Crucible and Sample **(Weight B)**: 74.6054g

Weight of Sample (B - A): (74.6054g – 72.6246g) = 1.9808g

Weight of Crucible and Dry Sample **(Weight C)**: 74.4979g

Weight of Dry Sample (C –A): (74.4979g – 72.6246g) = 1.8733g

Dry Matter Content (%) = $\frac{Weight\ C - Weight\ A}{Weight\ B - Weight\ A} \times 100$

= $\frac{1.8733g}{1.9808g} \times 100$

= 94.57%

Dry Matter Content (g/kg) = $\frac{Weight\ C - Weight\ A}{Weight\ B - Weight\ A} \times 1000$

= $\frac{1.8733g}{1.9808g} \times 1000$

= 945.73g/kg

SAMPLE E_2

Weight of Crucible **(Weight A)**: 68.3208g

Weight of Crucible and Sample **(Weight B)**: 70.3109g

Weight of Sample (B - A): (70.3109g – 68.3208g) = 1.9901g

Weight of Crucible and Dry Sample **(Weight C)**: 70.2025g

Weight of Dry Sample (C –A): (70.2025g – 68.3208g) = 1.8817g

$$\text{Dry Matter Content (\%)} = \frac{Weight\ C - Weight\ A}{Weight\ B - Weight\ A} \times 100$$

$$= \frac{1.8817\,g}{1.9901\,g} \times 100$$

$$= 94.55\%$$

$$\text{Dry Matter Content (g/kg)} = \frac{Weight\ C - Weight\ A}{Weight\ B - Weight\ A} \times 1000$$

$$= \frac{1.8817\,g}{1.9901\,g} \times 1000$$

$$= 945.53 \text{g/kg}$$

➢ DETERMINATION OF ASH AND ORGANIC MATTER

SAMPLE X_1

Weight of Crucible **(Weight A)**: from Expt. 1: 69.4019g

Weight of Crucible and Sample **(Weight B)**: from Expt. 1: 71.3887g

Weight of Sample (B - A) : (71.3887g – 69.4019g) = 1.9868g

Weight of Crucible and Dry Sample **(Weight C)** (Expt. 1) = 71.3205g

Weight of Dry Sample (C – A) = (71.3205g – 69.4019g) = 1.9186g

Dry Matter Content (g/kg) = 965.67g/kg

Weight of Crucible and Ash **(Weight D)**: 69.6205g

Weight of Ash (D-A) – (69.6205g – 69.4019g) = 0.2186g

Ash = ($\frac{Weight\ D - Weight\ A}{Weight\ B - Weight\ A}$) × 1000

= $\frac{0.2186\,g}{1.9868\,g}$ × 1000

= 110.03g/kg as fed basis

Ash Content, g/kg (DM Basis) = $\frac{Ash\ Content, g/kg (as\ is\ basis)}{DM\ content\ of\ sample, g/kg}$ **× 1000**

= $\frac{110.03\,g/kg}{965.67\,g/kg}$ × 1000

= 113.94g/kg DM

Organic matter content, g/kg (DM basis) = 1000 – Ash Content, g/kg DM

= 1000 – 113.94

= 886.06g/kg DM

SAMPLE X_2

Weight of Crucible **(Weight A)**: from Expt. 1: 71.6035g
Weight of Crucible and Sample **(Weight B)**: from Expt. 1: 73.5965g
Weight of Sample (B - A) : (73.5965g – 71.6035g) = 1.9930g
Weight of Crucible and Dry Sample **(Weight C)** (Expt. 1): 73.5053g
Weight of Dry Sample (C – A): (73.5053g – 71.6035g) = 1.9018g

Dry Matter Content (g/kg) = 954.24g/kg

Weight of Crucible and Ash **(Weight D)**: 71.8049g

Weight of Ash (D-A): (71.8049g – 71.6035g) = 0.2014g

Ash = ($\frac{Weight\ D - Weight\ A}{Weight\ B - Weight\ A}$) × 1000

$= \frac{0.2014\,g}{1.9930\,g} \times 1000$

= 101.05g/kg as fed basis

Ash Content, g/kg (DM Basis) = $\frac{Ash\ Content, g/kg (as\ is\ basis)}{DM\ content\ of\ sample, g/kg} \times 1000$

$= \frac{101.05\,g/kg}{954.24\,g/kg} \times 1000$

= 105.89g/kg DM

Organic matter content, g/kg (DM basis) = 1000 – Ash Content, g/kg DM
= 1000 – 105.89g/kg

= 894.10g/kg DM

SAMPLE E_1

Weight of Crucible **(Weight A)**: from Expt. 1: 72.6246g
Weight of Crucible and Sample **(Weight B)**: from Expt. 1: 74.6054g
Weight of Sample (B - A) : (74.6054g – 72.6246g) = 1.9808g
Weight of Crucible and Dry Sample **(Weight C)** (Expt. 1): 74.4979g
Weight of Dry Sample (C – A): (74.4979g – 72.6246g) = 1.8733g

Dry Matter Content (g/kg) = 945.73g/kg

Weight of Crucible and Ash **(Weight D)**: 72.8104g

Weight of Ash (D-A): (72.8104g – 72.6246g) = 0.1858

Ash = ($\frac{\boldsymbol{Weight\ D - Weight\ A}}{\boldsymbol{Weight\ B - Weight\ A}}$**) × 1000**

= ($\frac{0.1858\,g}{1.9808\,g}$) × 1000

= 93.80g/kg as fed basis

Ash Content, g/kg (DM Basis) = $\frac{\boldsymbol{Ash\ Content, g/kg (as\ is\ basis)}}{\boldsymbol{DM\ content\ of\ sample, g/kg}}$ **× 1000**

= $\frac{93.80\,g/kg}{945.73\,g/kg}$ × 1000

= 99.18g/kg DM

Organic matter content, g/kg (DM basis) = 1000 – Ash Content, g/kg DM

= 1000 – 99.18g/kg

= 900.82g/kg DM

SAMPLE E_2

Weight of Crucible **(Weight A)**: from Expt. 1: 68.3208g

Weight of Crucible and Sample **(Weight B)**: from Expt. 1: 70.3109g

Weight of Sample (B - A) : (70.3109g – 68.3208g) = 1.9901g

Weight of Crucible and Dry Sample **(Weight C)** (Expt. 1): 70.2025g

Weight of Dry Sample (C – A): (70.2025g – 68.3208g) = 1.8817g

Dry Matter Content (g/kg) = 945.53g/kg

Weight of Crucible and Ash **(Weight D)**: 68.5074g

Weight of Ash (D-A): (68.5074g – 68.3208g) = 0.1866g

Ash = ($\frac{Weight\ D - Weight\ A}{Weight\ B - Weight\ A}$) × 1000

= $\frac{0.1866\,g}{1.9901\,g}$ × 1000

= 93.76g/kg

Ash Content, g/kg (DM Basis) = $\frac{Ash\ Content, g/kg (as\ is\ basis)}{DM\ content\ of\ sample, g/kg}$ × 1000

= $\frac{93.76\,g/kg}{945.53\,g/kg}$ × 1000

= 99.17g/kg DM

Organic matter content, g/kg (DM basis) = 1000 – Ash Content, g/kg DM

= 1000 – 99.17g/kg

= 900.83g/kg DM

➢ DETERMINATION OF ETHER EXTRACTS

SAMPLE X_1

Weight of Sample **(Weight B)**: 1.5218g
Weight of Flask **(Weight D):** 146.3g
Weight of Flask and Ether Extracts **(Weight E)**: 147.1577g

Ether Extracts content, g/kg (as is basis) = $\frac{Weight\ E - Weight\ D}{Weight\ B}$ × 1000

= $\frac{147.1577\,g - 146.3g}{1.5218\,g}$ × 1000

=563.61g/kg (as is basis)

Ether Extracts content, g/kg (on DM basis) = $\frac{Ether\ extract\ content\ (g/kg\ as\ is)}{DM\ content\ of\ sample\ (g/kg)}$ × 1000

= $\frac{563.61 g/kg}{965.67\,g/kg}$ × 1000

=583.65g/kg DM

SAMPLE X_2

Weight of Sample **(Weight B)**: 1.5196g
Weight of Flask **(Weight D)**: 147.0g

Weight of Flask and Ether Extracts **(Weight E)**: 147.9315g

Ether Extracts content, g/kg (as is basis) $= \frac{\boldsymbol{Weight\ E - Weight\ D}}{\boldsymbol{Weight\ B}} \times \mathbf{1000}$

$= \frac{147.9315 - 147.0}{1.5196} \times 1000$

=612.99g/kg (as is basis)

Ether Extracts content, g/kg (on DM basis) $= \frac{\boldsymbol{Ether\ extract\ content\ (g/kg\ as\ is)}}{\boldsymbol{DM\ content\ of\ sample\ (g/kg)}} \times \mathbf{1000}$

$= \frac{612.99 g/kg}{954.24 g/kg} \times 1000$

= 624.39g/kg DM

SAMPLE E_1

Weight of Sample **(Weight B)**: 1.5408g

Weight of Flask **(Weight D)**: 149.3g

Weight of Flask and Ether Extracts **(Weight E)**: 150.1836g

Ether Extracts content, g/kg (as is basis) $= \frac{\boldsymbol{Weight\ E - Weight\ D}}{\boldsymbol{Weight\ B}} \times \mathbf{1000}$

$= \frac{150.1836 g - 149.3 g}{1.5408 g} \times 1000$

= 573.47g/kg (as is basis)

Ether Extracts content, g/kg (on DM basis) $= \frac{\boldsymbol{Ether\ extract\ content\ (g/kg\ as\ is)}}{\boldsymbol{DM\ content\ of\ sample\ (g/kg)}} \times \mathbf{1000}$

$= \frac{573.47 g/kg}{945.73 g/kg} \times 1000$

= 606.38g/kg DM

SAMPLE E_2

Weight of Sample **(Weight B)**: 1.5120g
Weight of Flask **(Weight D)**: 147.6g
Weight of Flask and Ether Extracts **(Weight E)**: 148.4259g

Ether Extracts content, g/kg (as is basis) = $\frac{\boldsymbol{Weight\ E - Weight\ D}}{\boldsymbol{Weight\ B}}$ **× 1000**

$= \frac{148.4259\,g - 147.6g}{1.5120\,g} \times 1000$

= 546.23g/kg (as is basis)

Ether Extracts content, g/kg (on DM basis) = $\frac{\boldsymbol{Ether\ extract\ content\ (g/kg\ as\ is)}}{\boldsymbol{DM\ content\ of\ sample\ (g/kg)}}$ **× 1000**

$= \frac{546.23g}{954.53g} \times 1000$

= 572.25g/kg DM

➢ DETERMINATION OF CRUDE FIBER

SAMPLE X_1

Weight of Sample (**Weight B** from Ether Extract Determination): 1.5218g
Weight of Crucible and Dry Sample **(Weight F)**: 69.3058g
Weight of Crucible and Ashed Sample **(Weight G)**: 69.1932g
Weight of Crude Fiber **(Weight H)**, obtained as (Weight F – Weight G): 0.1126g

Crude Fiber content, g/kg (as is basis) = $\frac{\boldsymbol{Weight\ H}}{\boldsymbol{Weight\ B}}$ **× 1000**

$= \frac{0.1126g}{1.5218\,g} \times 1000$

= 73.99g/kg

Crude Fiber Content, g/kg (on DM basis) = $\frac{\boldsymbol{Crude\ Fiber\ (g/kg\ as\ is)}}{\boldsymbol{DM\ content\ (g/kg)}}$ **× 1000**

$= \frac{73.99g/kg}{965.67\,g/kg}$

= 76.62g/kg DM

SAMPLE X_2

Weight of Sample (**Weight B** from Ether Extract Determination): 1.5196g
Weight of Crucible and Dry Sample **(Weight F)**: 69.3709g
Weight of Crucible and Ashed Sample **(Weight G)**: 69.2564g
Weight of Crude Fiber **(Weight H)**, obtained as (Weight F – Weight G): 0.1145g

Crude Fiber content, g/kg (as is basis) = $\frac{Weight\ H}{Weight\ B}$ **× 1000**

$$= \frac{0.1145g}{1.5196g} \times 1000$$

$$=75.35g/kg$$

Crude Fiber Content, g/kg (on DM basis) = $\frac{Crude\ Fiber\ (g/kg\ as\ is)}{DM\ content\ (g/kg)}$ **× 1000**

$$= \frac{75.35g/kg}{954.24g/kg} \times 1000$$

$$= 78.96g/kg\ DM$$

SAMPLE E_1

Weight of Sample (**Weight B** from Ether Extract Determination): 1.5408g
Weight of Crucible and Dry Sample **(Weight F)**: 34.0119g
Weight of Crucible and Ashed Sample **(Weight G)**: 33.9228g
Weight of Crude Fiber **(Weight H)**, obtained as (Weight F – Weight G): 0.0891g

Crude Fiber content, g/kg (as is basis) = $\frac{Weight\ H}{Weight\ B}$ **× 1000**

$$= \frac{0.0891g}{1.5408g} \times 1000$$

$$= 57.83g/kg$$

Crude Fiber Content, g/kg (on DM basis) = $\frac{Crude\ Fiber\ (g/kg\ as\ is)}{DM\ content\ (g/kg)}$ **× 1000**

$$= \frac{57.83g/kg}{945.73g/kg} \times 1000$$

$$=61.15g/kg\ DM$$

SAMPLE E_2

Weight of Sample (**Weight B** from Ether Extract Determination): 1.5120g
Weight of Crucible and Dry Sample **(Weight F)**: 68.8043g
Weight of Crucible and Ashed Sample **(Weight G)**: 68.7089g
Weight of Crude Fiber **(Weight H)**, obtained as (Weight F – Weight G): 0.0954g

Crude Fiber content, g/kg (as is basis) = $\frac{Weight\ H}{Weight\ B}$ **× 1000**

$$= \frac{0.0954g}{1.1520g} \times 1000$$

$$= 82.81 g/kg$$

Crude Fiber Content, g/kg (on DM basis) = $\frac{Crude\ Fiber\ (g/kg\ as\ is)}{DM\ content\ (g/kg)}$ **× 1000**

$$= \frac{82.8125\,g/kg}{945.53g/kg} \times 1000$$

$$=87.58 g/kg\ DM$$

➢ DETERMINATION OF NITROGEN AND CRUDE PROTEIN

SAMPLE X_1

Nitrogen Content, g/kg (as is basis) = $\frac{0.014\ x\ 50\ x\ Acid\ Volume\ x\ Acid\ Molarity}{Weight\ of\ Sample\ (g)}$ **× 1000**

$$= \frac{0.014\ x\ 50\ x\ 6.90\ x\ 0.01}{1.9753} \times 1000$$

$$=24.45 g/kg$$

Crude Protein content, g/kg (as is basis) = Nitrogen Content (g/kg as is basis) × 6.25

$$= 24.45 g/kg \times 6.25$$

$$= 152.82 g/kg$$

Crude Protein Content, g/kg (on DM basis) = $\frac{Crude\ Protein\ content\ (g/kg\ as\ is)}{DM\ content\ of\ sample\ (g/kg)}$ **× 1000**

$$= \frac{152.82g/kg}{965.67g/kg} \times 1000$$

$$=158.26 g/kg$$

SAMPLE X_2

Nitrogen Content, g/kg (as is basis) = $\frac{\mathbf{0.014\ x\ 50\ x\ Acid\ Volume\ x\ Acid\ Molarity}}{\boldsymbol{Weight\ of\ Sample\ (g)}}$ **× 1000**

$$= \frac{0.014\ x\ 50\ x\ 6.40\ x\ 0.01}{2.0030} \times 1000$$

$$= 22.37 g/kg$$

Crude Protein content, g/kg (as is basis) = Nitrogen Content (g/kg as is basis) × 6.25

$$= 22.37 g/kg \times 6.25$$

$$= 139.79 g/kg$$

Crude Protein Content, g/kg (on DM basis) = $\frac{\boldsymbol{Crude\ Protein\ content\ (g/kg\ as\ is)}}{\boldsymbol{DM\ content\ of\ sample\ (g/kg)}}$ **× 1000**

$$= \frac{139.79 g/kg}{954.24 g/kg} \times 1000$$

$$= 146.49 g/kg$$

SAMPLE E_1

Nitrogen Content, g/kg (as is basis) = $\frac{\mathbf{0.014\ x\ 50\ x\ Acid\ Volume\ x\ Acid\ Molarity}}{\boldsymbol{Weight\ of\ Sample\ (g)}}$ **× 1000**

$$= \frac{0.014\ x\ 50\ x\ 12.90\ x\ 0.01}{2.0007} \times 1000$$

$$= 45.13 g/kg$$

Crude Protein content, g/kg (as is basis) = Nitrogen Content (g/kg as is basis) × 6.25

$$= 45.13 g/kg \times 6.25$$

$$= 282.09 g/kg$$

Crude Protein Content, g/kg (on DM basis) = $\frac{\boldsymbol{Crude\ Protein\ content\ (g/kg\ as\ is)}}{\boldsymbol{DM\ content\ of\ sample\ (g/kg)}}$ **× 1000**

$$= \frac{282.09 g/kg}{945.73 g/kg} \times 1000$$

$$= 298.28 g/kg$$

SAMPLE E_2

Nitrogen Content, g/kg (as is basis) = $\frac{\boldsymbol{0.014\ x\ 50\ x\ Acid\ Volume\ x\ Acid\ Molarity}}{\boldsymbol{Weight\ of\ Sample\ (g)}}$ **× 1000**

$$= \frac{0.014\ x\ 50\ x\ 13.10\ x\ 0.01}{1.9933} \times 1000$$

$$= 46.00 g/kg$$

Crude Protein content, g/kg (as is basis) = Nitrogen Content (g/kg as is basis) × 6.25

$$= 46.00 g/kg \times 6.25$$

$$= 287.53 g/kg$$

Crude Protein Content, g/kg (on DM basis) = $\frac{\boldsymbol{Crude\ Protein\ content\ (g/kg\ as\ is)}}{\boldsymbol{DM\ content\ of\ sample\ (g/kg)}}$ **× 1000**

$$= \frac{287.53 g/kg}{945.53 g/kg} \times 1000$$

$$= 304.09 g/kg$$

Appendix 3: Sensory Evaluation of Chataigne(Breadnut) Pattie.

Please place a tick (√) the appropriate option to indicate your response for questions 1- 4.

1. **SEX:** Male ( ) Female ( )
2. **AGE:** 18-24yrs ( ) 25-34 yrs ( ) 35-54yrs ( ) 55+ yrs ( )
3. **RACE:** African ( ) East Indian ( ) Chinese ( ) Caucasian ( ) Other: _ _
4. **Have you ever consumed vegetarian patties?** Yes ( ) No ( )
5. **Have you ever consumed Chataigne (Breadnut)?** Yes ( ) No ( )

If you ticked Yes (√) as your response, answer the following:

6. **Do you like Chataigne (Breadnut)?** Yes ( ) No ( )

Use the scale below to rate the characteristics of the item.

Characteristic	Sample	
	17	**28**
7. Shape		
8. Colour of Surface		
9. Flavor		
10. Aroma		
11. Texture		
12. Appearance		
13. Overall Taste		

SCALE: 9= Like extremely
8= Like very much
7= Like moderately
6= Like slightly
5= Neither like nor dislike
4= Dislike slightly
3= Dislike Moderately
2= Dislike very much
1= Dislike extremely

14. Comment on the saltiness of the samples.

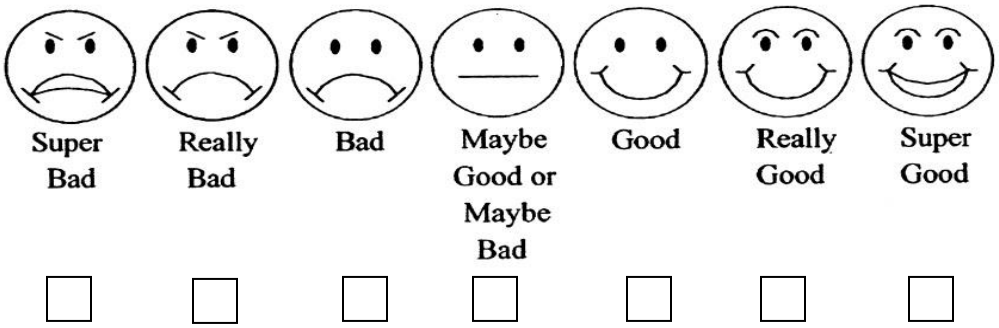
_____

_____

15. Place a tick (√) in the box to show which of the two samples you prefer?

17 ☐ 28☐

16. How would you rate these samples overall?



17. Would you choose your **preferred** **vegetable patty** over a **meat patty** as a **healthier choice**?

Yes ( ) No ( )