KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

KUMASI

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

FACULTY OF AGRICULTURE

DEPARTMENT OF HORTICULTURE

DEVELOPMENT OF CARROT BASED DRINK FROM TOKITA AND KURODA VARIETIES OF CARROT

A THESIS SUBMITTED TO THE SCHOOL OF RESEARCH AND GRADUATE STUDIES, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY (MPHIL) POST HARVEST TECHNOLOGY DEGREE.

BY

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JUNE, 2015

DECLARATION

I hereby declare that this submission is my own work towards the Master of Philosophy and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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DEDICATION

This work is dedicated to the Glory of God and to all Carrot Farmers at Bimma in the Mampong Municipality of Ashanti Region, Ghana and its environs for their hard work.

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ACKNOWLEDGEMENT

I thank God almighty for giving me the strength to undertake this work. I say, to him be the glory great things he has done and great things he has taught us.

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God bless you all.

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ABSTRACT

The study was designed to develop an acceptable carrot based drink from Tokita and Kuroda varieties of carrot grown in the Ashanti Mampong Municipal area. Survey and laboratory work was carried out during the study. Standard procedures were used in the study. Analysis of the data collected from respondents revealed that 78% of carrot producers and 70% of carrot sellers were willing to try the new product (i.e. the carrot drink) whilst 80% of the general carrot consuming populace also expressed interest in the carrot drink. Analysis of the Kuroda and Tokita carrot roots revealed that protein and fat were higher in Tokita, i.e. 40.78% and 3.17% respectively than Kuroda which recorded 36.55% and 2.00% respectively. The findings also indicated that Vitamin C was higher in Tokita root than in Kuroda root that is 7.49mg/100g and 6.78mg/100g respectively. In terms of minerals, Potassium and Phosphorus were higher in Kuroda root that is 6.13% and 3.22% respectively than in Tokita which recorded 5.08% and 3.11%, respectively. The final consumer acceptable drinks were subjected to proximate, vitamins and mineral analyses in the laboratory. pH, Titratable Acidity and vitamin C were also monitored under two (2) storage conditions, i.e. room (ambient) temperature at 26°C and refrigeration temperature of 5°C for seven (7) days to determine the shelf life. The acidity of both the kuroda and tokita drinks increased slightly from 5.22 to 4.19 and 5.19 to 4.67 respectively after being stored for seven (7) days in the refrigerator. Meanwhile, under room temperature of 26°C storage, the pH of Kuroda increased from 5.22 to 4.11 and that of Tokita from 5.19 to 4.06. Vitamin C was better preserved under refrigerator storage of drinks of both varieties than under room temperature storage. It is recommended that further studies be carried out on shelf life beyond the seven (7) days to ascertain the keeping quality of the drinks.

KNUST

TABLE OF CONTENT

KNUST

KNUST

KNUST

KNUST

LIST OF TABLES

KNUST

LIST OF FIGURES

KNUST

….

CHAPTER ONE

1.0 INTRODUCTION

Carrot is a dicotyledonous herbaceous crop grown for it's enlarged tap root. It is an important vegetable which is ranked third among the succulent vegetables in the world production. (Yamaguchi, 1983). A cross section of the root reveals two distinct zones, the outer zone where sugar and carotene are mainly stored and a woody inner central core which is not as palatable as the outer zone. (Tindall,1983). The edible roots are nutritious and contain protein, ash, vitamin and mineral. (Norman, 1992). According to Arthey (1975), although, carrots do not possess retinol, its carotene content also known as provitamin A is converted by the body into vitamin A. Analysis of the composition of the root of carrot reveals that it has with many medicinal properties such as being diuretic, antidiarrheal and antianemic. It is also rich in alkaline elements which purify and revitalize the blood. Purseglove (1986) asserted that the seed of carrot contains an essential oil which is used for flavouring and in the perfumery industry.

Carrot was introduced into Ghana by the Europeans around 1930 (Sinnadurai, 1992). Among the varieties of carrot grown in Ghana are Improved Kuroda, Amsterdam Grace, Amsterdam forcing, Tokita, Superior chantenay, Nantes and Cape (Tindall, 1983).

Kuroda is a popular carrot with sweet taste. It is almost cylindrical in shape and rounds off at the end rather than tapering off, as compared to Tokita. Both are orange in colour and have a core and an outer cortex accumulated with sugar.

The root of carrot is mostly used as vegetables and for preparing soup, stew, curries and other dishes. The grated roots are also used in salads whilst the top is used to feed livestock. The juice, extracted from the root can also be consumed as beverage.

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Carotene which is extracted from the roots is used in colouring margarine and for improving the colour of egg yolk when added to layer feed (Kahangi, 2004). Because carrots have a broad temperature tolerance, its production is feasible throughout the year (Simon and Wolff, 1987). Carrot is one of the exotic vegetables with high value and great demand in urban centers in Ghana, and also, a potential export crop. (MOFA, 2002)

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Justification of the study

One of the major themes of research in the domain of research and development, innovation and product design over the past 50 years has been that of designing organizations to engage in innovative activity (Shane and Ulrich, 2004). Barker (2006) stated that finding ways to improve consumer satisfaction is a major key to boosting sales and profitability. For this reason, many businesses are redefining their traditional practices to generate quality products for their customers.

This proposed study, once completed, will add value to the production of carrot in the Ashanti Mampong Municipality and Ghana as a whole.

It will also create an employment avenue for the natives of the carrot producing areas in the Ashanti Mampong Municipality, leading to the expansion of carrot production in Ghana. Presently, carrot is known to be used in the preparation of stew, soup and salad. The development of the drink will expand the use of the crop, Whiles extending its consumption to boost the hospitality industries in Ghana.

Problem Statement

Mampong Municipality, located within the Savannah and forest transitional zone of Ghana is noted as one of Municipalities with a large population of farmers who carry out carrot production.

Most of farmers aim at increasing the quantity of their carrot, without thinking of how to store or process the surplus or excess carrots which are not purchased.

Although, there is a high production of carrot within the Mampong Municipal area, farmers do not obtain the expected income of their efforts because a chunk of the produce which are in excess or are not sold within a stipulated time spoil or are sold at a cheaper price, owing to the fact that there is lack of proper storage facilities and the knowledge of processing as a value addition.

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It is important to find alternative uses for the excess carrot by exploring the possibility of developing a carrot based drink.

Therefore, the main objective of this study was to develop a carrot based drink from the two varieties of carrots ('Kuroda' and 'Tokita') which are produced in Bimma in the Mampong Municipal Area of Ashanti Region, to minimize the postharvest losses incurred by the farmers.

The specific objectives were to:

- identify preharvest and postharvest practices carried out on carrots by the stakeholders in the chain.
- determine the chemical properties of the two varieties of carrot
- assess consumer preference of the two varieties of carrot
- develop consumer acceptable carrot drink
- assess the keeping quality of the final drink under different storage conditions over a period of time.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Origin and Distribution of Carrot

Carrot (*Daucus carota* L) is believed to have originated from Afghanistan which remains the centre of diversity. The wild carrot, also known as 'Queen Anne's' lace, was introduced to North America from Europe as a medicinal herb (Banga, 1984). Carrot is a popular root vegetable grown throughout the world. It is also the most important source of dietary carotenoids in the western countries including the United States of America (Torrenen *et al*., 1996). According to a report issued by FAO (2008), China is the major carrot producing country in the world.

The consumption of carrot and its products are said to have increased steadily due to their recognition as an important source of natural antioxidants, besides the anticancer activities of β-carotene, which is a precursor of vitamin A. (Dreosti 1993).

2.2 Chemical Composition of Carrot

According to Gopalan *et al*. (1991), the moisture content of carrot ranges from 80% to 89%. Other chemical constituents of carrot as reported by Gopalan *et al.,* (1991) are; Carbohydrate 10.6%, protein 0.9%, fat 0.2%, crude fibre 1.2% and ash 1.1%. Holland et al. (1991) also reported that in general, carrot contains 34 mg/100g of Calcium, 0.4 mg/100g of Iron, 25 mg/100g of Phosphorus and 240 mg/100g of Potassium, making carrots a good source of Potassium.

Simon and Lindsay (1983) are of the view that reducing sugars accounted for 6 – 32% of free sugars in four (4) hybrid varieties of carrot. They further stated that the free sugars identified are sucrose, glucose, xylose and fructose.

2.10 Phytonutrients in Carrot

Phytonutrients are plant compounds that are secondary metabolites with health promoting properties. According to Kalt (2005), in vitro studies indicated that phytonutrients such as carotenoids and phenolics have the ability to protect biological systems from the effect of oxidative stress. According to Hager and Howard (2006), due to the appreciable level of different compounds present in carrots, they are considered a functional food with significant health promoting properties.

Nocolle *et al*. (2003) are of the view that the importance of carotenoids as a phytonutrient, goes beyond providing natural pigments but also, serves as a precursor of vitamin A. according to Nagai *et al*., (2003) phenolics or polyphenols which are important phytonutrients in carrot have received considerable attention because of their ability to combat free radicals which are harmful to the human body and food system.

2.11 Nutritional and Health Benefits of Carrot

Carrot is a major source of vitamin A required for the protection of most tissues of the body. Although, carrot do not possess the actual compound (retinol) their carotene content (also known as provitamin A) is converted by the body into vitamin A (Arthey, 1975). Carotene, which is the famous ingredient in carrots is an anti-oxidant that has powerful healing virtues for many diseases. Drinking a cup of carrot juice over a period of time can boost the immune system and also, help to correct disorders such as acidosis, anaemia, atherosclerosis, asthma, cancer, constipation, and poor eye sight.(http://juicing-for-health.com/basic-nutrition/healing-vegetables/health-benefits -of-carrot.html). Accessed on 14/06/14.

2.12 Food Drinks / Beverages

According to the Eleventh Edition of the Concised Oxford English Dictionary, a drink is any liquid consumed as refreshment or nourishment. The essential components of any food drink are the water that it contains and some other components such as stimulants and flavours (Ihekoronye and Ngoddy, 1985). Food drinks commonly consumed in the tropics can be divided into two; Non-alcoholic and alcoholic drinks. The former can further be divided into non-carbonated (juices, coffee, tea, energy drinks, etc.) and carbonated (soda, coca cola, tonic water, etc.). (The European Commission on Food Safety, 1999).

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2.12.1 Carbonated Drink

A carbonated drink is one with Carbon dioxide dissolved in it to improve the taste, texture or both. Example of such drinks includes coca cola, ginger ale, etc.

2.12.2 Non-Carbonated Drink

Non-carbonated drink on the other hand, lacks the presevation against spoilage that is offered by carbonation. Usually, non-carbonated drinks are pasteurised either in bulk or by continuous flash pasteurization prior to filling or in the bottle. Examples are; energy drinks, sports drinks, fruit and vegetable juices, etc.

2.12.2.1 Energy Drink

The consumption of energy drink is very popular among consumers especially adolescents and may have adverse effects on their health. According to O'Dea (2003), in a survey of 78 youth, ranging from 11- 18 years, 42.3% of them were found to consume energy drinks. Concern, however, has been raised about the effects of the

ingredients found in energy drinks on children and adolescents. (Australia New Zealand Food Authority, 2001).

2.12.2.2 Sports drink

The purpose of sports drink is to help athletes rehydrate, as well as replenish carbohydrates and other nutrients which can be depleted after training or competition (Casa, 2000). Sports drink can further be divided into three (3) categories. These are; isotonic sport drinks, hypertonic sports drink and hypotonic sports drink. Isotonic sports drink contains proportions of water and other nutrients similar to the human body and normally composed of six to eight percent sugar. In the hypertonic sports drink, there is a lesser proportion of water and sugar than the human body. Finally, hypotonic sports drink contains a greater proportion of water and a lesser proportion of sugar than the human body (Casa, 2000).

2.12.2.3 Fruit and Vegetable Juice

Preparation of juices involves mechanical squeezing or maceration of fresh fruits or vegetables without the application of heat or solvents (Kalra *et al*., 1987). Juices are normally consumed for their nutritional and health promoting properties. Example is vitamin C obtained from orange juice. Torregosa *et al*. (2006) reported that the incorporation of a proportion each of two different juices, contributes considerably to the health of the consumer. Therefore, mixture of lemon juice and carrot juice is a rich dietetic source of antioxidants (Torregosa *et al*., 2006).

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2.13 Juice Processing

According to Ihekoronyo and Ngoddy (1985), the major steps of juice processing involves extraction of the juice, clarification, deaeration of the juice, pasteurization, concentration, essence add-back, canning or bottling and freezing (i.e. if the juice is to be marketed). According to Kalra *et al*. (1987), carrots can be processed into beverages, candies, Juices or dehydrated and canned.

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2.13.1 Pasteurization

Pasteurization is defined as the partial sterilization of foods at a temperature that destroys harmful microorganisms without major changes in the chemistry of the food (Microsoft Student Encarta, 2009). Pasteurization is purposely done to make a food product safer to drink or eat and to improve its keeping quality. For small-scale batch pasteurization of some liquid foods, swept heat exchangers or open boiling pans are normally used. Barclay *et al*. (1984). In the case of low viscosity liquids like milk and other fruit juices, plate heat exchangers are employed in their pasteurization. To prevent recontamination, pasteurized foods or drinks are immediately filled in cans or bottles and sealed to make them air tight.

2.13.2 Effect of Heat on Juices

As much as pasteurization has little or no effect on the nutritional and sensory characteristics of most juices, the shelf-life of pasteurized juices are usually of a few days or weeks as compared to those with more severe heat sterilization. According to a report by F.A.O (2008), deaeration prior to pasteurization is very necessary as it prevents colour change in juices due to enzymic browning. Fellows (2000) asserted that a very small amount of volatile aroma compounds are lost during pasteurization

of juices whereas losses of vitamin C and carotene are however minimized by deaeration.

2.14 Product Quality

Quality of a product is its conformity to a given level of excellence which represents a particular standard or specifications with minimum cost to the produce whiles providing satisfaction to the consumer. The following parameters are considered necessary when evaluating the quality of a product: appearance, flavour, physical characteristics (i.e. shape, size, specific gravity and weight), mechanical properties, spectrophotometric properties and chemical properties (such as moisture, sugar, soluble solids, acidity, pH, impurities, rancidity and fibre). (Olympio and Kumah, 2008). These parameters may be measured objectively by physical or chemical procedures, or subjectively through sensory evaluation by one or more human observers (Joselyn and Heids, 1963).

2.15 Ghana Standards for Fruit Juices (GS 724:2003)

This standard describes fruit juice as unfermented or fermentable juice, pulpy and turbid, intended for direct consumption and obtained by a mechanical process from fruits that are sound and ripe or the flesh thereof, and preserved exclusively by physical means. The Ghana standards on fruit juice lays emphasis on hygienic standards expected of fruit juices and demands strict attention on the tolerance of microbial count (Yeast and moulds, and Coliforms).

2.16 Ghana Standards for Vegetable Juices (GS725:2003)

The Ghana standard for vegetable juices also describes vegetable juice as the liquid unfermented or fermentable product or lactic acid fermented product, intended for consumption and obtained from the edible part of one or more sound vegetables, preserved exclusively by physical means. This standard demands that the juice be free from skins, seeds and other coarse parts of the vegetables. It may be clear, turbid or pulpy. Similar to the standards for fruit juices, the vegetable juice standard is also stringent on hygienic and microbial standard.

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CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area and Scope of the Study

A survey was conducted in Bimma, one of the carrot producing communities in the Mampong municipal area to have a fair view of the pre and post-harvest practices, marketing, consumption patterns and the perception of beverages, fruit and vegetable juice for consumption. Respondents were randomly chosen based on consent, during visits to farms, markets, homes, schools and work places in the selected community.

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3.2. Questionnaire Design

Structured questionnaires were designed for data collection. Respondents were in three (3) categories, namely; producers of carrot, sellers of carrot and regular consumers of carrot. Therefore, three (3) separate questionnaires where prepared.

3.2.1 Questionnaire for Carrot Producers

For the producers, some of the parameters considered included their bio-data, such as age, gender, educational background, marital status, yield of carrot per acre, etc. (Appendix A).

3.2.2 Questionnaire for Carrot Sellers

The questionnaire for carrot sellers covered their bio-data, variety of carrot consumed, preference of carrot drink etc. (Appendix B)

3.2.3 Questionnaire for Carrot Consumers

The questionnaire for carrot consumers included parameters like their bio-data, variety of carrot consumed, perception of drinks, beverage and juice consumption, preference of carrot based drink, etc. (Appendix C).

3.3 Pre-testing of Questionnaire

A preliminary survey was conducted to sample the views of the stakeholders in the carrot production chain. Interviews were conducted to sample the views of respondents. Those who could neither read nor write English were interviewed in the local dialect and information transcribed into English.

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3.4 Questionnaire Administration

Fifty (50) questionnaires were administered to each of the three (3) categories of respondents in the selected community within the Municipality. In all, a total of one hundred and fifty (150) respondents were surveyed.

3.5 Source of Carrot for Laboratory Work

Fresh carrot (Kuroda and Tokita varieties) were harvested from a farm in Bimma, Ashanti-Mampong Municipal area. These were packed into sterilized polythene bags and transported to the KNUST Soil Science Laboratory for mineral and proximate analysis. Vitamin analysis was conducted at the Food and Agricultural Division of Ghana Standards Board, Okponglo, Accra, whilst Shelf-life analysis was carried out at the Micro-Biology Department of KNUST, Kumasi.

3.6 Laboratory Analysis of Carrot Roots

Laboratory analysis were performed on samples of the two varieties of carrot before processing, after processing in to a drink and after a period of storage by following the protocol below;

3.6.1 Proximate Analysis

3.6.1.1 Determination of Moisture Content

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Moisture content was determined using the dry method (Indirect Distillation Method). In this method, the moisture can or crucibles were initially weighed, followed by weighing 5.0g of the samples. The samples were then allowed to dry over night in an air oven at 105°C for 24 hours and then cooled in a desiccator, together with the crucibles, after which the new weight was taken. The results were recorded in triplicate.

The following calculations were employed to arrive at the final percentage moisture of the two different samples;

(A+B) – A = B

(A+B) – (A+C) = B – C = D

% Moisture = D/B x 100

Where A= crucible weight, B = sample weight, C = dry weight, D = moisture weight.

3.6.1.2 Ash Determination

The dry method of ashing in accordance with AOAC (1990), using Gallenkamp Muffle Furnace, England was followed to determine the percentage of ash,.

Ash crucible was removed from the oven, placed in a desiccator to cool and weighed.

2.0g of the samples were placed in a porcelain crucible in triplicate. The samples were then put into the furnace for 4 hours at 550°C. The furnace was allowed to cool below 200°C for 20 minutes, and finally the crucible was placed in a desiccator with stopper top to cool and then weighed.

The following calculations were employed to arrive at the final percentage ash of the samples and results recorded in triplicate.

(A + B) – A = B

(A + C) – A = C

% Ash = C/B x 100 Where A = crucible weight, B = sample weight, C = ash weight.

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3.6.1.3 Ether Extract (Fat) Determination

The percentage fat in the two varieties of carrot were determined using the following; Whatman No. 2 filter paper, Absorbent cotton wool and Soxhlet apparatus.

Procedure:

A piece of paper was folded in such a way to hold the sample, after which a piece of cotton wool was placed at the top to evenly distribute the solvent as it drops on the sample during extraction.

The sample packet was placed in the butt tubes of the Soxhlet extraction apparatus.

Petroleum ether was used to do the extraction with gentle heating for 2 hours without interruption.

The extract was allowed to cool to a temperature of 5°C whilst the extraction flask was dismantled.

The ether was allowed to evaporate on a steam or water bath at a temperature of 90°C until no odour of ether remained.

Dirts or moisture that accumulated outside the flask were carefully removed or wiped and the flask was weighed.

Calculations:

(A + B) – A = B

% ether extract = B/C x 100

Where A = flask weight, B = either extract weight, C = sample weight.

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3.6.1.4 Crude Protein determination

The Macro Kjeldahl procedure which is based on the AOAC (1990) method 984.13 was used. The resultant protein content of the samples was determined in triplicate by analysing the total nitrogen present and converting it to protein with the aid of the conversion factor 6.25. The end result was recorded in percentage (%).

The nitrogen content of the samples was calculated using the following formula.

$$N\ (gkg^{-1}) = \frac{(ml\ HCl - ml\ blank) \times Normality \times 14.01)}{Weight\ of\ sample\ (g) \times 10}$$

3.6.2 Determination of pH

The pH of the drinks was determined using the Electrometric method. 50 ml of each drink was added to 25 ml of distilled water. The suspension was stirred vigorously for 20 minutes and allowed to stand for 30 minutes by which time most of the suspended ions would have settled out from the suspension. A pH meter was calibrated with blanks at pH of 4 and 7 respectively. The electrode of the pH meter was then inserted into the partly settled suspension, whiles the pH value on the pH meter was read and the results recorded in triplicates.

3.6.3 Titratable Acidity

Ten (10) millilitres of each drink was mixed with 100 ml distilled water. The mixture in triplicate was then titrated against 0.1M NaOH using 1% phenolphthalein as indicator. Acidity was calculated as acetic acid.

3.6.4 Determination of Vitamin C

This was determined by using the 2, 6-Dichloroindophenol Titrimetric method (AOAC, 2006) and the results, which was in mg/100g of Vitamin C was recorded in triplicate. The ascorbic acid content of the fruit was calculated as follows:

Ascorbic acid (mg/100g) = (X-B) x (F/E) x (V/Y)

Where:

F = mg ascorbic acid equivalent to 1.0 ml indophenols standard solution

X = Average ml for test solution titration

B = Average ml for test blank titration

E = Volume of sample taken

V = Total Volume of solution

Y = Volume of test solution taken.

3.6.5 Determination of Provitamin A

The HPLC method as described in Pearson's composition and analysis of foods (1987) was used to determine the presence and quantity of provitamin A in the samples and results recorded in milligram (mg) per 100 grammes (g).

3.7 Juice Extraction

Fresh carrot roots were cleaned to ensure that there were no dirt on them and then sliced (0.5 cm) with a clean knife to ensure easy blending. It was then blanched in hot

water at 90°C for 10 minutes (Luh and Woodroof, 1975). Two hundred grams (200 g) of the sliced carrot were slurred in a commercial laboratory blender (Christison Laboratory Blender, California, USA) at a speed of 18,000 rpm for 2 minutes using different volumes of treated water (boiled at 100°C and cooled) ranging from 100 ml to 800 ml. The final acceptable volume of water, which gave a resultant concentration that was acceptable to consumers for both the Kuroda and Tokita were determined after a sensory evaluation test was performed on the different preliminary formulations. The slurry was then filtered using a sterilized cheese cloth to obtain the juice. The juice was boiled for three (3) minutes, allowed to cool, bottled and pasteurised at 62°C for 30 minutes (Aurand *et al.*, 1987). This experiment was performed on both the Kuroda and Tokita varieties of carrot, resulting in eight (8) different formulations each of the two varieties of carrot drink as shown in Tables 3.1 and 3.2.

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Table 3.1: Formulations of Kuroda Carrot Drink

Formula Number	Formulation
K001	200ml of Water : 200g of Carrot
K002	300ml of Water : 200g of Carrot
K003	400ml of Water : 200g of Carrot
K004	500ml of Water : 200g of Carrot
K005	600ml of Water : 200g of Carrot
K006	700ml of Water : 200g of Carrot
K007	800ml of Water : 200g of Carrot
K008	900ml of Water : 200g of Carrot

NB: the Letter ‘K’ represents Kuroda

Table 3.2: Formulations of Tokita Carrot Drink

Formula Number	Formulation
T001	200ml of Water : 200g of Carrot
T002	300ml of Water : 200g of Carrot
T003	400ml of Water : 200g of Carrot
T004	500ml of Water : 200g of Carrot
T005	600ml of Water : 200g of Carrot
T006	700ml of Water : 200g of Carrot
T007	800ml of Water : 200g of Carrot
T008	900ml of Water : 200g of Carrot

NB: the Letter 'T' represents Tokita

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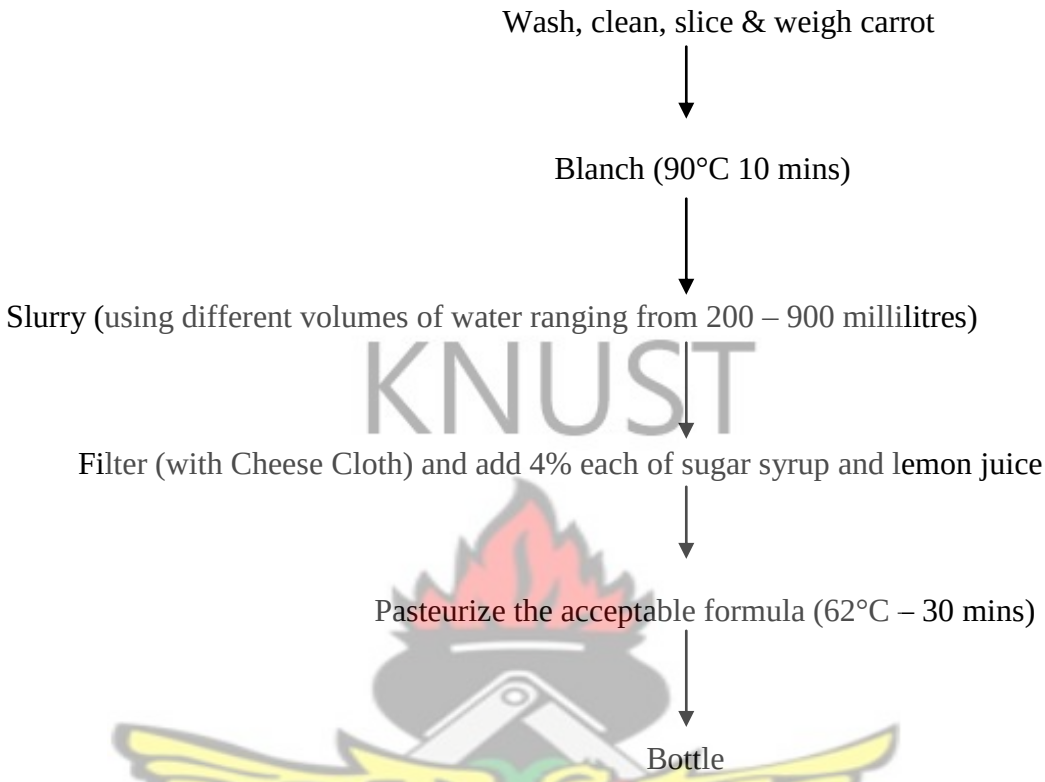
3.7.1 Preparation of Sugar Syrup

50 g of table sugar was dissolved in 500 mls of distilled water and heated at a temperature of 90°C to speed up dissolution. The syrup was then allowed to cool, after which 20 mls (4%) of the total volume of syrup was added to each of the eight (8) formulations of drink from the two varieties of carrot, and stirred to ensure a uniform mixture.

3.7.2 Extraction of Lemon Juice

Mechanical fruit juice extractor was used to extract lemon juice from lemon fruits purchased at Bimma market, to be used as a natural preservative and flavouring agent. The juice was sieved with a cheese cloth to remove all impurities, after which 4% of the total volume of the juice was added to both drinks and stirred to ensure a uniform mixture.

Flow Chart of the Processing of Carrot Drink



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3.8 Sensory Evaluation

As much as the objective was to develop a consumer acceptable carrot based drink, the practical realities of an agreeable taste and flavour, demanded the inclusion of other ingredients to serve those functions. Therefore, an appropriate sweetener, (4% by volume of sugar syrup solution) and an appropriate flavour cum preservative (4% by volume of lemon juice) were used in all the eight (8) formulation of the two (2) varieties of carrot drink. The formulations were then subjected to panelist assessment. Untrained consumers (n = 56) were randomly recruited from among the staff and students of St. Joseph Seminary Senior High School, Mampong-Ashanti to judge and select an acceptable drink from eight (8) different formulations each of the Kuroda and Tokita varieties of carrot drink. The criteria employed for the selection of the

panelist were that (a) they will be available and willing to participate in the panel test, (b) they are regular consumers of carrot and other juices and (c) they are of sound health. A balance incomplete block designed (t=8, k=4, r=7, b=14, λ=3) (Appendix G) described by Cochran and Cox, (1957) was used to assign the eight (8) formulations to the fifty-six (56) panelist such that each panelist evaluated only four (4) products without fatigue. The sensory attributes considered for the evaluation were colour, taste, flavour, aftertaste and overall acceptance. Panelist assessed and assigned scores to the attributes using the 9 – point Hedonic scale, where one (1) represented dislike extremely and 9 represented like extremely (Appendix E). Unsalted crackers and water were provided to panelist for rinsing of their mouth between formulations. Mean values of the responses were analyzed using ANOVA and Correlation analysis.

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3.9 Shelf-life Study

Samples of the acceptable Kuroda and Tokita carrot drinks were each stored in a refrigerator and on a shelf (under normal room temperature) respectively for one (1) week at the Micro-Biology Department of The Kwame Nkrumah University of Science and Technology (KNUST), after which they were tested for microbial load, pH, TTA and Vitamin C.

3.10 Experimental Design and Statistical Analysis

Data from the survey were analyzed for frequencies, percentages and Pearson's Chi-square test of association using SPSS 11.5. The mean values obtained from the proximate, vitamins and mineral analysis of the two varieties of fresh and processed carrots were also separated and compared using the t-test of the student edition of statistix 9.0. A balance Incomplete Block Design (BIBD) was also used (Cochran and

Cox, 1957) to assign the eight (8) formulations to four (4) sets of 14 untrained panelists (56 untrained panelist). Data for each sensory attribute was analyzed using ANOVA. Analyses were also carried out to correlate overall acceptance with the other sensory attributes to assess the relationship between them.

Finally, data from shelf-life study was also analysed using the student edition of statistix 9.0.

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CHAPTER 4

4.0 RESULTS

4.1 Survey on Preharvest and Postharvest Practices and Consumption pattern of Drink

4.1.1 Bio-data of Respondents

Fifty (50) each of respondents, namely producers, sellers, and consumers of carrot were sampled. Table 4.1 indicates the ages, educational background and gender of the respondents sampled from Bimma in the Ashanti Mampong Municipality where the research was conducted. From the Table, data for producers below 20 years of age was zero (0) and consumers below 20 years of age were 4% and 20% respectively. Age group 31 – 40 years recorded the highest percentage of producers 50% whilst 4%, 6% and 14% of producers, sellers and consumers respectively were above 50 years. The number of males who were into carrot production was four (4) times higher than the females. That was 40 males, representing 80% of the total number of carrot producers and 10 females representing 20% of the total number of producers. In the same way, 48 sellers representing 96% were females whilst 2 sellers representing 4% were males. For the general consumer populace, gender was balanced, such that 50% each of males and females were recorded. The frequency distribution based on educational background of the three (3) categories of respondents showed that only five (5) of them, made up of four (4) producers and one (1) seller had no formal education. There were no consumers without formal education. The rest, totalling one hundred and forty-five (145) had some level of primary, JHS, Secondary and Tertiary education as shown in Table 4.1. The percentage distribution based on family life was skewed. Thirty percent (30%) of producers were single whilst 70% were married. Thirty-two percent (32%) of the sellers were single whilst 68% were married. Also,

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sixty percent (60%) of consumers were single whilst (40%) were married as shown in Table 4.1.

Table 4.1: Demography of Respondents

BIO-DATA	PRODUCERS		SELLERS		CONSUMERS	
	Freq.	%	Freq.	%	Freq.	%
AGE						
Below 20	0	0	2	4	10	20
21 – 30	18	36	18	36	13	26
31 – 40	25	50	15	30	11	22
41 – 50	5	10	9	18	9	18
50 and above	2	4	6	12	7	14
Total	50	100	50	100	50	100
GENDER						
Male	40	80	2	4	25	50
Female	10	20	48	96	25	50
Total	50	100	50	100	50	100
EDUCATIONAL BACKGROUND						
Primary / JHS	35	70	41	82	27	54
SHS / Tech / Voc	10	20	8	16	15	30
Tertiary	1	2	0	0	8	16
No Formal Education	4	8	1	2	0	0
Total	50	100	50	100	50	100
Marital Status						
Single	15	30	16	32	30	60
Married	35	70	34	68	20	40
Total	100	50	100	50	50	100

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4.1.2 Variety of Carrot Cultivated by Producers in the Study Area

Fifty percent (50%) of farmers responded that they cultivated Kuroda, 32% responded they cultivated Tokita, whilst 13% cultivated both varieties as shown in Figure 1.

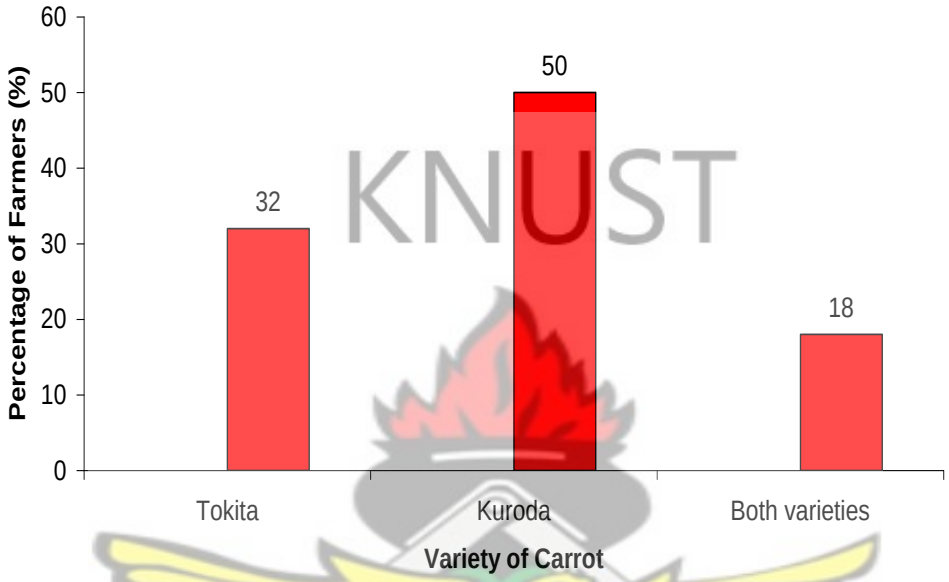

Figure 1: Variety of Carrot Cultivated

4.1.3 Yield of Carrot Harvested per Acre

Ten percent (10%) of the producers (farmers) harvested below 20 bags whilst 60% and 30% respectively, harvested between 21 – 30 bags and 31 bags and beyond as shown in Figure 2.

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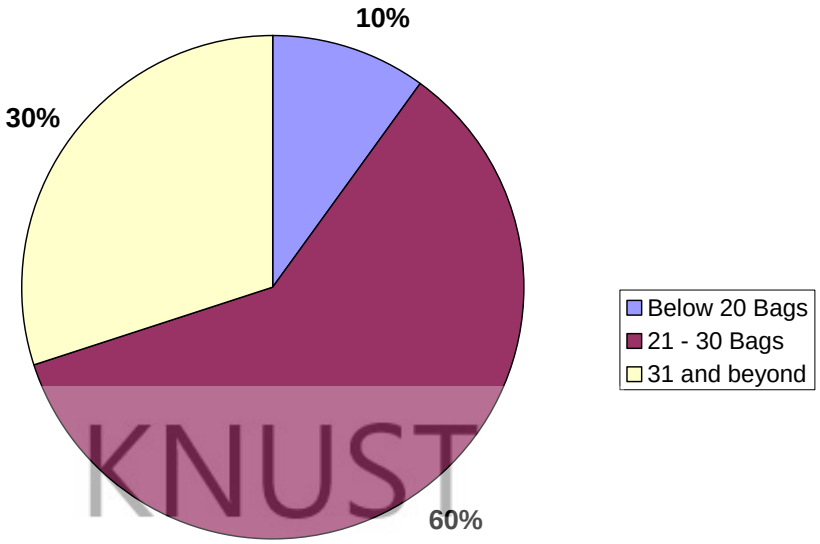

Figure 2: Bags of Carrot Harvested Per Acre

4.1.4 Treatment Given to Carrots Left Unpurchased

Seventy percent (70%) and 58% of producers and sellers respectively, had no option than to sell their carrot left unpurchased after some period of time at a cheaper price. Thirty percent (30%) and 42% of both producers and sellers respectively, decided to keep their unpurchased carrot in a storage facility for sale in the future as (Table 4.2.)

Table 4.2: Treatment Given to Carrots Left Unpurchased

Treatment	Producers		Sellers	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Kept in storage facility	15	30	21	42
Sold at cheaper price	35	70	29	58
Total	**50**	**100**	**50**	**100**

4.1.5 Consumption of Carrot by Producers and Sellers

Analysis of the data on carrot consumption using Chi-Square test (χ^2) at a probability level of ($p \leq 0.05$), indicated that, there was a significant difference between producers and sellers and their likeness and dislikeness of carrot (Appendix E). Forty-six (46), representing 92% and forty-eight (48), representing 96% of the total number of carrot producers and sellers respectively, expressed their interest in the consumption of carrot whilst four (4) representing 8% and two (2) representing 4% expressed their dislike for carrot as shown in Table 4.3.

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Table 4.3: Consumption of Carrot by the Producers and Sellers of Carrot

	Producers		Sellers	
Response	Frequency	Percentage (%)	Frequency	Percentage (%)
Yes	46	92	48	96
No	4	8	2	4
Total	**50**	**100**	**50**	**100**

4.1.6 Consumption Pattern of Drink in the Study Area

Responses given by the stakeholders indicated that alcoholic drinks were the least favourite drink consumed. 20%, 14% and 10% consumption of alcoholic drinks were recorded for producers, sellers and the general carrot consuming populace, respectively. Fruit and vegetable juices were the most favourite drink consumed by the stakeholders, followed by carbonated drinks and energy drinks as shown in figure 3.

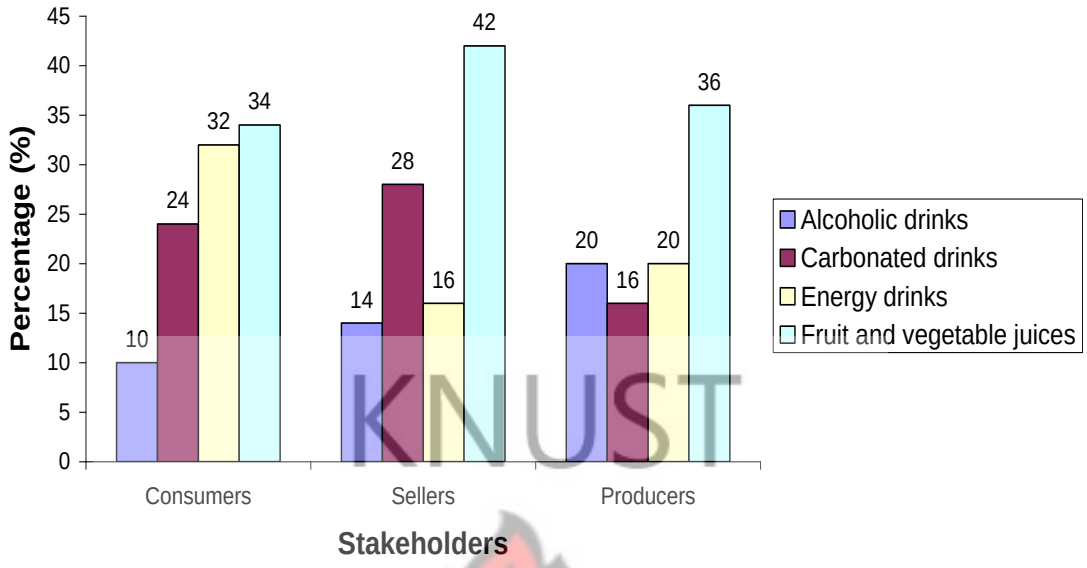

Figure 3: Consumption Pattern of Drink

4.1.7 Preference of Carrot Drink by the Stakeholders

There were significant differences ($p \leq 0.05$) among the producers, sellers and consumers, and their preference of carrot drink as shown in Appendix E. Eighty percent (80%) of regular carrot consumers, 78% and 70% of producers and sellers, respectively, who expressed their interest in carrot consumption were willing to try the new product (carrot drink), whilst 20%, 22% and 30% of consumers, producers and sellers were not ready to consume the new product (carrot drink) as showed in Figure 4.

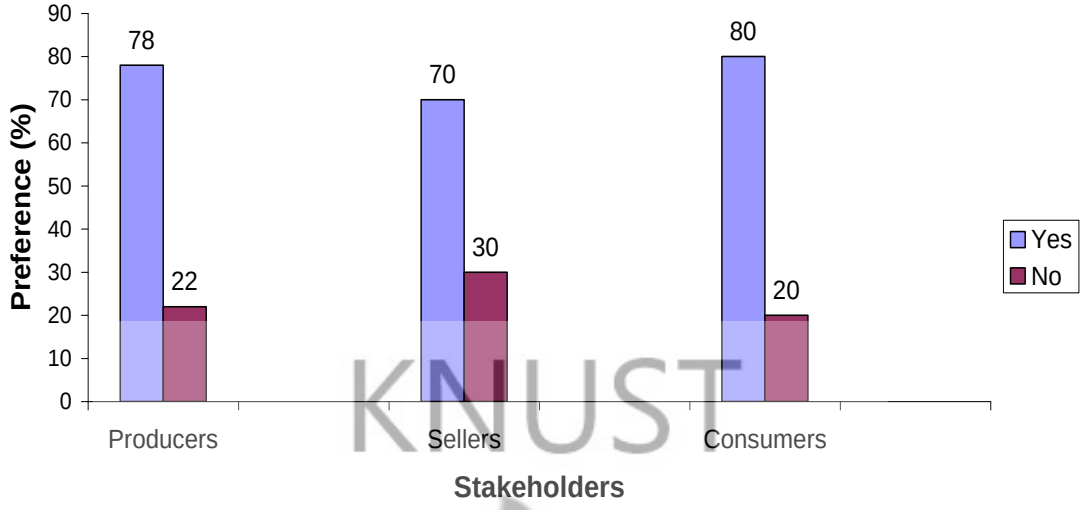

Figure 4: Preference of Carrot Drink by the Stakeholders

4.2.0 Sensory Analysis

4.2.1 Screening for Acceptable Carrot Drink

Analysis of the sensory data from the screening indicated that there were some significant differences ($p \leq 0.05$) within the parameters under consideration (i.e. colour, taste, flavour, aftertaste and overall acceptability) for the eight (8) different formulations of the two (2) varieties of Kuroda and Tokita carrot drinks as shown in Tables 4.3 and 4.4, respectively.

Table 4.4: Mean score values of eight (8) formulations of Kuroda carrot drink

Formula	Colour	Flavour	Taste	Aftertaste	Overall acceptance
K001	7.50a	7.68a	5.39de	5.86c	3.75d
K002	6.63b	7.07b	5.98c	5.82c	4.50c
K003	6.16bc	6.11c	6.77b	6.48b	5.34b
K004	5.75c	5.77cd	7.73a	7.45a	6.61a
K005	4.86d	5.50d	5.93cd	5.45c	4.86bc
K006	4.05e	4.68e	5.02e	4.13d	3.66d
K007	3.21f	4.11f	4.16f	3.66e	2.82e
K008	2.34g	3.36g	3.50g	3.05f	2.14f
Hsd	**0.541**	**0.425**	**0.560**	**0.437**	**0.520**

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Table 4.5: Mean score values of eight (8) formulations of Tokita carrot drink

Formula	Colour	Flavour	Taste	Aftertaste	Overall acceptance
T001	7.88a	7.68a	5.52c	5.79cd	3.93de
T002	7.11b	6.84b	6.16b	5.75d	4.43cd
T003	6.55c	5.95c	7.48a	7.63a	6.50a
T004	5.70d	5.32d	6.30b	6.66b	5.25b
T005	4.46e	4.61e	5.88bc	6.20c	4.79bc
T006	3.71f	3.64f	4.91d	5.04e	3.79e
T007	2.86g	3.07g	4.09e	4.30f	2.89f
T008	2.43g	2.11h	3.23f	3.50g	2.32g
Hsd	**0.478**	**0.493**	**0.538**	**0.428**	**0.540**

4.2.2 Colour

The mean score data for the various formulations showed that in both the Kuroda and Tokita drinks, product numbers K001 and T001 were more highly scored for colour. That is, 7.50 and 7.88 respectively. In the Kuroda drink, there were no significant differences between formulations K002 and K003, and then K003 and K004 as shown in table 4.4. Meanwhile, colour stood independent through out all the formulations in the Tokita drink as shown in Table 4.5.

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4.2.3 Taste

In the Kuroda drink, taste was rated by the panelist from "like very much" to "dislike slightly". That was from 7.73 in formulation K004, down to 3.50 in formulation K008 as shown in Table 4.4. Meanwhile, there were no significant differences between formulation K001 and K002, K001 and K006 and between K002 and K005. The Tokita drink, on the other hand was rated by the panelist from "like very much", that is 7.48 in formulation T003 to "dislike moderately". That was 3.23 in formulation T008 as shown in Table 4.5. Meanwhile, there were no significant differences between T002, T004 and T005, and then T001 and T005.

4.2.4 Flavour

The mean score values in Tables 4.4 and 4.5 indicated that products K001 and T001 were rated as having the best acceptable flavour in both varieties. That is 7.68 for both varieties of drinks. Meanwhile, for the different formulations of Kuroda drink, there were no significant difference between formulas K003 and K004 on one hand and K004 and K005 on the other hand in terms of flavour. The mean scored values for

flavour in the Tokita drinks, also indicated that there were significant differences in all the eight (8) formulations.

4.2.5 Aftertaste

In the Kuroda drink, aftertaste was rated by the panelist from "like very much" to "dislike slightly". That is from 7.45 in formulation K004, down to 3.05 in formulation K008 as shown in Table 4.4. Meanwhile, there were no significant differences between formulas K001 and K002 as shown in Table 4.4. Meanwhile among the Tokita formulation, aftertaste was rated from 7.63 in formula T003 down to 3.50 in formula T008. There were no significant differences between formulations T001 and T002 as shown in Table 4.5.

4.2.6 Overall acceptance

The Kuroda drink, composed of 200g of carrot and 500mls of water and coded as K004 was most accepted by the panel of consumers, with a mean score value of 7.0 approximately, indicating "liked moderately". There were no significant differences between formulas K001 and K006, K003 and K005 and also K002 and K005 as shown in Table 4.4. On the other hand, formula number T003 of the Tokita drink, composed of 200g of carrot and 400mls of water was also the most accepted drink by the consumers with a mean score value of 7.0 approximately, indicating "liked moderately". Analysis of the data indicated that there were no significant differences between formulas T001 and T002 on one hand and T004 and T005 on the other hand as shown in Table 4.5.

Figure 5: Consumer acceptable drinks

4.3 Correlation Analysis

Table 4.5.1: Correlation Analysis of Kuroda Carrot Drink

Correlation	Correlation Co-efficient (r)
Colour verses Flavour	+0.990**
Colour verses Taste	+0.694*
Colour verses Overall Acceptance	+0.613*
Flavour verses Overall Acceptance	+0.523*
Taste verses Overall Acceptance	+0.992**
Aftertaste verses Overall Acceptance	+0.939**

* Significant difference ($p \leq 0.05$) ** No significant difference ($p \leq 0.05$)

Table 4.5.2: Correlation Analysis of Tokita Carrot Drink

Correlation	Correlation Co-efficient (r)
Colour verses Flavour	+0.992**
Colour verses Taste	+0.763**
Colour verses Overall Acceptance	+0.615*
Flavour verses Overall Acceptance	+0.581*
Taste verses Overall Acceptance	+0.974**
Aftertaste verses Overall Acceptance	+0.939**

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* Significant difference ($p \leq 0.05$) ** No significant difference ($p \leq 0.05$)

There was a highly positive correlation (+0.990) between colour and flavour in both varieties of carrot drink, when their mean values were correlated. Also, in carrot drinks of varieties, taste and aftertaste highly correlated positively with overall acceptance i.e. (+0.992) and (+0.939) respectively for Kuroda carrot drink and (+0.974) and (+0.939) respectively for Tokita carrot drink as shown in Tables 4.5.1 and 4.5.2.

4.4 Chemical Analysis of the Root of Kuroda and Tokita Carrot

4.4.1 Proximate Analysis

Analysis of the mean values of the triplicate results obtained from the proximate analysis of the Kuroda and Tokita varieties of carrot using the student t-test, gave a significant different relationship ($p \leq 0.05$) between Protein, Carbohydrate and Ash content of the two varieties of carrot. Kuroda recorded 36.55% of protein whilst Tokita recorded 40.78%. Kuroda recorded 76.20% of carbohydrate whilst Tokita recorded 74.88%. Finally, Kuroda recorded 10.63% of ash whilst Tokita recorded

9.34%. Meanwhile, there were no significant differences between the fat and moisture contents of the two varieties of carrot. Moisture was 12.36% and 11.83% respectively in both Kuroda and Tokita whilst fat recorded 2.00% and 3.17% respectively in both Kuroda and Tokita varieties of carrot as shown in Table 4.6.

Table 4.6: Proximate Analysis of the Root of Kuroda and Tokita Carrot.

Parameter (%)	Variety			
	Kuroda	Tokita	Lsd	Cv
Moisture Content	12.36	11.83	0.554	1.22
Protein Content	36.55	40.78	2.502	1.72
Fat	2.00	3.17	1.535	15.80
Carbohydrate	76.20	74.88	0.963	0.34
Ash	10.63	9.34	0.709	1.89

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4.4.2 Vitamin and Mineral Analysis of the Root of Kuroda and Tokita Carrot

The mean values obtained from the vitamin and mineral analysis of the unprocessed Kuroda and Tokita varieties of carrot, using student t-test, showed a significant different relationship ($p \leq 0.05$) between vitamin A, calcium, phosphorus and potassium as indicated in Table 4.7. Meanwhile, there was no significant difference between the Kuroda and Tokita carrot varieties in terms of their vitamin C content.

Table 4.7: Vitamin and Mineral Analysis of Kuroda and Tokita Carrot Roots

Parameter	Variety			
	Kuroda	Tokita	Lsd	Cv
Vitamin C (mg/100g)	6.78	7.49	1.489	5.55
Vitamin A (Mg/100g)	12.50	10.84	0.087	0.20
Calcium (%)	2.11	2.98	0.022	0.23
Potassium (%)	5.08	6.13	0.022	0.10
Phosphorus (%)	3.11	3.22	0.031	0.26

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4.5 Chemical Analysis of Kuroda and Tokita Varieties of Carrot Drink.

4.5.1 Proximate Analysis

Statistical analysis of the mean values of the results obtained from the proximate analysis, of the drinks of Kuroda and Tokita varieties of carrot gave a significantly different relationship ($p \leq 0.05$) in all the parameters under consideration that is moisture, protein, fat, carbohydrate and ash contents. Kuroda recorded 92.56% of moisture whilst Tokita recorded 94.94%. Kuroda recorded 11.17% of protein whilst Tokita recorded 12.63%. Kuroda recorded 1.00% of fat whilst Tokita recorded 2.02%. Kuroda recorded 60.35% of carbohydrate whilst tokita recorded 54.91%. Finally, Kuroda also recorded 2.11% of ash whilst Tokita recorded 3.01% as shown in Table 4.8.

Table 4.8: Proximate Analysis of Kuroda and Tokita Carrot drinks.

Parameter (%)	Variety			
	Kuroda	Tokita	Lsd	Cv
Moisture Content	96.52	94.94	0.949	0.26
Protein Content	11.17	12.63	0.294	0.66
Fat	1.00	2.02	0.852	15.01
Carbohydrate	60.35	54.91	0.774	0.36
Ash	2.11	3.01	0.414	4.31

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4.5.2 Vitamin and Mineral Analysis of Kuroda and Tokita Carrot Drinks

Statistical analysis of the mean values obtained from vitamins A and C indicated a significantly different relationship ($p \leq 0.05$) between drinks of the two varieties of carrot. Kuroda recorded 4.21mg/100g and 11.97mg/100g of vitamin C and vitamin A respectively whilst Tokita also recorded 5.52 mg/100g and 10.04 mg/100g of vitamin C and vitamin A respectively as shown in Table 4.8.

Mineral analysis of calcium, potassium and phosphorus also gave a significantly different relationship ($p \leq 0.05$) when the mean values were analysed statistically using student t-test. Kuroda recorded 0.22% of calcium whilst Tokita recorded 0.11%. Tokita recorded 4.03% of potassium whilst Kuroda recorded 3.02%.

Kuroda recorded 0.07% of phosphorus whilst Tokita recorded 1.01% as shown in Table 4.9.

Table 4.9: Vitamin and Mineral Analysis of Kuroda and Tokita Carrot Drink

Parameter	Variety			
	Kuroda	Tokita	Lsd	Cv
Vitamin C (mg/100g)	4.21	5.52	0.476	2.60
Vitamin A (mg/100g)	11.97	10.04	0.217	0.52
Calcium (%)	0.22	0.11	0.069	11.07
Potassium (%)	3.02	4.03	0.041	0.31
Phosphorus (%)	0.07	1.01	0.015	0.76

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4.6 Shelf-Life Analysis of Kuroda and Tokita Carrot Drinks

The final composite drinks were both pasteurized (62°C for 30 mins), bottled and closely monitored under two (2) different storage conditions; that is, refrigerator (5°C) and room temperature (26°C) to determine the shelf-life for seven (7) days. The following parameters were monitored during the period under consideration; ascorbic acid, Titratable Acidity (TTA), pH, alcohol and microbial content.

4.6.1 Effect of Different Storage Conditions on pH of Kuroda and Tokita Carrot drinks.

Statistical analysis of the mean values obtained from the pH of the two (2) acceptable drinks of Kuroda and Tokita varieties of carrot gave a significant different relationship ($p \leq 0.05$) after being stored for seven (7) days in a refrigerator at a temperature of 5°C. That is, 4.17 and 4.67 for Kuroda and Tokita drinks, respectively, meanwhile, Kuroda recorded a pH of 4.11 whilst Tokita recorded 4.06 after being

stored at a room temperature of 26°C for seven (7) days, indicating no significantly different relationship as shown in Tables 4.10 and 4.11.

Table 4.10: Effect of Refrigerator Storage on Kuroda and Tokita Carrot Drinks.

Parameter	Variety			
	Kuroda	Tokita	Lsd	Cv
pH	4.17	4.67	0.089	0.54
TTA	0.26	0.22	0.057	6.45
Vitamin C	6.33	7.01	0.089	0.36

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Table 4.11: Effect of Room Temperature Storage on Kuroda and Tokita Carrot Drinks.

Parameter	Variety			
	Kuroda	Tokita	Lsd	Cv
pH	4.11	4.06	0.078	0.51
TTA	0.33	0.20	0.078	7.86
Vitamin C	5.00	6.60	0.969	4.45

4.6.2 Effect of Different Storage Conditions on Titratable Acidity of Kuroda and Tokita Carrot Drinks

There were no significant differences ($p \leq 0.05$) between both Kuroda and Tokita carrot drinks, that is 0.26 in Kuroda and 0.22 in Tokita when analysed for Titratable Acidity (TTA) after a storage period of seven (7) days in a refrigerator.

Meanwhile, Kuroda recorded 0.33 and Tokita 0.20 after being stored at a room temperature of 26°C for seven (7) days, indicating a significantly different relationship at $p \leq 0.05$ as shown in Tables 4.10 and 4.11.

4.6.3 Effect of Different Storage Conditions on Vitamin C

Statistical analysis of the mean values of vitamin C gave a significant different relationship between the Kuroda and Tokita varieties of carrot drink, after a storage period of seven (7) days under both refrigerator and room temperature storage. Kuroda recorded 6.33mg/100g and 5.00mg/100g for both the refrigerator and ambient storage conditions, respectively, whilst Tokita also recorded 7.01mg/100g and 6.60mg/100g for the same conditions, respectively as shown in Tables 4.10 and 4.11.

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4.6.4 Alcohol and Microbial Analysis

Alcohol content after the seventh day was zero (0) for both storage conditions. Microbial growth, in terms of total plate count recorded a value of one (1), total coliforms zero (0), and both *Staphylococcus aureus*, and yeast / mould recorded a value of less than 10 (<10) for both storage conditions as shown in Table 4.12.

Table 4.12: Microbial Analysis of Kuroda and Tokita Carrot Drink

Storage Condition	MICROBIAL ANALYSIS							
	Total Coliforms (10^{-1})		Yeast and Moulds (10^{-1})		*Staphylococcus aureus* (10^{-1})		Total Plate Count	
	Kuroda	Tokita	Kuroda	Tokita	Kuroda	Tokita	Kuroda	Tokita
Refrigerator	0	0	< 10	< 10	< 10	< 10	1	1
Room Temperature	0	0	< 10	< 10	< 10	< 10	1	1

CHAPTER 5

5.0 DISCUSSION

5.1 Preharvest and Postharvest Practices and Consumption Pattern of Drink

5.1.1 Bio-data of Respondents

Carrot sellers below the age of twenty (20) years were 4% whilst data on carrot producers at that same age was zero (0). This could be due to the fact that at that age, most of them were still in School or did not find carrot production a lucrative venture because of the losses incurred by the sellers when carrots were not purchased on time. Meanwhile, 20% of consumers below 20 years consumed carrot, which may be due to its nutritional and health benefits.

The age range of 31 – 40 years recorded the highest percentage of carrot producers, i.e. 50% whilst 30% of carrot sellers were also within this age group. The assumption is that most of them are responsible family heads and bread winners who need to engage in a self employed venture like carrot production to support their families. Twenty-two percent (22%) of the carrot consuming populace were also within this age group and was an indication that carrot was used in most households. Carrot producers above fifty (50) years were only 4% and this could be due to the fact that at that age, most of them were weak and found the production activities (i.e. weeding, making of bed and general cultural practices) very difficult. Meanwhile, carrot consumers above that same age were 14% and this implies that carrot consumption had no age limit.

80%, of carrot producers were males whilst 20% where females. The low percentage of female in carrot production may be attributed to the fact that the females found carrot production very tedious. Meanwhile, selling of carrot was dominated by females in the community. Barker (2006) reported that urban retail marketing and

petty trading are sectors that have long been dominated by women in West Africa and has been the common way for women to earn income.

There was a gender balance in terms of carrot consumption, as 50% each of both male and females consumed carrot. This depicted that carrot is a very nutritious vegetable which is liked by all, irrespective of gender.

Carrot producers who were Primary/Junior High School (JHS) levers were 70%, Senior High School (SHS) /Technical/Vocational school leavers were 20% whilst only 2% had tertiary education. This hierarchy clearly showed that higher education enables people to be employed in other sectors, neglecting the farming sector. The 4% carrot producers with no formal education had no option than to engage themselves with carrot farming which needed little training and exposure. The trend was the same in the sales of carrot, as 82% of the sellers were JHS leavers, 16% were SHS/Technical/Vocational school leavers, 2% had no formal education and none being a tertiary leaver. The responses from the carrot consuming populace revealed that all of them had some level of formal education. Primary/JHS leavers were 54% followed by SHS/Technical/Vocational school 30% and Tertiary leavers being 16%. This implied that the respondents were enlightened and had knowledge about the nutritional and health benefits of carrot.

Seventy percent (70%) of the producers were married whilst 30% were single. In the same way, 68% of sellers were married whilst 32% were single. The higher percentage of producers and sellers being married could be due to the fact that most of them were bread winners and had dependants to cater for and had to depend on carrot production as a means of generating income.

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5.1.2 Variety of Carrot Cultivated by the Producers in the Study Area

Cultivation of Kuroda variety of carrot was dominant in the study area, more than the Tokita variety, as 50% and 32% of both kuroda and tokita cultivations were recorded. This may be due to the fact that Kuroda was more nutritious, as can be seen from the analysis in Tables 4.3 and 4.4 and for that matter, consumers demanded more of it. 13% of the producers decided to balance the supply by going into the production of both varieties.

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5.1.3 Yield of Carrot Per Acre

Ten percent (10%) of carrot producers harvested below 20 bags of carrot whilst 60% and 30% respectively, harvested between 21 – 30 bags, and 31 bags and beyond. The low yield per acre may be due to disease and pest infestation, as well as poor harvesting practices which might have caused damage to most of the roots.

5.1.4 Treatments given to Unpurchased Carrot

Seventy percent (70%) and 58% of producers and sellers respectively, sold their carrots which were not purchased within a stipulated time and at a prevailing market price at a cheaper price because they had no means of storing the unpurchased carrots for future sale, or can not afford to purchase and use refrigerators and other storage facilities. On the other hand, 30% and 42% of both the producers and sellers respectively, found the use of refrigerators a convenient means of storing their unpurchased carrots.

5.1.5 Consumption of Carrot by Producers and Sellers

There was a significant difference in the consumption of carrot by producers and sellers in the study area, as 92% and 96% of producers and sellers respectively, expressed their interest in carrot and for that matter, its consumption, whilst 8% and 4% of producers and sellers of carrot, expressed their dislike for it. The high percentage of producers and sellers who expressed their interest in carrot consumption may have realized its nutritional and health benefits. Those who are into its production and sales, but dislike to consume it might have some medical reasons to support their actions or might be allergic to its consumption.

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5.1.6 Consumption Pattern of Drinks in the Study Area

Responses from the stakeholders indicated that alcoholic drinks were the least favourite drink consumed, as 20%, 14% and 10% were recorded for producers, sellers and the general carrot consuming populace respectively. Fruit and vegetable juices, which recorded 36%, 42% and 34% for producers, sellers and the general consumer populace, were the favourite drinks consumed by the stakeholders, followed by carbonated drinks and energy drinks. This showed that drinking of fruit and vegetable juices was a popular practice among the natives of Bimma in the Ashanti Mampong Municipality.

5.1.7 Preference of Carrot Drink by the Stakeholders

There was no significant difference between the consumers, sellers and producers who expressed their interest in the proposed carrot drink and those who showed their dislike for. This implied that majority of the stakeholders thus; sellers, consumers and producers of carrot were willing to consume the new product (the carrot based drink).

Those who expressed their dislike for the carrot drink may have reasons assigned to their actions. Some may probably be contemplating on the form in which the drink would take and others may also be thinking whether it would be possible to develop drink from carrot.

5.2.0 Sensory Analysis

5.2.1 Colour

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Colour is a sensation that forms part of the sense of vision for judging the appearance of food (Jellinek, 1985). Product numbers K001 and T001 for drinks of both varieties of carrot scored highest. i.e. 200 mls : 200 g of carrot. This may be attributed to the fact that the volume of water used to blend the carrot was less as compared to the amount of carrot and for that matter; consumers were attracted to the deep orange pigment, posed by the carotene in the carrot (Nocolle *et al*., 2003). The different volumes of water, i.e. 300ml, 400ml and 500ml in formulas K002, K003 and K004 respectively of the Kuroda drink, had little impact on colour change to the extent that the panelist were unable to assess the differences. Therefore from Tables 4.4 and 4.5, increased volume of water affected the perception of the panelist choice with regards to colour. The mean values of colour in both varieties, correlated positively with no significant difference between flavour in both types of carrot drinks, i.e. (r) = +0.990 ($P \leq 0.05$) and +0.992 ($P \leq 0.05$) for Kuroda and Tokita drinks respectively. This implied that a unit change in colour will result in a non significant increase in flavour. Meanwhile, there was a significant positive correlation (r) = +0.613 ($P \leq 0.05$) and +0.615 ($P \leq 0.05$) between colour and overall acceptance of both the Kuroda and Tokita drinks, respectively. This indicated a significant increase in the acceptance of a particular formulation of drink, upon a unit change in colour. This affirms the

assertion of Neilsen (1998) that the first impression of the quality and acceptability of a particular food is judged upon its appearance.

5.2.2 Taste

Products K004, T004 and K003, T003 scored the highest mean value for taste whilst product numbers K008 and T008 scored the least mean value for taste in both types of drinks. This may be due to the fact that the carrot to water ratio of products K003, K004, T003 and T004, made up of 200 g of carrot : 500 ml of water and 200g of carrot : 400ml of water in both the Kuroda and Tokita drinks respectively was perfect and stimulated the taste buds on the tongue and throats of the panelist leading to their highest mean scores. On the other hand, product numbers K008 and T008 for both types of Kuroda and Tokita carrot drinks, comprising 200 g of carrot : 900 ml of water was not able to stimulate the panelist in terms of sweetness. There was a non significant positive correlation (r) = +0.992 ($P \leq 0.05$) and (r) = +0.974 ($P \leq 0.05$) between the mean values of taste and overall acceptance for both the Kuroda and Tokita carrot drinks, indicating a non significant increase in the overall acceptance of a drink when there was a unit change in taste.

5.2.3 Flavour

According to Jellinek (1985), flavour included taste and aroma perceived through tasting. In both types of drink, products K001 and T001 scored the highest mean values whilst products K008 and T008 scored the least mean values. Flavour in both drinks decreased with an increase in the volume of water. The mean values of flavour were used to correlate with the mean values of colour and overall acceptance for both types of carrot drink. The result indicated a non significant positive correlation (r) =

+0.990 ($P \leq 0.05$) and (r) = +0.992 ($P \leq 0.05$) between flavour and colour on one hand and flavour and overall acceptance on the other hand within the Kuroda drink. The relationship between flavour and colour, within the Tokita drink gave a non significant positive correlation (r) = +0.992 ($P \leq 0.05$) whilst there was a significant positive correlation (r) = +0.581 ($P \leq 0.05$) between flavour and overall acceptance of the two varieties of carrot drink. The implications here were that, a unit change in flavour resulted in a non significant increase in the perception of colour by the panelist for both Kuroda and Tokita drinks, whilst there was a significant increase in overall acceptance of the two types of carrot drinks, owning to a unit change in flavour.

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5.2.4 Aftertaste

Aftertaste is the dawdling of the sense of taste of a product on the taste bud. There were no significant differences in products K001, K002 and K005 in the Kuroda drink and products T001 and T002 in the Tokita drinks respectively. This may be due to the fact that the different volumes of water for those formulations of Kuroda and Tokita carrot drinks made no impact on the taste buds of the panelists. Meanwhile, product numbers K004, T004 and K003, T003 scored the highest mean which may be attributed to a good carrot to water ratio that lingered the sense of taste of the panelist. The mean values of aftertaste were used to correlate with the mean values of overall acceptance for both types of carrot drink. The result depicted a non significant positive correlation (r) = +0.939 ($P \leq 0.05$), indicating that a unit change in aftertaste, resulted in a non significant increase in overall acceptance of the products by the panelist.

5.2.5 Overall Acceptance

The product with a formulation of 200g of carrot : 500 ml of water among the Kuroda drinks, that is K004 and 200 g of carrot : 400 ml of water among the Tokita drinks, that is T003 were most accepted by the consumers. Meanwhile, there was a highly significant different relationship between overall acceptance and colour on one hand and overall acceptance and flavour on the other hand when their mean values were correlated (r) =+0.613 ($P \leq 0.05$) and +0.523 ($P \leq 0.05$) respectively for the Kuroda drink and (r) =+0.615 ($P \leq 0.05$) and +0.581 ($P \leq 0.05$) for the Tokita drink formulations. This implied that a unit change in colour and flavour resulted in a significant increase in the product's acceptability by the consumers.

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5.3 Proximate Analysis

5.3.1 Moisture Content

The total amount of water extracted from the fresh (unprocessed) carrot root was 12.36% for Kuroda and 11.83% for Tokita (Table: 4.6). This implied that Kuroda carrot root had more water than Tokita. The use of water in slurring the carrots increased the water content to 96.52% in Kuroda drink and 94.94% in the Tokita drink (Table: 4.8). The amount of water extracted from Kuroda was higher in both the fresh and processed (drink) froms.

5.3.2 Protein Content

The amount of protein extracted from the fresh Kuroda and Tokita carrot roots were 36.55% and 40.78% respectively, as compared to the amount in their final compositional drink form which was 11.17% and 12.63% for both Kuroda and Tokita respectively. This reduction after processing into drink may be attributed to the fact

that some proteins are insoluble in water and therefore could not be extracted in the aqueous medium. Aurand and Wood (1987) reported that the colloidal dimensional structure of proteins makes it uneasy to pass through semi permeable membranes.

5.3.3 Fat Content

The percentage of fat extracted from the fresh Kuroda and Tokita carrot roots were 2.00% and 3.17% respectively, indicating that Tokita has a higher amount of fat than Kuroda. The significant different relationship between the Kuroda and the Tokita carrot drinks may be attributed to the fact that, fat is soluble in organic solvents like petroleum ether and therefore since water was used in the extraction process, only 1.00% and 2.02% of it was extracted from the fresh carrot roots as recorded in the final compositional Kuroda and Tokita drinks respectively.

5.3.4 Carbohydrate Content

Carbohydrate content of the two (2) varieties of carrot in their fresh or unprocessed state was 76.20% and 74.88% for Kuroda and Tokita, respectively, indicating a higher amount of carbohydrate in Kuroda than Tokita. However, the following results on carbohydrate content were obtained from the final consumer acceptable drinks. Kuroda 60.35% and tokita 54.91%. The reduction in carbohydrate content after processing into drink in both the Kuroda and Tokita carrot drinks may be attributed to the squeezing of the liquid part of the carrot root from the fibre which left behind some insoluble carbohydrate (Wardlaw and Insel, 1996). Also, it may be due to the wet heat treatment given to the carrots, such as blanching and boiling, which took off some considerable amount of low molecular weight carbohydrate. (Kalt, 2005).

5.3.5 Ash Content

Kuroda carrot roots recorded 10.63% of ash whilst Tokita recorded 9.34% of ash. After processing the carrots into drink, the ash content reduced to 2.11% and 3.01% in both Kuroda and Tokita respectively. This may be attributed to the heat treatment given to the raw carrots during processing in to drink. (Kalt, 2005).

5.4 Vitamin Analysis

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Wardlaw and Insel (1996) stated that adequate amount of fat-soluble vitamins such as vitamin A depended on efficient fat absorption. Kalt (2005) also reported that the effect of heat processing or cooking on the bioavailability of beta-carotene, which is converted in the body as vitamin A is very minimal. This might be the reason why provitamin A did not change much after processing in both varieties.

Though, it was hypothesised that the addition of lemon juice, which is rich in ascorbic acid would have an impact on the vitamin C content of the final drink, Wardlaw and Insel (1996), reported otherwise that water soluble vitamins like vitamin C are easily destroyed by heat, light and exposure to air and cooking. This implies that the extraction medium (i.e. water) for vitamin C strongly reflected in the values recorded. A total of 6.78mg/100g and 4.21mg/100g were recorded in Kuroda for both the fresh and processed forms, respectively, whilst 7.49mg/100g and 5.52mg/100g were recorded in Tokita for both the fresh and processed forms, respectively (Tables: 4.7 and 4.9)

5.5 Mineral Analysis

Analysis for calcium, potassium and phosphorus revealed that there was a general reduction after extraction from the fresh carrot in both varieties of carrot (Tables: 4.7 and 4.9). However, literature made it clear that a good amount of Potassium can be found in carrots of different cultivars (Campden and Chorleywood, 1998). This indicated why potassium recorded 5.08% and 6.13% in both fresh Kuroda and Tokita roots, respectively and 3.02% and 4.03% in both Kuroda and Tokita carrot drinks, respectively.

KNUST

5.6 Shelf-Life Analysis

5.6.1 Effect of Different Storage Conditions on pH and Titratable Acidity

The hydrogen ion concentration of the two drinks stored under ambient temperature was slightly higher than that stored in the refrigerator, even though there was no significant difference between the two drinks when stored under ambient temperature. This could be due to heat induced degradation of some components like protein that might have affected the pH. Such a reaction could not have been caused by microbial activities because there was no microbial growth.

Titratable Acidity (TTA) at the end of storage in a refrigerator was slightly lower than that stored under ambient temperature for both types of carrot drinks. Both Kuroda and Tokita carrot drinks stored at ambient temperature recorded a higher TTA, with a corresponding higher pH. This is a very difficult trend to explain, but the implication could be the buffering effect of the proteins in the drinks.

5.6.2 Effect of Different Storage Conditions on Vitamin C

The rate of vitamin C degradation was lower when the drinks were stored in the refrigerator than at room temperature. The degradation under ambient temperature could be attributed to the heat to which the drinks were exposed. Wardlaw and Insel (1996) reported that water soluble vitamins like vitamin C are easily destroyed by heat, exposure to light, air and cooking.

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5.6.3 Alcohol content

There were no detectable amounts of alcohol in the drinks under any of the storage conditions for the entire shelf life period of seven (7) days. Indeed, the microbial analysis confirmed that there were no growths under any of the storage conditions.

5.6.4 Microbial Analysis

The result for total coliforms, *Staphylococcus aureus*, yeast / mould and total plate count (Table 4.12) indicated that there were few *Staphylococcus aureus* and yeast / mould (<10), no total coliforms, with a total plate count of one (1) in both varieties of drink under the two storage conditions for the seven (7) day storage period.

The suppression of microbial growth could be attributed to the significant increase in the ascorbic acid content after the seven day storage period.

CHAPTER 6

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

Findings from the survey indicated that carrot is a popular vegetable consumed by the people of Ashanti Mampong Municipality. Both Kuroda and Tokita varieties of carrot were cultivated by farmers, but 50% of the farmers cultivated more of the Kuroda than Tokita which recorded 32%. Eighteen percent (18%) of the farmers cultivated both varieties of carrot on their farms. It was also found that 70% of carrot farmers and 58% of carrot sellers, sold their carrots at cheaper prices because of inadequate storage facilities and for that matter, were willing to adopt the idea of processing carrot into drink.

Chemical analysis of the two varieties of carrot root and drink indicated that Tokita contains more protein and fat in the root and drink form whilst Kuroda contains more carbohydrate in both the root and drink form. The findings also indicated that the amount of vitamin C in Tokita was higher in both the root and drink form than that of Kuroda, whilst Kuroda recorded a higher amount of vitamin A than Tokita in both the root and drink form. In terms of minerals, Tokita was found to contain more potassium and phosphorus in both the root and drink form than Kuroda.

Consumers in their choice of carrot drink, considered the Kuroda drink formulated with 200 g of carrot, 500 ml of water and 4% each of sugar syrup and lemon juice than that of Tokita formulated with 200g of carrot, 400ml of water and 4% each of sugar syrup and lemon juice.

The keeping quality of both types of carrot drinks at an ambient temperature of 26°C and a refrigeration of 5°C for seven (7) days performed better. However, almost all

the quality attributes of the two types of carrot based drink under study were preserved after storage in the refrigerator than those stored under ambient temperature. The rate of vitamin C degradation was also slower in the refrigerator than that under ambient temperature.

6.2 Recommendations

Further studies should be carried out on the medicinal properties of both types of carrot drinks.

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More work on shelf life study beyond the seven days should be carried out to ascertain the keeping quality of both Kuroda and Tokita carrot drinks.

Studies on packaging effect on storability should be carried out to determine the type of packaging that can best prevent interaction between the environment and the product.

Other formulations using different amount of carrot and water should be carried out to improve upon the developed drinks.

Finally, further studies should be carried out on the development of carrot drink from other varieties of carrot.

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APPENDICES

A. QUESTIONNAIRE FOR CARROT PRODUCERS

Please tick (/) or write short answers where appropriate

1. Name (optional) ……
2. Residence …….
3. Age ……
4. Sex
   [ ] Male [ ] Female
5. Educational background
   [ ] Primary / JHS [ ] SHS / Vocational / Technical /
   [ ] Degree [ ] No formal Education Other (please specify) ……
6. Marital status
   [ ] Single [ ] Married
7. Variety of Carrot Cultivated
   [ ] Papa (Tokita) [ ] Social (Kuroda) [ ] Both varieties
8. Are you able to meet the demands of your consumers? [ ] yes [ ] no
9. How do you handle excess or unpurchased carrots?
   [ ] kept in a storage facility [ ] Sold at a cheaper price
10. Do you consume some of the carrot yourself? [ ] yes [ ] no
11. If yes, which of the varieties do you consume [ ] Kuroda [ ] Tokita
12. Do you consume beverage or food drink? [ ] yes [ ] no
13. If yes, indicate the form of drink or beverage

Product	Yes (Y) / No (N)
Alcoholic drink	
Carbonated drinks	
Energy drinks	
Fruit and Vegetable drinks	

14. Will you prefer a carrot drink? [ ] yes [ ] no

B. QUESIONNAIRE FOR CARROT SELLERS

Please tick (/) or write short answers where appropriate

1. Name (optional) ……

2. Residence …….

3. Age ……

4. Sex

[ ] Male [ ] Female

5. Educational background

[ ] Primary / JHS [ ] SHS / Vocational / Technical /

[ ] Degree [ ] No formal Education Other (please specify) ……

6. Marital status

[ ] Single [ ] Married

7. Where do you get your carrots to sell?

[ ] own farm [ ] carrot farmers [ ] others (please specify) ……

7. Which of the varieties of carrot do you sell?

[ ] Papa (Tokita) [ ] Social (Kuroda) [ ] both varieties

9. Are you able to meet the demand of your consumers? [ ] yes [ ] no

10. How do you handle or manage your unsold carrots?

[ ] kept in a storage facility [ ] Sold at a cheaper price [ ] left to rot

11. What value do you add to your carrot before selling? ……

12. Any problem / constraints in their sales? [ ] the pricing
[ ] not getting enough to sell [ ] having excess unsold

[ ] any other (specify) ……

13. Do you consume some of the carrot yourself? [ ] yes [ ] no

14. If yes, which of the varieties do you prefer? [ ] kuroda [ ] Tokita [ ] both
15. Do you consume beverage or food drink? [ ] yes [ ] no

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16. If yes, indicate the form of drink or beverage

Product	Yes (Y) / No (N)
Alcoholic drink	
Carbonated drinks	
Energy drinks	
Fruit and Vegetable drinks	

17. Will you prefer a carrot drink? [ ] yes [ ] no

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C. QUESTIONNAIRE FOR CARROT CONSUMERS

Please tick (/) or write short answers where appropriate

1. Name (optional) ……

2. Residence …….

3. Age ……

4. Sex

[ ] Male [ ] Female

5. Educational background

[ ] Primary / JHS [ ] SHS / Vocational / Technical /

[ ] Degree [ ] No formal Education Other (please specify) ……

6. Marital status

[ ] Single [ ] Married

8. Which of the varieties of carrot do you prefer to consume?

[ ] Tokita (Papa) [ ] Kuroda (Social) [ ] both varieties

8. Why do you prefer to consume your choice of carrot? …….....

9. Do you have any problem with storage? [ ] yes [ ] no

10. Do you consume beverage or food drink? [ ] yes [ ] no

11. If yes, indicate the form of drink or beverage

Product	Yes (Y) / No (N)
Alcoholic drink	
Carbonated drinks	
Energy drinks	
Fruit and Vegetable drinks	

12. Will you prefer a carrot drink? [ ] yes [ ] no

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D. CHI-SQUARE ANALYSIS

Parameter	Chi-Square Value
Consumption of Carrot by producers and sellers (of carrot) only	0.177
Preference of carrot drink by the stakeholders (producers, sellers and consumers of carrot)	2.246

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E. SENSORY EVALUATION FORM

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF HORTICULTURE

NAME: ……

PRODUCT BEING TESTED: Carrot Drink

INSTRUCTIONS:

Please, you are provided with different formulated Carrot drinks. You are requested to make independent and fair judgement on the following sensory attributes given below for each coded product. Using the 9-point Hedonic scale with numbers 1, 2, 3…….9 (as shown below); please indicate your preference by matching each attribute with an appropriate score number.

A NINE POINT HEDONIC SCALE

1 – Dislike extremely	4- Dislike slightly	7 - Like moderately
2 – Dislike very much	5 – Neither like nor dislike	8 – Like very much
3 – Dislike moderately	6 – Like slightly	9 – Like extremely

CODE	COLOUR	TASTE	FLAVOUR	AFTER TASTE	OA
……..	……	……	……	……	……
…….	……	……	……	……	……
…….	……	……	……	……	……
……..	……	……	……	……	……
…….	……	……	……	……	……
…….	……	……	……	……	……
……..	……	……	……	……	……
…….	……	……	……	……	……

NB: OA= OVERALL ACCEPTANCE

Any other comment(s) ……...

Thank you for your cooperation

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F. PROTOCOL FOR SENSORY EVALUATION OF EIGHT (8) FORMULATIONS OF CARROT DRINK USING BALANCE INCOMPLETE BLOCK DESIGN

PANELIST	BLOCK	TREATMENT
1	1	1
2	1	3
3	1	7
4	1	8
5	2	1
6	2	2
7	2	4
8	2	8
9	3	2
10	3	3
11	3	5
12	3	8
13	4	3
14	4	4
15	4	6
16	4	8
17	5	4
18	5	5
19	5	7
20	5	8
21	6	1

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NYANSAPƆ WƆ SANE NO BADWENMA

PANELIST	BLOCK	TREATMENT
22	6	5
23	6	6
24	6	8
25	7	2
25	7	6
27	7	7
28	7	8
29	8	1
30	8	2
31	8	3
32	8	6
33	9	1
34	9	2
35	9	5
36	9	7
37	10	1
38	10	3
39	10	4
40	10	5
41	11	1
42	11	4
43	11	6
44	11	7

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PANELIST	BLOCK	TREATMENT
45	12	2
46	12	3
47	12	4
48	12	7
49	13	2
50	13	4
51	13	5
52	13	6
53	14	3
54	14	5
55	14	6
56	14	7

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NB: (t = 14, r = 7, n = 56, k = 4, $\lambda = 3$)

Where t = number of formulations; b = number of panelist for each set

n = total number of panelist (4 sets); r =testing frequency of a formulation in each set

k = number of formulations tested by each panelist

λ = maximum number of panelist testing the same formulation

G. Analysis of Variance (ANOVA) of Kuroda and Tokita Varieties of Carrot Root using Student Edition of Statistix 9.0

Mineral Analysis:

Calcium

Source	DF	SS	MS	F	P
Varities	1	1.13535	1.13535	34060.5	0.0000
Error	4	0.00013	0.00003		
Total	5	1.13548			

Grand Mean 2.5417 CV 0.23

Observations per Mean 3
Standard Error of a Mean 3.333E-03
Std Error (Diff of 2 Means) 4.714E-03

Phosphorus

Source	DF	SS	MS	F	P
Varities	1	0.01927	0.01927	289	0.0001
Error	4	0.00027	0.00007		
Total	5	0.01953			

Grand Mean 3.1633 CV 0.26

Observations per Mean 3
Standard Error of a Mean 4.714E-03
Std Error (Diff of 2 Means) 6.667E-03

Potassium

Source	DF	SS	MS	F	P
Varities	1	1.67482	1.67482	50245	0.0000
Error	4	0.00013	0.00003		
Total	5	1.67495			

Grand Mean 5.6050 CV 0.10

Observations per Mean 3
Standard Error of a Mean 3.333E-03
Std Error (Diff of 2 Means) 4.714E-03

Vitamin Analysis:

Vitamin A

Source	DF	SS	MS	F	P
Varities	1	4.16667	4.16667	7813	0.0000
Error	4	0.00213	0.00053		
Total	5	4.16880			

Grand Mean 11.670 CV 0.20

Observations per Mean	3
Standard Error of a Mean	0.0133
Std Error (Diff of 2 Means)	0.0189

KNUST

Vitamin C

Source	DF	SS	MS	F	P
Varities	1	0.77042	0.77042	4.90	0.0912
Error	4	0.62833	0.15708		
Total	5	1.39875			

Grand Mean 7.1350 CV 5.55

Observations per Mean	3
Standard Error of a Mean	0.2288
Std Error (Diff of 2 Means)	0.3236

Proximate Analysis:

Ash

Source	DF	SS	MS	F	P
Varities	1	2.49615	2.49615	70.1	0.0011
Error	4	0.14240	0.03560		
Total	5	2.63855			

Grand Mean 9.9850 CV 1.89

Observations per Mean	3
Standard Error of a Mean	0.1089
Std Error (Diff of 2 Means)	0.1541

Carbohydrate

Source	DF	SS	MS	F	P
Varities	1	2.60042	2.60042	39.6	0.0033
Error	4	0.26267	0.06567		
Total	5	2.86308			

Grand Mean 75.542 CV 0.34
Observations per Mean 3
Standard Error of a Mean 0.1479
Std Error (Diff of 2 Means) 0.2092

Fat

Source	DF	SS	MS	F	P
Varities	1	2.04167	2.04167	12.2	0.0249
Error	4	0.66667	0.16667		
Total	5	2.70833			

Grand Mean 2.5833 CV 15.80

Observations per Mean 3
Standard Error of a Mean 0.2357
Std Error (Diff of 2 Means) 0.3333

Moisture

Source	DF	SS	MS	F	P
Varities	1	0.41082	0.41082	18.9	0.0121
Error	4	0.08673	0.02168		
Total	5	0.49755			

Grand Mean 12.095 CV 1.22

Observations per Mean 3
Standard Error of a Mean 0.0850
Std Error (Diff of 2 Means) 0.1202

Protein

Source	DF	SS	MS	F	P
Varieties	1	26.9240	26.9240	60.8	0.0015
Error	4	1.7713	0.4428		
Total	5	28.6953			

Grand Mean 38.665 CV 1.72

Observations per Mean 3
Standard Error of a Mean 0.3842
Std Error (Diff of 2 Means) 0.5433

KNUST

H. Analysis of Variance (ANOVA) of Kuroda and Tokita Varieties of Carrot Drink using Student Edition of Statistix 9.0

Mineral Analysis:

Calcium

Source	DF	SS	MS	F	P
Varities	1	0.02042	0.02042	61.25	0.0014
Error	4	0.00133	0.00033		
Total	5	0.02175			

Grand Mean 0.1650 CV 11.07

Observations per Mean 3
Standard Error of a Mean 0.0105
Std Error (Diff of 2 Means) 0.0149

Phosphorus

Source	DF	SS	MS	F	P
Varities	1	1.31602	1.31602	78961.0	0.0000
Error	4	0.00007	0.00002		
Total	5	1.31608			

Grand Mean 0.5383 CV 0.76

Observations per Mean 3
Standard Error of a Mean 2.357E-03
Std Error (Diff of 2 Means) 3.333E-03

Potassium

Source	DF	SS	MS	F	P
Varities	1	1.52007	1.52007	13029.1	0.0000
Error	4	0.00047	0.00012		
Total	5	1.52053			

Grand Mean 3.5233 CV 0.31

Observations per Mean 3
Standard Error of a Mean 6.236E-03
Std Error (Diff of 2 Means) 8.819E-03

Vitamin Analysis:

Vitamin A

Source	DF	SS	MS	F	P
Varities	1	5.60667	5.60667	1682.00	0.0000
Error	4	0.01333	0.00333		
Total	5	5.62000			

Grand Mean 11.000 CV 0.52

Observations per Mean	3
Standard Error of a Mean	0.0333
Std Error (Diff of 2 Means)	0.0471

KNUST

Vitamin C

Source	DF	SS	MS	F	P
Varities	1	2.60042	2.60042	162.19	0.0002
Error	4	0.06413	0.01603		
Total	5	2.66455			

Grand Mean 4.8650 CV 2.60

Observations per Mean	3
Standard Error of a Mean	0.0731
Std Error (Diff of 2 Means)	0.1034

Proximate Analysis:

Ash

Source	DF	SS	MS	F	P
Varities	1	1.21500	1.21500	100.14	0.0006
Error	4	0.04853	0.01213		
Total	5	1.26353			

Grand Mean 2.5567 CV 4.31

Observations per Mean	3
Standard Error of a Mean	0.0636
Std Error (Diff of 2 Means)	0.0899

Carbohydrate

Source	DF	SS	MS	F	P
Varities	1	44.2817	44.2817	1046.02	0.0000
Error	4	0.1693	0.0423		
Total	5	44.4510			

Grand Mean 57.630 CV 0.36

Observations per Mean	3
Standard Error of a Mean	0.1188
Std Error (Diff of 2 Means)	0.1680

KNUST

Fat

Source	DF	SS	MS	F	P
Varities	1	1.56060	1.56060	30.39	0.0053
Error	4	0.20540	0.05135		
Total	5	1.76600			

Grand Mean 1.5100 CV 15.01

Observations per Mean	3
Standard Error of a Mean	0.1308
Std Error (Diff of 2 Means)	0.1850

Moisture

Source	DF	SS	MS	F	P
Varities	1	3.76042	3.76042	59.06	0.0015
Error	4	0.25467	0.06367		
Total	5	4.01508			

Grand Mean 95.732 CV 0.26

Observations per Mean	3
Standard Error of a Mean	0.1457
Std Error (Diff of 2 Means)	0.2060

Protein

Source	DF	SS	MS	F	P
Varities	1	3.19740	3.19740	524.16	0.0000
Error	4	0.02440	0.00610		
Total	5	3.22180			

Grand Mean 11.900 CV 0.66

Observations per Mean	3
Standard Error of a Mean	0.0451
Std Error (Diff of 2 Means)	0.0638

KNUST

Shelf life Analysis:

Room / Ambient Temperature

TTA

Source	DF	SS	MS	F	P
Varities	1	0.02282	0.02282	52.65	0.0019
Error	4	0.00173	0.00043		
Total	5	0.02455			

Grand Mean 0.2650 CV 7.86

Observations per Mean	3
Standard Error of a Mean	0.0120
Std Error (Diff of 2 Means)	0.0170

Vitamin C

Source	DF	SS	MS	F	P
Varities	1	3.84000	3.84000	57.70	0.0016
Error	4	0.26620	0.06655		
Total	5	4.10620			

Grand Mean 5.8000 CV 4.45

Observations per Mean	3
Standard Error of a Mean	0.1489
Std Error (Diff of 2 Means)	0.2106

pH

Source	DF	SS	MS	F	P
Varities	1	0.00375	0.00375	8.65	0.0423
Error	4	0.00173	0.00043		
Total	5	0.00548			

Grand Mean 4.0817 CV 0.51

Observations per Mean	3
Standard Error of a Mean	0.0120
Std Error (Diff of 2 Means)	0.0170

KNUST

Shelf life Analysis:

Refrigeration Temperature

TTA

Source	DF	SS	MS	F	P
Varieties	1	0.00240	0.00240	10.29	0.0327
Error	4	0.00093	0.00023		
Total	5	0.00333			

Grand Mean 0.2367 CV 6.45

Observations per Mean	3
Standard Error of a Mean	8.819E-03
Std Error (Diff of 2 Means)	0.0125

Vitamin C

Source	DF	SS	MS	F	P
Varieties	1	0.68007	0.68007	1200.12	0.0000
Error	4	0.00227	0.00057		
Total	5	0.68233			

Grand Mean 6.6733 CV 0.36

Observations per Mean	3
Standard Error of a Mean	0.0137
Std Error (Diff of 2 Means)	0.0194

PH

Source	DF	SS	MS	F	P
Varieties	1	0.36507	0.36507	644.24	0.0000
Error	4	0.00227	0.00057		
Total	5	0.36733			

Grand Mean 4.4233 CV 0.54

Observations per Mean	3
Standard Error of a Mean	0.0137
Std Error (Diff of 2 Means)	0.0194

KNUST

I. LSD All-Pair wise Comparisons Test of Kuroda and Tokita carrot Root using Statistix 8.0

Minerals

Calcium

Varieties	Mean	Homogeneous Groups
Kuroda	12.107	A
Tokita	2.9767	B

Alpha 0.01 Standard Error for Comparison 4.714E-03

Critical T Value 4.604 Critical Value for Comparison 0.0217

All 2 means are significantly different from one another.

Phosphorus

Varieties	Mean	Homogeneous Groups
Tokita	3.2200	A
Kuroda	3.1067	B

Alpha 0.01 Standard Error for Comparison 6.667E-03

Critical T Value 4.604 Critical Value for Comparison 0.0307

All 2 means are significantly different from one another.

Potassium

Varieties	Mean	Homogeneous Groups
Tokita	6.1333	A
Kuroda	5.0767	B

Alpha 0.01 Standard Error for Comparison 4.714E-03

Critical T Value 4.604 Critical Value for Comparison 0.0217

All 2 means are significantly different from one another.

KNUST

Vitamins

Vitamin A

Varieties	Mean	Homogeneous Groups
Kuroda	12.503	A
Tokita	10.837	B

Alpha 0.01 Standard Error for Comparison 0.0189

Critical T Value 4.604 Critical Value for Comparison 0.0868

All 2 means are significantly different from one another.

Vitamin C

Varieties	Mean	Homogeneous Groups
Tokita	7.4933	A
Kuroda	6.7767	A

Alpha 0.01 Standard Error for Comparison 0.3236

Critical T Value 4.604 Critical Value for Comparison 1.4899

There are no significant pair wise differences among the means.

Proximate

Ash

Varieties	Mean	Homogeneous Groups
Kuroda	10.630	A
Tokita	9.3400	B

Alpha 0.01 Standard Error for Comparison 0.1541

Critical T Value 4.604 Critical Value for Comparison 0.7093

All 2 means are significantly different from one another.

KNUST

Carbohydrate

Varieties	**Mean**	**Homogeneous Groups**
Kuroda	76.200	A
Tokita	74.883	B

Alpha 0.01 Standard Error for Comparison 0.2092

Critical T Value 4.604 Critical Value for Comparison 0.9633

All 2 means are significantly different from one another.

Fat

Varieties	**Mean**	**Homogeneous Groups**
Tokita	3.1667	A
Kuroda	2.0000	A

Alpha 0.01 Standard Error for Comparison 0.3333

Critical T Value 4.604 Critical Value for Comparison 1.5347

There are no significant pair wise differences among the means.

Moisture

Varieties	**Mean**	**Homogeneous Groups**
Kuroda	12.357	A
Tokita	11.833	A

Alpha 0.01 Standard Error for Comparison 0.1202

Critical T Value 4.604 Critical Value for Comparison 0.5536

There are no significant pair wise differences among the means.

KNUST

Protein

Varieties	**Mean**	**Homogeneous Groups**
Tokita	40.783	A
Kuroda	36.547	B

Alpha 0.01 Standard Error for Comparison 0.5433

Critical T Value 4.604 Critical Value for Comparison 2.5016

All 2 means are significantly different from one another.

KNUST

J. LSD All-Pair wise Comparisons Test of Kuroda and Tokita carrot Drinks using Statistix 8.0

Minerals

Calcium

Varieties	Mean	Homogeneous Groups
Kuroda	0.2233	A
Tokita	0.1067	B

Alpha 0.01 Standard Error for Comparison 0.0149

Critical T Value 4.604 Critical Value for Comparison 0.0686

All 2 means are significantly different from one another.

Phosphorus

Varieties	Mean	Homogeneous Groups
Tokita	1.0067	A
Kuroda	0.0700	B

Alpha 0.01 Standard Error for Comparison 3.333E-03

Critical T Value 4.604 Critical Value for Comparison 0.0153

All 2 means are significantly different from one another.

Potassium

Varieties	Mean	Homogeneous Groups
Tokita	4.0267	A
Kuroda	3.0200	B

Alpha 0.01 Standard Error for Comparison 8.819E-03

Critical T Value 4.604 Critical Value for Comparison 0.0406

All 2 means are significantly different from one another.

KNUST

Vitamins

Vitamin A

Varieties	Mean	Homogeneous Groups
Kuroda	11.967	A
Tokita	10.033	B

Alpha 0.01 Standard Error for Comparison 0.0471

Critical T Value 4.604 Critical Value for Comparison 0.2170

All 2 means are significantly different from one another.

KNUST

Vitamin C

Varieties	Mean	Homogeneous Groups
Tokita	5.5233	A
Kuroda	4.2067	B

Alpha 0.01 Standard Error for Comparison 0.1034

Critical T Value 4.604 Critical Value for Comparison 0.4760

All 2 means are significantly different from one another.

Proximate

Ash

Varieties	Mean	Homogeneous Groups
Tokita	3.0067	A
Kuroda	2.1067	B

Alpha 0.01 Standard Error for Comparison 0.0899

Critical T Value 4.604 Critical Value for Comparison 0.4141

All 2 means are significantly different from one another.

Carbohydrate

Varieties	**Mean**	**Homogeneous Groups**
Kuroda	60.347	A
Tokita	54.913	B

Alpha 0.01 Standard Error for Comparison 0.1680

Critical T Value 4.604 Critical Value for Comparison 0.7735

All 2 means are significantly different from one another.

KNUST

Fat

Varieties	**Mean**	**Homogeneous Groups**
Tokita	2.0200	A
Kuroda	1.0000	B

Alpha 0.01 Standard Error for Comparison 0.1850

Critical T Value 4.604 Critical Value for Comparison 0.8519

All 2 means are significantly different from one another.

Moisture

Varieties	**Mean**	**Homogeneous Groups**
Kuroda	96.523	A
Tokita	94.940	B

Alpha 0.01 Standard Error for Comparison 0.2060

Critical T Value 4.604 Critical Value for Comparison 0.9485

All 2 means are significantly different from one another.

Protein

Varieties	Mean	Homogeneous Groups
Tokita	12.630	A
Kuroda	11.170	B

Alpha 0.01 Standard Error for Comparison 0.0638

Critical T Value 4.604 Critical Value for Comparison 0.2936

All 2 means are significantly different from one another.

KNUST

Shelf life:

Room / Ambient Temperature

TTA

Varieties	Mean	Homogeneous Groups
Kuroda	0.3267	A
Tokita	0.2033	B

Alpha 0.01 Standard Error for Comparison 0.0170

Critical T Value 4.604 Critical Value for Comparison 0.0783

All 2 means are significantly different from one another.

Vitamin C

Varieties	Mean	Homogeneous Groups
Tokita	6.6000	A
Kuroda	5.0000	B

Alpha 0.01 Standard Error for Comparison 0.2106

Critical T Value 4.604 Critical Value for Comparison 0.9698

All 2 means are significantly different from one another.

PH

Varieties	Mean	Homogeneous Groups
Kuroda	4.1067	A
Tokita	4.0567	A

Alpha 0.01 Standard Error for Comparison 0.0170

Critical T Value 4.604 Critical Value for Comparison 0.0783

There are no significant pairwise differences among the means.

KNUST

Shelf life:

Refrigeration Temperature

TTA

Varieties	Mean	Homogeneous Groups
Kuroda	0.2567	A
Tokita	0.2167	A

Alpha 0.01 Standard Error for Comparison 0.0125

Critical T Value 4.604 Critical Value for Comparison 0.0574

There are no significant pairwise differences among the means.

Vitamin C

Varieties	Mean	Homogeneous Groups
Tokita	7.0100	A
Kuroda	6.3367	B

Alpha 0.01 Standard Error for Comparison 0.0194

Critical T Value 4.604 Critical Value for Comparison 0.0895

All 2 means are significantly different from one another.

PH

Varieties	**Mean**	**Homogeneous Groups**
Tokita	4.6700	A
Kuroda	4.1767	B

Alpha 0.01 Standard Error for Comparison 0.0194

Critical T Value 4.604 Critical Value for Comparison 0.0895

All 2 means are significantly different from one another.

KNUST

K. ANALYSIS OF VARIENCE (ANOVA) OF THE SENSORY EVALUATION TEST OF THE EIGHT (8) FORMULATIONS OF KURODA CARROT DRINK USING STUDENTS EDITION OF STATISTIX 9.0

Completely Randomized ANOVA for COLOUR

Source	DF	SS	MS	F	P
CODE	7	1229.39	175.628	265.68	0.0000
Error	440	290.86	0.661		
Total	447	1520.25			

Grand Mean 5.0625 CV 16.06

KNUST

Homogeneity of Variances	F	P
Levene's Test	13.0	0.0000
O'Brien's Test	12.8	0.0000
Brown and Forsythe Test	5.38	0.0000

Welch's Test for Mean Differences

Source	DF	F	P
CODE	7.0	235.78	0.0000
Error	187.4		

Component of variance for between groups 3.12440
Effective cell size 56.0

CODE	Mean
K001	7.5000
K002	6.6250
K003	6.1607
K004	5.7500
K005	4.8571
K006	4.0536
K007	3.2143
K008	2.3393

Observations per Mean 56
Standard Error of a Mean 0.1086
Std Error (Diff of 2 Means) 0.1537

Completely Randomized ANOVA for FLAVOUR

Source	DF	SS	MS	F	P
CODE	7	831.80	118.829	290.96	0.0000
Error	440	179.70	0.408		
Total	447	1011.50			

Grand Mean 5.5335 CV 11.55

Homogeneity of Variances	F	P
Levene's Test	2.83	0.0069
O'Brien's Test	2.77	0.0079
Brown and Forsythe Test	1.30	0.2480

Welch's Test for Mean Differences

Source	DF	F	P
CODE	7.0	331.89	0.0000
Error	188.3		

Component of variance for between groups 2.11465
Effective cell size 56.0

CODE	Mean
K001	7.6786
K002	7.0714
K003	6.1071
K004	5.7679
K005	5.5000
K006	4.6786
K007	4.1071
K008	3.3571

Observations per Mean 56
Standard Error of a Mean 0.0854
Std Error (Diff of 2 Means) 0.1208

KNUST

Completely Randomized ANOVA for TASTE

Source	DF	SS	MS	F	P
CODE	7	728.82	104.117	147.04	0.0000
Error	440	311.55	0.708		
Total	447	1040.37			

Grand Mean 5.5603 CV 15.13

Homogeneity of Variances	F	P
Levene's Test	6.63	0.0000
O'Brien's Test	6.50	0.0000
Brown and Forsythe Test	3.97	0.0003

KNUST

Welch's Test for Mean Differences

Source	DF	F	P
CODE	7.0	122.64	0.0000
Error	187.4		

Component of variance for between groups 1.84659
Effective cell size 56.0

CODE	Mean
K001	5.3929
K002	5.9821
K003	6.7679
K004	7.7321
K005	5.9286
K006	5.0179
K007	4.1607
K008	3.5000

Observations per Mean 56
Standard Error of a Mean 0.1124
Std Error (Diff of 2 Means) 0.1590

Completely Randomized ANOVA for AFTERTASTE

Source	DF	SS	MS	F	P
CODE	7	878.67	125.524	290.31	0.0000
Error	440	190.25	0.432		
Total	447	1068.92			

Grand Mean 5.2366 CV 12.56

Homogeneity of Variances	F	P
Levene's Test	38.9	0.0000
O'Brien's Test	38.2	0.0000
Brown and Forsythe Test	18.5	0.0000

Welch's Test for Mean Differences

Source	DF	F	P
CODE	7.0	492.23	0.0000
Error	187.4		

Component of variance for between groups 2.23378
Effective cell size 56.0

CODE	Mean
K001	5.8571
K002	5.8214
K003	6.4821
K004	7.4464
K005	5.4464
K006	4.1250
K007	3.6607
K008	3.0536

Observations per Mean 56
Standard Error of a Mean 0.0879
Std Error (Diff of 2 Means) 0.1243

KNUST

Completely Randomized ANOVA for OVERALL ACCEPTANCE

Source	DF	SS	MS	F	P
CODE	7	797.38	113.912	186.40	0.0000
Error	440	268.89	0.611		
Total	447	1066.28			

Grand Mean 4.2098 CV 18.57

Homogeneity of Variances	F	P
Levene's Test	18.1	0.0000
O'Brien's Test	17.8	0.0000
Brown and Forsythe Test	9.12	0.0000

Welch's Test for Mean Differences

Source	DF	F	P
CODE	7.0	295.57	0.0000
Error	187.4		

Component of variance for between groups 2.02323
Effective cell size 56.0

CODE	Mean
K001	3.7500
K002	4.5000
K003	5.3393
K004	6.6071
K005	4.8571
K006	3.6607
K007	2.8214
K008	2.1429

Observations per Mean 56
Standard Error of a Mean 0.1045
Std Error (Diff of 2 Means) 0.1477

KNUST

L. ANALYSIS OF VARIENCE (ANOVA) OF THE SENSORY EVALUATION TEST OF THE EIGHT (8) FORMULATIONS OF TOKITA CARROT DRINK USING STUDENTS EDITION OF STATISTIX 9.0

Completely Randomized AOV for COLOUR

Source	DF	SS	MS	F	P
CODE	7	1606.52	229.502	444.68	0.0000
Error	440	227.09	0.516		
Total	447	1833.60			

Grand Mean 5.0871 CV 14.12

KNUST

Homogeneity of Variances	F	P
Levene's Test	1.66	0.1162
O'Brien's Test	1.63	0.1242
Brown and Forsythe Test	0.94	0.4748

Welch's Test for Mean Differences

Source	DF	F	P
CODE	7.0	419.89	0.0000
Error	188.4		

Component of variance for between groups 4.08904
Effective cell size 56.0

CODE	Mean
T001	7.8750
T002	7.1071
T003	6.5536
T004	5.6964
T005	4.4643
T006	3.7143
T007	2.8571
T008	2.4286

Observations per Mean 56
Standard Error of a Mean 0.0960
Std Error (Diff of 2 Means) 0.1358

Completely Randomized AOV for FLAVOUR

Source	DF	SS	MS	F	P
CODE	7	1431.57	204.510	371.67	0.0000
Error	440	242.11	0.550		
Total	447	1673.68			

Grand Mean 4.9018 CV 15.13

Homogeneity of Variances	F	P
Levene's Test	6.60	0.0000
O'Brien's Test	6.48	0.0000
Brown and Forsythe Test	13.4	0.0000

KNUST

Welch's Test for Mean Differences

Source	DF	F	P
CODE	7.0	486.18	0.0000
Error	186.5		

Component of variance for between groups 3.64214
Effective cell size 56.0

CODE	Mean
T001	7.6786
T002	6.8393
T003	5.9464
T004	5.3214
T005	4.6071
T006	3.6429
T007	3.0714
T008	2.1071

Observations per Mean 56
Standard Error of a Mean 0.0991
Std Error (Diff of 2 Means) 0.1402

Completely Randomized ANOVA for TASTE

Source	DF	SS	MS	F	P
CODE	7	706.143	100.878	153.81	0.0000
Error	440	288.571	0.656		
Total	447	994.714			

Grand Mean 5.4464 CV 14.87

Homogeneity of Variances	F	P
Levene's Test	15.6	0.0000
O'Brien's Test	15.3	0.0000
Brown and Forsythe Test	9.63	0.0000

Welch's Test for Mean Differences

Source	DF	F	P
CODE	7.0	201.10	0.0000
Error	187.6		

Component of variance for between groups 1.78967
Effective cell size 56.0

CODE	Mean
T001	5.5179
T002	6.1607
T003	6.3036
T004	7.4821
T005	5.8750
T006	4.9107
T007	4.0893
T008	3.2321

Observations per Mean 56
Standard Error of a Mean 0.1082
Std Error (Diff of 2 Means) 0.1530

KNUST

Completely Randomized AOV for AFTERTASTE

Source	DF	SS	MS	F	P
CODE	7	674.643	96.3776	232.73	0.0000
Error	440	182.214	0.4141		
Total	447	856.857			

Grand Mean 5.6071 CV 11.48

Homogeneity of Variances	**F**	**P**
Levene's Test	7.64	0.0000
O'Brien's Test	7.50	0.0000
Brown and Forsythe Test	6.39	0.0000

Welch's Test for Mean Differences

Source	**DF**	**F**	**P**
CODE	7.0	331.50	0.0000
Error	187.5		

Component of variance for between groups 1.71363
Effective cell size 56.0

CODE	**Mean**
T001	5.7857
T002	5.7500
T003	6.6607
T004	7.6250
T005	6.1964
T006	5.0357
T007	4.3036
T008	3.5000

Observations per Mean 56
Standard Error of a Mean 0.0860
Std Error (Diff of 2 Means) 0.1216

KNUST

Completely Randomized AOV for OVERALL ACCEPTANCE

Source	DF	SS	MS	F	P
CODE	7	686.562	98.0804	148.63	0.0000
Error	440	290.357	0.6599		
Total	447	976.920			

Grand Mean 4.2366 CV 19.17

Homogeneity of Variances	F	P
Levene's Test	22.9	0.0000
O'Brien's Test	22.5	0.0000
Brown and Forsythe Test	9.20	0.0000

Welch's Test for Mean Differences

Source	DF	F	P
CODE	7.0	287.63	0.0000
Error	187.6		

Component of variance for between groups 1.73965
Effective cell size 56.0

CODE	Mean
T001	3.9286
T002	4.4286
T003	5.2500
T004	6.5000
T005	4.7857
T006	3.7857
T007	2.8929
T008	2.3214

Observations per Mean 56
Standard Error of a Mean 0.1086
Std Error (Diff of 2 Means) 0.1535

KNUST

M. **HSD ALL-PAIR WISE COMPARISONS TEST OF EIGHT (8) FORMULATIONS OF KURODA CARROT DRINK USING STUDENT STATISTIX 8.0**

Tukey HSD All-Pairwise Comparisons Test of COLOUR by CODE

CODE	Mean	Homogeneous Groups
K001	7.5000	A
K002	6.6250	B
K003	6.1607	BC
K004	5.7500	C
K005	4.8571	D
K006	4.0536	E
K007	3.2143	F
K008	2.3393	G

Alpha 0.01 Standard Error for Comparison 0.1537
Critical Q Value 4.976 Critical Value for Comparison 0.5406

There are 7 groups (A, B, etc.) in which the means are not significantly different from one another.

Tukey HSD All-Pairwise Comparisons Test of FLAVOUR by CODE

CODE	Mean	Homogeneous Groups
K001	7.6786	A
K002	7.0714	B
K003	6.1071	C
K004	5.7679	CD
K005	5.5000	D
K006	4.6786	E
K007	4.1071	F
K008	3.3571	G

Alpha 0.01 Standard Error for Comparison 0.1208
Critical Q Value 4.976 Critical Value for Comparison 0.4249

There are 7 groups (A, B, etc.) in which the means are not significantly different from one another.

KNUST

Tukey HSD All-Pairwise Comparisons Test of TASTE by CODE

CODE	Mean	Homogeneous Groups
K004	7.7321	A
K003	6.7679	B
K002	5.9821	C
K005	5.9286	CD
K001	5.3929	DE
K006	5.0179	E
K007	4.1607	F
K008	3.5000	G

Alpha 0.01 Standard Error for Comparison 0.1590

Critical Q Value 4.976 Critical Value for Comparison 0.5595

There are 7 groups (A, B, etc.) in which the means are not significantly different from one another.

Tukey HSD All-Pairwise Comparisons Test of AFTERTASTE by CODE

CODE	Mean	Homogeneous Groups
K004	7.4464	A
K003	6.4821	B
K001	5.8571	C
K002	5.8214	C
K005	5.4464	C
K006	4.1250	D
K007	3.6607	E
K008	3.0536	F

Alpha 0.01 Standard Error for Comparison 0.1243

Critical Q Value 4.976 Critical Value for Comparison 0.4372

There are 6 groups (A, B, etc.) in which the means are not significantly different from one another.

KNUST

Tukey HSD All-Pairwise Comparisons Test of OVERALL ACCEPTANCE by CODE

CODE	Mean	Homogeneous Groups
K004	6.6071	A
K003	5.3393	B
K005	4.8571	BC
K002	4.5000	C
K001	3.7500	D
K006	3.6607	D
K007	2.8214	E
K008	2.1429	F

Alpha 0.01 Standard Error for Comparison 0.1477

Critical Q Value 4.976 Critical Value for Comparison 0.5198

There are 6 groups (A, B, etc.) in which the means are not significantly different from one another.

KNUST

N. HSD ALL-PAIR WISE COMPARISONS TEST OF EIGHT (8) FORMULATIONS OF TOKITA CARROT DRINK USING STUDENT STATISTIX 8.0

Tukey HSD All-Pairwise Comparisons Test of COLOUR by CODE

CODE	Mean	Homogeneous Groups
T001	7.8750	A
T002	7.1071	B
T003	6.5536	C
T004	5.6964	D
T005	4.4643	E
T006	3.7143	F
T007	2.8571	G
T008	2.4286	G

Alpha 0.01 Standard Error for Comparison 0.1358

Critical Q Value 4.976 Critical Value for Comparison 0.4777

There are 7 groups (A, B, etc.) in which the means are not significantly different from one another.

Tukey HSD All-Pairwise Comparisons Test of FLAVOUR by CODE

CODE	Mean	Homogeneous Groups
T001	7.6786	A
T002	6.8393	B
T003	5.9464	C
T004	5.3214	D
T005	4.6071	E
T006	3.6429	F
T007	3.0714	G
T008	2.1071	H

Alpha 0.01 Standard Error for Comparison 0.1402

Critical Q Value 4.976 Critical Value for Comparison 0.4932

All 8 means are significantly different from one another.

Tukey HSD All-Pairwise Comparisons Test of TASTE by CODE

CODE	Mean	Homogeneous Groups
T004	7.4821	A
T003	6.3036	B
T002	6.1607	B
T005	5.8750	BC
T001	5.5179	C
T006	4.9107	D
T007	4.0893	E
T008	3.2321	F

Alpha 0.01 Standard Error for Comparison 0.1530

Critical Q Value 4.976 Critical Value for Comparison 0.5384

There are 6 groups (A, B, etc.) in which the means are not significantly different from one another.

Tukey HSD All-Pairwise Comparisons Test of AFTERTASTE by CODE

CODE	Mean	Homogeneous Groups
T004	7.6250	A
T003	6.6607	B
T005	6.1964	C
T001	5.7857	CD
T002	5.7500	D
T006	5.0357	E
T007	4.3036	F
T008	3.5000	G

Alpha 0.01 Standard Error for Comparison 0.1216

Critical Q Value 4.976 Critical Value for Comparison 0.4279

There are 7 groups (A, B, etc.) in which the means are not significantly different from one another.

KNUST

Tukey HSD All-Pairwise Comparisons Test of OA by CODE

CODE	Mean	Homogeneous Groups
T004	6.5000	A
T003	5.2500	B
T005	4.7857	BC
T002	4.4286	CD
T001	3.9286	DE
T006	3.7857	E
T007	2.8929	F
T008	2.3214	G

Alpha 0.01 Standard Error for Comparison 0.1535

KNUST

Critical Q Value 4.976 Critical Value for Comparison 0.5401

There are 7 groups (A, B, etc.) in which the means are not significantly different from one another.

APPENDIX M

PLATE 1: KURODA CARROTS

PLATE 2: TOKITA CARROTS