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

Samuel Yeboah Asiedu[1],
Alexander Kafui Jarh[2i],
Joseph Oscar Azaglo[2],
Lavoe Robert[2]
[1]Department of Horticulture KNUST, Ghana
[2]Akatsi College of Education, Ghana

Abstract:
A survey and laboratory work were carried out during a study conducted within the Ashanti Mampong Municipal area of Ghana to develop an acceptable carrot-based drink from Tokita and Kuroda varieties of carrot. A sample size of one hundred and fifty (150), comprising producers of carrot, sellers of carrot and regular consumers of carrot were used. Respondents were randomly chosen based on consent. 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.

[i] Correspondence: email alexanderjarh8@gmail.com

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1. Introduction

Carrot is a dicotyledonous herbaceous crop grown for its enlarged tap root. It is an important vegetable which is ranked third among the succulent vegetables in the world production. (Yamaguchi, 1983).

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. 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)

2. 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.

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.

2.1 Research Questions

1) Will consumers of carrot prefer an acceptable drink from Tokita and Kuroda varieties of carrot?
2) To what extent will the chemical properties of Tokita and Kuroda varieties of carrot, have on the supposed drink?

2.2 Significance of the Study

This study is intended to add value to the production of carrot and to create employment for the natives of the carrot producing areas in the Ashanti Mampong Municipality, leading to the expansion of carrot production, whiles extending its consumption to boost the hospitality industries in Ghana.

2.3 Limitations of the Study

The research work should have covered the whole Ashanti Mampong Municipality, but owing to financial constraints, it was limited to only one carrot producing community in the Municipality.

Another big challenge was the language barrier between the researcher and the stakeholders involved in terms of data collection. Most of the interviews were conducted in the local dialect and later transcribed into English with the original responses not altered.

3. 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 workplaces in the selected community.

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 were prepared:

A. 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).

B. Questionnaire for Carrot Sellers

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

C. 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 with the original responses not altered in any way.

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;

3.7 Proximate Analysis

A. Determination of Moisture Content

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;

$$(A+B) - A = B$$

$$(A+B) - (A+C) = B - C = D$$

$$\% \text{ Moisture} = D/B \times 100$$

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

B. 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.

$$(A + B) - A = B$$

$$(A + C) - A = C$$

$$\% \text{ Ash} = C/B \times 100$$

Where:
A = crucible weight,
B = sample weight,
C = ash weight.

C. 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:

$$(A + B) - A = B$$

$$\% \text{ ether extract} = B/C \times 100$$

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

D. 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.

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

E. 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.

F. 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.

G. Determination of Vitamin C

This was determined by using the 2, 6-Dichloroindophenol Titrimetric method (AOAC, 1990) 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.

H. 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).

3.8 Juice Extraction

Fresh carrot roots were cleaned to ensure that there was 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.

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.

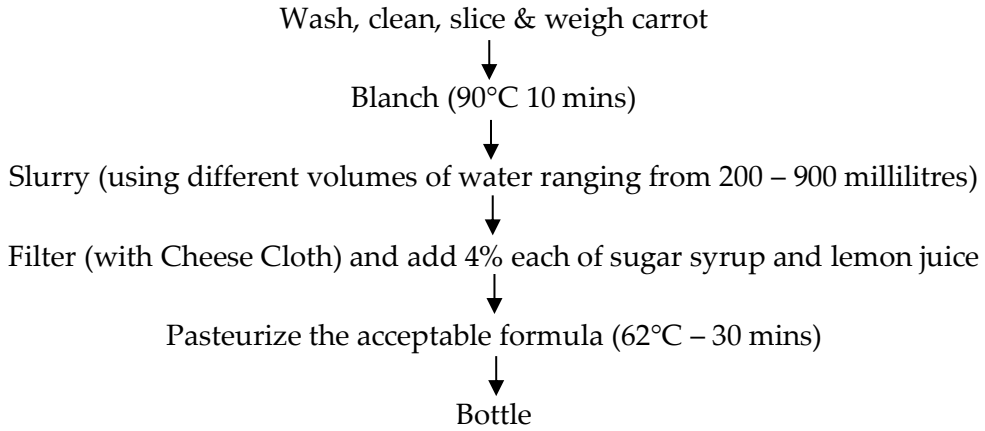
3.9 Preparation of Sugar Syrup

50 g of table sugar was dissolved in 500ml 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.

3.10 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.

Figure 1: Flow Chart of the Processing of Carrot Drink



3.11 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 analysed using ANOVA and Correlation analysis.

3.12 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.

3.13 Experimental Design and Statistical Analysis

Data from the survey were analysed 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 analysed 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.

4. Results and Discussion

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

4.1.1 Biodata 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. 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.

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 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. 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. 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.

For the general consumer populace, gender was balanced, such that 50% each of males and females were recorded. This depicted that carrot is a very nutritious vegetable which is liked by all, irrespective of gender.

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. This hierarchy clearly shows that higher education enables people to be employed in other sectors, neglecting the farming sector.

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, sixty percent (60%) of consumers were single whilst (40%) were married as shown in Table 4.1. The higher percentage of producers and sellers being married could be due to the fact that most of them were bread winners and had dependents to cater for and had to depend on carrot production as a means of generating income.

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

4.2 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.

This is an indication that majority of the stakeholders; thus, sellers, consumers and producers of carrot were willing to consume the new product (the carrot-based drink).

Figure 4: Preference for Carrot Drink by Stakeholders

4.3 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**

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**

4.3.1 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 throughout all the formulations in the Tokita drink as shown in Table 4.5. 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 was 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.

4.3.2 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.

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.

4.3.3 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.

According to Jellinek (1985), flavour included taste and aroma perceived through tasting. 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 as shown in Tables 4.5.1 and 4.5.2. 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.

4.3.4 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. Aftertaste was rated from 7.63 in formula T003 down to 3.50 in formula T008 among the Tokita formulation. There were no significant differences between formulations T001 and T002 as shown in Table 4.5.

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 panellist. The mean values of aftertaste were used to correlate with the mean values of overall acceptance for both types of carrot drink (Tables 4.5.1 and 4.5.2). 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 panellist.

4.3.5 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. 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 as shown in Tables 4.5.1 and 4.5.2. This implied that a unit change in colour and flavour resulted in a significant increase in the product's acceptability by the consumers.

4.4 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**

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

5. Chemical Analysis of the Root of Kuroda And Tokita Carrot

5.1 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
Carbohydrates	76.20	74.88	0.963	0.34
Ash	10.63	9.34	0.709	1.89

The total amount of moisture 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) forms.

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.

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.

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).

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).

5.2 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

	Variety			
Parameter	**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

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)

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.

5.3 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.

5.4 Effect of Different Storage Conditions on Ph and Titratable Acidity of Kuroda and Tokita Carrot Drink

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

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

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

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.

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.

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.

5.5 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.

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.

5.6 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 *Staphylococus 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

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.

6. Conclusion

Findings from the survey indicated that carrot is a popular vegetable consumed by the people of Ashanti Mampong Municipality of Ghana. Both Kuroda and Tokita varieties of carrot were cultivated by farmers

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.

6.1 Recommendations

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

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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