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Quality Evaluation and Sensory Profile of Mixed Fruit Juice from Cabbage and Orange

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ABSTRACT---- ***To know through sensory evaluation the optimum formulation of cabbage (Oxylus variety) juice blended with juices from two cultivars of orange (Valencia late and blood) (nine blends) through Design Expert (8.0.7.1 version) software. Each optimum from each orange variety was selected and with a control (100% late Valencia and blood orange), subjected to physicochemical and nutritional analyses (minerals, β-carotene and vitamin C). The optimum formulation of blend was 80% orange Valencia late and 20% cabbage through the sensory attributes by design expert program. Also, the 74% of blood orange and 26% of cabbage was selected in the case of the blood orange variety. There were significant differences (p< 0.05) in the physico-chemical parameters with the exception of the total ash content. The nutritional (β-carotene and vitamin C) contents of two orange varieties and their optimum were significantly different (p<0.05).Also, mineral composition such as zinc, potassium, magnesium, iron and calcium recorded a significant difference (p<0.05) between the blends and the orange varieties. Sensory analysis has revealed a clear profile for the blended mixed juice.***

Keywords--- Blends, Fruit Juice, Orange, Cabbage, Acceptability

1. INTRODUCTION

Consumer demands for healthy and nutritious food products with a fresh-like appearance have undergone a continuous rise during recent years. The term mixture experiment refers to blending of ingredients together to form a product (Bondari, 2002). Piepel and Cornell (1994) have discussed about the planning of mixture experiments and mixture design. Deka*et al.* (2001) applied mixture methodology for quality evaluation of mixed fruit juice/pulp ready to serve beverages. Chauhan*et al.* (2012) developed a mixed fruit juice by blending coconut water with lemon juice, to obtain a refreshing beverage. Mixture experiments make use of mixture design and mixture regression by taking response variable as the function of the proportion of ingredients in mixture (Cornell, 2002; SAS, 2002-2003). The synergistic effects of the blending components and a highly acceptable product can be known easily using mixture regression (Montgomery and Voth, 1994).

In a health-awareness society, consumption of fresh vegetable juices with less sweetness and lower calorie, like kale, cabbage, lettuce, celery, pepper juices, etc., is springing up (Simsek*et al.*, 2014; Song *et al.*, 2007), but these juices are not widely acceptable due to their unpleasant flavor and taste. Blending with fresh fruit juices becomes a solution for this problem. Juice blending is also one of the best methods to improve the nutritional quality of the juice (Rathod*et al.*, 2014).Fruits and vegetables, when viewed within the context of the total food supply contribute a significant amount of the micro nutrients compared to the macro nutrients; 90% of the dietary vitamin C, more than 50% of the vitamin A and more than 35% of the vitamin B6. The importance of fruit and vegetables in human nutrition is clearly evident (Weatherspoon*et al.*, 2005).Craig and Beck (1999), reveals that fruit and vegetable juice play a significant role in human nutrition, especially as sources of vitamins C, A, thiamine (B_1), niacin (B_3), pyridoxine (B_6), folacin (also known as folic acid or folate) (B_9), E, minerals, and dietary fibre. Their contribution is estimated at 91% of vitamin C, 48% of vitamin A in the U.S. diet. They also supply 16% of magnesium, 19% of iron, and 9% of the calories. Other important nutrients supplied by fruit and vegetable juice include riboflavin (B2), zinc, calcium, potassium, and phosphorus. Beside these, there are antioxidantsand phytochemicals (carotenoids and flavonoids which are all considered phytochemicals).

Ghana recorded a 45.7% loss of all the fruit in 2009 against a 2008 loss figure of 18%. Orange ranked first in post-harvest loss in 2008 and the percentage of 30.6%.Alzamora*et al*.(2000) has reported that about 30-50% of fruits and vegetables harvested in developing countries including Ghana are never consumed due to spoilage during transportation, storage and processing. Post-harvest loss of cabbage and other green leafy vegetable has also reached 20-40 % becauseharvesting, processing or storage techniques are inefficient and therefore resulted in unstable supply (Mrema and Rolle, 2002).Ghanaian juice market is in need to exploit other possible uses of the fruit and vegetable which could arrest the alarming post-harvest research. In Ghana 2015, fruit juices are the most consumed beverage next to water, however approximately 70% of these juice products are imported. According to estimates, 10.4 million litres of fruit juice is consumed yearly. The orange juice is the world most popular fruit juice constituting a major portion of the food industry (TetraPak, 2004)

Cabbage (*Brassica oleracea* L.) is an important vegetable crop and its production is a major economic sideline in Ghana. It is cultivated mostly on the outskirts of urban cities. Also, the cabbage cultivar Oxylus, commonly cultivated in Ghana. Cabbage is a rich source of vitamins and minerals with significant medicinal values (Fahey *et al.*, 2001).Moreover, cabbage juice is rich in fiber which helps prevent diabetes, thus preventing the absorption of sugar in the body. Cabbage juice is rich in protein, vitamins C, B1, B2, B6, β-carotene, potassium and magnesium. Despite the seven days shelf-life of cabbage (Boyer *et al.,* 2009) it has limited used in pastries, stew soup and salad even though cabbage is produced throughout the country all year round (Nyarko and Timbilla, 2004).

Donahue *et al*. (2004) demonstrated that turbidity is highly correlated with colour. It was reported that as the juice colour gets darker, the turbidity increases directly. Carotenoid pigments found in the plastids in the juice cells are said to be responsible for the yellow colour of orange juice (Cortes *et al*., 2008). Karadeniz (2004) reported the citric acid content of orange juices (sweet variety) as 1.338 g/100 ml. Torregosa *et al.* (2006) combined orange juice (high content of vitamin C) and carrot juice that contains high level of carotene. The mixture of orange juice and carrot juice was rich dietetic source of antioxidants. Similarly, a blended beverage of cashew and apple juice and orange aiming to reduce the acidity of the cashew apple juice was reported by Inyang and Abah (1997).
The objective of this study was therefore; to assess the quality and sensory acceptability of a mixed fruit juice produced using blends of cabbage and orange juices.

2. MATERIALS AND METHODS

Sources of materials

The two varieties of the orange (*Citrus aurantium)* namely late Valencia and blood orange and the cabbage (Oxylus variety) and ginger (*Zingiberofficinale*) were procured from a satellite market in Kumasi, Ashanti region, Ghana. The samples were washed to remove dirt, well drained and rinsed in distilled water. They were packed into sterilized low density polyethylene (LDPE) bags and transported for juice extraction at the Natural Renewable Resource Laboratory at the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana.

Preparation of juice sample

Orange and cabbage were washed thoroughly in tap water and washed again with treated water (boiled at 100 ^{O}C and cooled). The oranges were peeled before sliced into pieces (5 cm long) to remove the seeds. The pieces were then blended using a Binatone Blender (Model BLG 401, China). A cheese cloth was used to extract the juice from the pulp to obtain a clear orange juice and kept in refrigerator at 4 °C.Fresh cabbage (Oxylus variety) outer covers were removed before washed thoroughly in tap water and sliced (2 cm thick) with a clean knife. This was steam blanched at 80 ^{O}C ± 2 for 10 min. The 200 g of cabbage and 200 ml of distil water were blended with a blender and filtered using a cheese cloth to obtain the juice. The juice was kept in a refrigerator at 4 °C.Ten grams of ginger rhizomes were thoroughly washed, cleaned, peeled and sliced (0.5 cm) using a sterilized knife. The slices were mixed with water (20 ml) by blender. A clear ginger extract was obtained after sieved with cheese cloth. The clear extract was kept in a refrigerator at 4 °C.A clear ginger extract which was mixed with orange and cabbage juice before pasteurized at 62 ^{O}C for 30 minutes (LTHM,low temperature holdingmethod, holding method) (Aurand*et al.*, 1987) and kept in HDPE packaging material. It was then kept in a refrigerator at a temperature of 4 ^{O}C.

Juice formulation

A plausible lower and upper level for the two component mixture of the juices was chosen deliberately for 50% cabbage maximum for the formulation as shown in Table 1.1.

Table 1.1: Lower and upper limits of the juice formulation

Type of juice	Lower Limit (%)	Upper Limit (%)
Orange	50	100
Cabbage	0	50

Based on the above limits, the Design Expert version 8.0.7.1 was used to generate the various compositions of the juice formulations using mixture study and optimal design type. The compositions were generated as shown in Table 1.2 and ginger and sugar were added as additives for flavour and taste, respectively.

Table 1.2: Formulation ratios of the juice blends

Ingredient	F1	F2	F3	F4	F5	F6	F7	F8	F9
Orange (%)	50	60	73	95	87	80	55	67	100
Cabbage (%)	50	40	27	5	13	20	45	33	0
Ginger (ml)	14	14	14	14	14	14	14	14	14
Sugar (g)	10	10	10	10	10	10	10	10	10

Sensory analysis:

The 15 recruited panelists were selected and it consisted of five males and ten females whose ages ranged from 24 to 45 years. They were grouped into three to generate the sensory attribute to be used in the sensory analyses. General procedures for developing definitions and references were from the flavor profile method (Keane, 1992). Leaders were selected for each group by members. The panel leader instructed the panelists to make individual notes on descriptors for the sensory attributes of the orange-cabbage juices. Afterwards the panel leader then led a discussion to reach agreement on the descriptors of the orange-cabbage juice samples. Once the panel came to an agreement on the descriptors, a concise definition was provided for each descriptor. Synonymous descriptors were identified and eliminated. The panelists were provided with references for each descriptor. As much as possible, panelists were made to use reference that was representative and exhibiting a specific attribute as suggested by Keane (1992). Specific attention were given to references because they could be used to overcome communication difficulties (Barcenas*et al.*, 1999) are helpful in lowering variability in scoring panelists (Stampanoni, 1994) and help reduce the time needed to train a panel (Rainey, 1986). During the training of the panellists, a total of 7 descriptors were generated (Table 1.3), defined, referenced and scored by the panellists. These were grouped into aroma, colour, taste, clarity and aftertaste descriptors.

The panel was also introduced to the 15-point numerical line scale where "0" represents "very weak" and "15" represents "very strong" as described by Munoz and Civille (1998). In the sensory evaluation, the panellists evaluated the sensory characteristics of the orange-cabbage juice based on the descriptors generated during training. The aroma attributes were evaluated first followed by the colour and taste attributes. The rest of the assessed attribute were aftertastes and clarity. The nine blends were presented to each subject in the order based on a balanced incomplete block design to prevent any biasing effect. Each orange-cabbage juice was given to the panellists in triplicate and was scored as such.

Analyses

Physico-chemical properties

pH, total soluble solid (TSS) andtotal titratable acid(TTA) were determined by WTW 526 pH meter (WTW, Germany) and Abbe Refractometer (DR-A1 1310Atago Co., Ltd, Japan) at 20 ± 1 °C, respectively according to AOAC (1990). TSS was reported as degrees Brix and TTA was expressed as the percentage of citric acid content.The Brix / acid ratio was obtained by dividing the total soluble solids (°Brix) by the total titratable acid (% Acid, w/w) as follows: Brix / Acid Ratio = °Brix / % Acidity (w/w).Total solids were determined according to AOAC (1990). Measurements were taken in triplicates.

Ash

The mineral composition was determined using the atomic absorption spectrophotometer (UNICAM 960 series) as described by AOAC (1990).

Nutritional Properties

Some minerals content

The elemental contents (Zn, Mg, Fe, Ca, and K) were determined, after wet digestion of juice samples ash with an Atomic Absorption Spectrophotometer (AAS, Hitachi Z6100, Tokyo, Japan)as described by AOAC (2012).

Vitamin C

Ascorbic acid (vitamin C) content in the experimental design above were assayed using titrimetric analysis with 2,6-dichlorophenolindophenol (AOAC, 1990).

Beta Carotene (Pro-Vitamin A)

This was determined by AOAC Official Methods (Method 941.15), (AOAC, 1995) and procedures similar to those described by Murkovic*et al.* (2002) using HPLC and modified by (Rodriguez-Amaya and Kimura, 2004).

Statistical Analysis
Experiments were carried out in triplicate. Analyses were performed using MINITAB 16 for Microsoft Windows (Minitab Inc., USA). Least Significance Difference (LSD) was determined using Fisher's Method to determine the significance of the differences between the means of the measured parameters**.**

3. RESULTS AND DISCUSSION

Mixed blend juice beverages are gaining popularity to satisfy consumer taste and preferences (Jan and Masih, 2012). Making them with additional functional benefits will help in popularizing them further.

Selecting mixing ratios of cabbage and orange juices
The sensory evaluation of the optimum A (OPTA) and optimum B(OPTB) were carried as a function of mixing cabbage juice and orange juice (late Valencia and blood cultivars). The sensory attributes, including color, appearance, flavor, mouth-feel and overall acceptability of the OPTA with different ratios are shown in Fig. 1.1 and OPTB in Fig. 1.2. The orange fruity aroma was accepted whiles others descriptors namely cabbage and pungent scent were rejected by panelists. Cabbage releases Dimethyl sulfide (DMS) or methylthiomethane, an organosulfur compound when cooking. This water insoluble flammable liquid compound boils at 37 ^{O}C and has a characteristic disagreeable odor (Parliment*et al.*, 1977). Accordingly, the orange aroma was hence preferred when compared to cabbage aroma in the cabbage-orange juice formulation for both orange-cabbage juices. For the colour property, it was observed; the higher the orange percentage in the formulation the higher the mean value and therefore preferred in both late-Valencia and blood orange blends. For the taste attribute, blood orange was highly rated than late Valencia orange in the sweet taste (Figure 1.1) while the vice versa occurred in the sour taste (Figure 1.2).This could be attributed to the less acidity (1.02 %) blood orange contains as revealed by the pH values (Inyang and Abah, 1997).Also, the lower pH in the orange juice (late Valencia) made the formulation hence its taste as sourness in taste (Karadeniz, 2004). For aftertaste attribute (astringency), the increasing of cabbage juice content in the formulation the weak astringency (blood orange) was observed. The blood orange juices contained less amount of acid hence the less astringent mouth feeling. Also, the orange juices contained high amount of acid had more astringent (Fuglie, 2001). For clarity character, the effect of the cabbage green colour was known to have a decreasing effect on the clarity of the juice as also noticed by Bates *et al.* (2001).

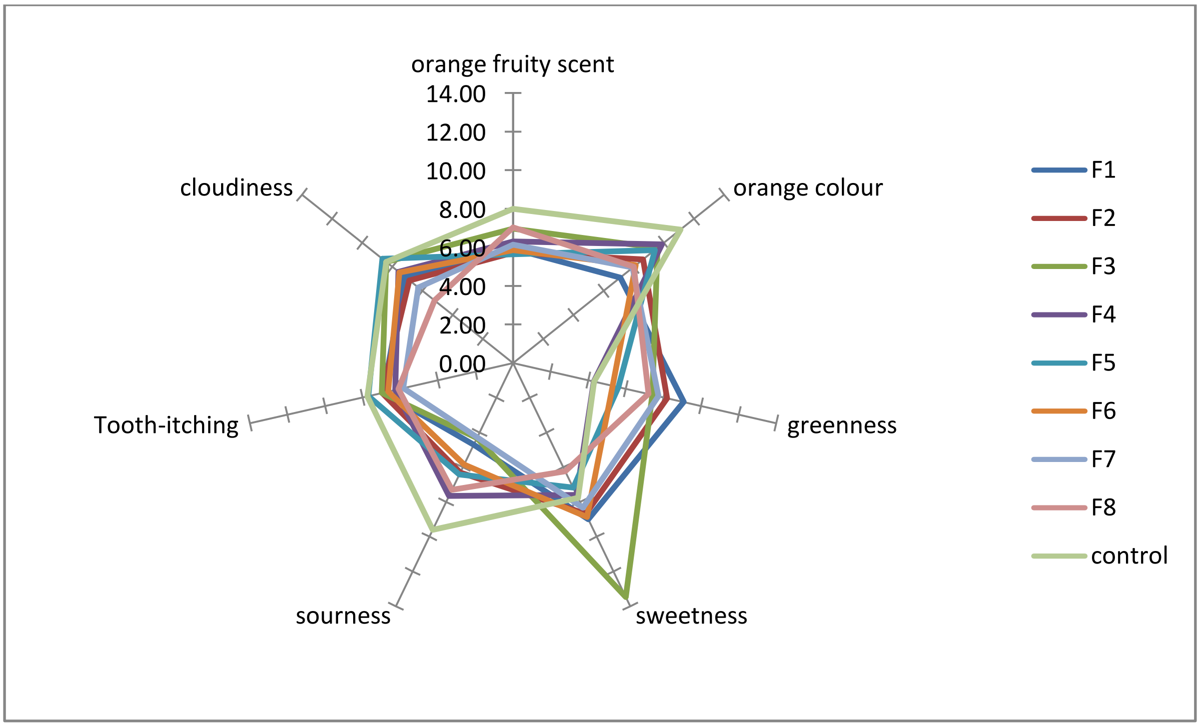

Figure 1.1: Sensory profile of the OPTAs. (OPTAs were prepared with different ratios of cabbage juice/orange late Valencia juice =v/v.Data is means of duplicate assessments and trained panellists (n=15)

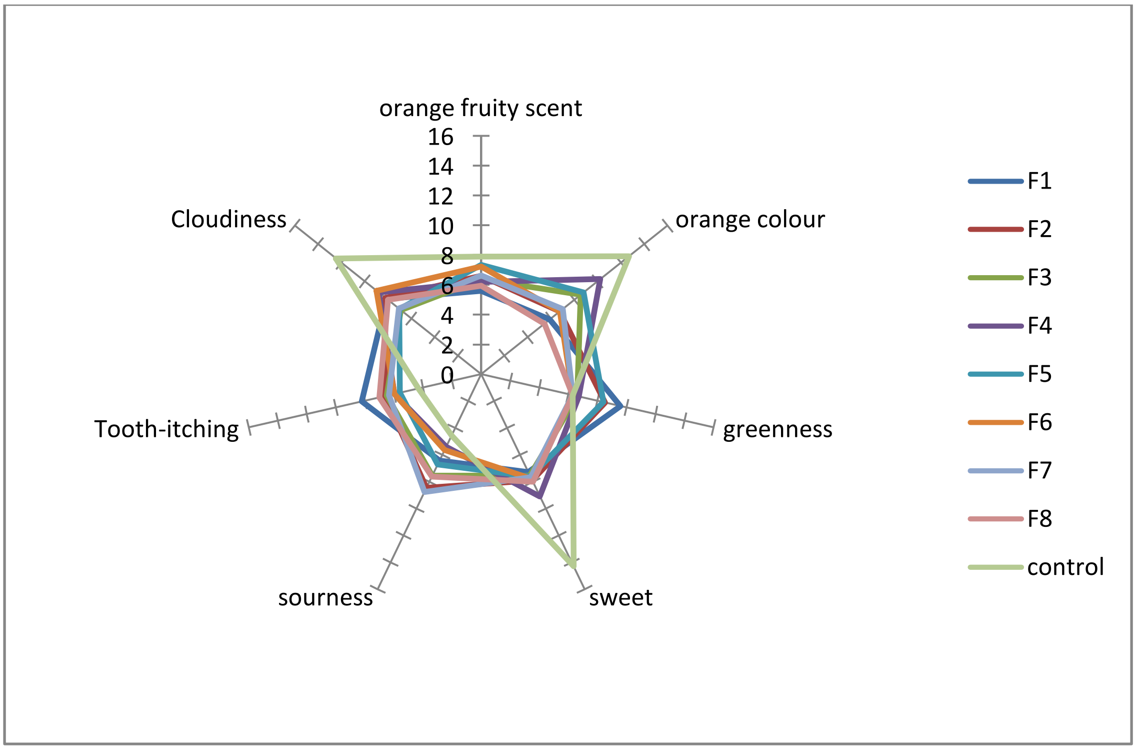

Figure 1.2:Sensory profile of the OPTBs. (OPTBs were prepared with different ratios of cabbage juice/orange blood juice =v/v.Data is means of duplicate assessments and trained panellists (n=15)

Optimization of the juice blends

The data from the sensory analysis were imputed into the Design-Expert Software (8.0.7.1 Version) and each of the sensory attribute was optimized with the software. A desirability graph (also known as optimal graph) was obtained from the Design-Expert Software (8.0.7.1 Version) using the entire sensory attributes with which optimal peaks or ratio for the formulation of juice blends. Two peaks were obtained for each variety of the orange and these peaks correspond to the orange - cabbage formulation. For late Valencia orange variety, the two regions selected were 80% orange and 20% cabbage as well as 96% orange and 4% cabbage by the software.

Physicochemical properties of cabbage-orange juice blends

Total solids

In citrus juices, brix is used to indicate the percentage of soluble sugars and is one of the most important factors for grading the quality of a citrus juice (McAllister, 1980). Generally, pH and titratable acidity of juices are used primarily to estimate consumption quality. They could be considered as indicators of fruit maturity or ripeness. The pH has influence on the flavour (sweet or sour) of the fruit and to a large extent determines the marketable quality of the fruit juices.

The total solids value of many vegetables including cabbage was in the range of 13-19% (Aidoo, 2011). The presence of cabbage had a significant effect on the total solids ($p < 0.05$). The late Valencia variety significantly decreased from 13.33 to 9.97% while the blood orange also decreased significantly from 14.29 to 10.65% (Table 1.1). The high content of total solids in the orange juice is attributed to the high fibre as reported by Gelroth and Ranhotra (2001). However, juice blends or beverages with less than 7 ºBrix are categorized as weak and watery meaning that the total soluble solids are low i.e. < 7 gm/100 ml solution (Bates *et al.* 2001).

Table 1.3: Physicochemical properties of the two varieties of orange and the cabbage-orange juices blend.

Property	late Valencia	Blood orange	OPT A (Late, 80/20)	OPT B (Blood, 74/26)
TS (%)	13.33±0.37[b]	14.29±1.21[a]	9.97±0.01[d]	10.66±0.19[c]
Ash (%)	0.97±0.03[a]	0.96±0.03[a]	0.97±0.01[a]	0.96±0.01[a]
TSS (^{O}Brix)	10.58±0.11[c]	13.56±0.01[a]	11.37±0.04[b]	13.56±0.01[a]
pH	3.23±0.01[c]	5.25±0.01[a]	3.82±0.03[b]	5.28±0.04[a]
TA (%)	1.53±0.04[a]	1.02±0.01[c]	1.15±0.02[b]	1.10±0.01[b]

Data are presented as means ± SE (n=3)Different letters in a row show a significance differences between the juices.

According to Belitz and Grosch (1999), reported that total ash was within the expected literature range of 0.3 - 2% for fresh fruit and vegetable. There was no significant difference (p> 0.05) between the varieties of orange and the optimum blends (OPT A and OPT B). This implies that the cabbage had little or no effect on the total ash content of the optimum formulations of the varieties of orange. The cabbage total soluble solids had a significant difference (p< 0.05) on the two optimums of the orange-cabbage juices. While the late Valencia increased significantly from a value of 10.58 to 11.37% in OPT A, the blood orange remained the same value of 13.56% in its optimum (OPT B). The increase may be attributed to the addition of cabbage during preparation of the juice blend. The late Valencia variety of orange had the least pH value of 3.23 as compared to that of blood orange of 5.25 which were within the range of 3 to 5 for fruit and vegetable juices (Harris and Silcocks, 1991). The pH value increased slightly from 5.25 to 5.28. The Brix/ acid ratio is one of the most commonly used indicators of juice quality as well as a flavor quality indicator in citrus juices. Brix to acid ratio is crucial since it constitutes a measure of the balance between sugars and acids as well as serves as an indication of the palatability of the juice.Large values indicate a sweeter taste, but very high values may be indicative of an insipid tasting juice (FAO, 2006). The Brix to acid ratio revealed that late Valencia and OPT A values were 6.915 and 9.887 (Table 1.4) which are below 12.0. Hence the juices had less sugar to make them sweet. On the other hand, blood orange and OPT B values were 13.294 and 12.327 which values were above 12.0. This meant that the blood orange and OPT B contained more sugar to enhance it sweetness taste. The late Valencia increased significantly (P < 0.05) from 3.23 to 3.82 (Table 1.3) whiles there was no significant increase (p > 0.05) in that of blood orange and its corresponding optimum (OPT B).

Table1.4: Total soluble solid (sugar) to acid ratio in orange juices and blends

Ratio	late Valencia	Blood orange	OPT A (Late, 80/20)	OPT B (Blood, 74/26)
TSS/TA	6.915	13.294	9.887	12.327

The titratable acidity was higher in the late Valencia than in the blood orange variety and consequently the Valencia orange had a lower pH compared to the blood orange variety. According to FAO (2005), the juices containing more than ~1.2% acid are sour, independent of °Brix/Acid (Bates *et al.*, 2001).There was a significant difference (p< 0.05) between the titratable acidity of orange varieties and the optimums (OPT A and OPT B). The late Valencia decreased significantly (p< 0.05) from 1.53 to 1.15% in its optimum (OPT A) whiles the blood orange variety increased significantly (p< 0.05) from 1.02 to 1.10% in its optimum (OPT B).

Nutritional properties of orange juices and cabbage-orange juice blends

The nutritional composition in two cultivars of orange juices and cabbage-orange juice (OPT A and OPT B) blends are presented in Tables (1.5 and 1.6).

Minerals composition

The zinc content in cabbage was higher than that of the varieties of orange and therefore led to its increase in the cabbage-orange juice. The late Valencia variety increased significantly from 0.44 to 0.84 mg/l in OPT A whiles the blood orange also increased significantly (P < 0.05) from 0.39 to 0.68 mg/l in OPT B as shown in Table 1.3.

Table 1.5: Mineral composition of the two varieties of orange and the two selected optimums

Mineral type (mg/l)	late Valencia	Blood orange	OPT A (Late, 80/20)	OPT B (Blood, 74/26)
Zinc	0.44±0.01^{c}	0.39±0.01^{d}	0.84±0.02^{a}	0.68±0.01^{b}
Potassium	1700.2±0.02^{d}	1990.05±2.79^{b}	1743.75±1.74^{c}	1995.75±1.48^{a}
Magnesium	80.54±0.21^{d}	118.02±0.01^{b}	88.75±0.34^{c}	120.08±0.14^{a}
Iron	0.38±0.01^{c}	1.16±0.01^{b}	1.28±0.01^{a}	1.27±0.02^{a}
Calcium	74.08±0.01^{d}	110.82±0.92^{b}	87.07±0.08^{c}	111.47±0.04^{a}

Data are presented as means ± SE (n=3)
Different letters in a row show a significance differences between the juices

Potassium (K) was higher as compared to the other fruits and vegetables aside bananas (2100 mg/l) which naturally has high potassium content. There were significant differences ($p < 0.05$) between the two varieties of orange (late Valencia and blood orange) and the optimums which is attributed to the addition of cabbage to the orange formulations in the selected optimums. The late Valencia variety increased significantly ($p < 0.05$) from 1700.2 to 1743.75 mg/l in OPT A whiles the blood orange variety increased significantly ($p < 0.05$) from 1990.05 to 1995.75 mg/l in OPT B. The cabbage-orange juice blends in the selected optimums (OPT A and OPT B) are good sources of K since the values give the half to third the recommended daily allowances (RDAs) for children, adult, woman (old or breast feeding) (Ahuja*et al.*, 2012).

Magnesium is one of the essential minerals required by the body for maintenance of normal muscle and nerve function, keeping a healthy immune system. It maintains heart rhythm, builds strong bones and is normally found in high quantities in fruits, vegetables and other animal products (Appel *et al*., 1997). The late Valencia increased significantly ($p < 0.05$) from 80.54 to 88.75 mg/l in its optimum (OPT A) whiles the blood orange increased significantly ($p < 0.05$) from 118.02 to 120.08 mg/l in its optimum (OPT B).

The amount of Fe in the blood orange and cabbage shows that these samples are good sources of Fe. The late Valencia increased significantly ($p < 0.05$) from 0.38 to 1.28 mg/l in its optimum (OPT A) whiles the blood orange increased significantly ($p < 0.05$) from 1.16 to 1.27 mg/l in its optimum (OPT B). The cabbage-orange juice blends in the selected optimums (OPT A and OPT B) are good sources of Fe since the values exceed the recommended daily allowance (RDAs). The iron content range from 0.10 to 0.13 mg/l for children; 0.2 to 0.7 mg/l for men; and 0.12 mg/l to 0.16 mg/l for women and breast feeding mothers (Fuglie, 2001).

Calcium (Ca) is another essential macronutrient require for strong bones, teeth, muscle and for proper functioning of the nervous system (Jensen, 2000). The late Valencia increased significantly ($p < 0.05$) from 74.08 to 87.07 mg/L in its optimum (OPT A) whiles the blood orange increased significantly ($p < 0.05$) from 110.82 to 111.47 mg/l in its optimum (OPT B).

Vitamin c and β-carotene

Higher vitamin C content was recorded in the blood orange variety than in the late Valencia but all the values were within literature values of 22.2 to 65.5 mg/100 ml for orange juices (Massaioli and Haddad, 1981). The cabbage had a lower vitamin C content of 32.4 mg/100 ml (Table 1.6) as compared to the orange. This was obvious because orange is noted to be one of the fruit with high vitamin C content beside guava (228 mg/100 ml) papayas (62 mg/100 ml) and kiwi fruit (93 mg/100 ml) (Gokce *et al*., 1999). There was again significant difference ($p < 0.05$) between the two varieties of orange and the optimum blends. The significant difference may also be attributed to heating processing both varieties hence a decrease in vitamin C content which is lost mainly due to oxidation (Moore, 1995).The late Valencia decreased significantly ($p < 0.05$) from 45.103 to 37.54 mg/l in its optimum (OPT A) whiles the blood orange decreased significantly ($p < 0.05$) from 55.81 to 49.64 mg/l in its optimum (OPT B). The entire juice blend samples to higher than adult RDAs (Gamman and Sherrington, 1990).

Table 1.6:Vitamin C and β-carotenes of the two varieties of orange juice and orange-cabbage juice blends

Juice / blend	Vitamin C (mg/100 ml)	B-carotene (μg/ml)
Late Valencia	45.103±0.19^{c}	587.469± 1.02^{b}
Blood orange	55.811± 0.21^{a}	126.720± 2.63^{c}
OPT A (late, 80/20)	37.581± 0.26^{d}	602.112± 3.33^{a}
OPT B (Blood, 74/26)	49.646± 0.43^{b}	129.545± 1.40^{c}

Data are presented as means ± SE (n=3). Different letters in a column show a significance differences between the juices

The β-carotene for late Valencia and blood orange were 587.46 μg/ml and 126.72 μg/ml, respectively which were all below the daily β-carotene requirements for adult men and women which are 5400 μg and 4200 μg/ml, respectively (Food and Nutrition Board, 2001). The late Valencia increased significantly ($p < 0.05$) from 587.46 to

602.112 µg/mlin its optimum (OPT A) whiles statistics show no significant differences in the blood orange and its optimum (OPT B).

4. CONCLUSION

The result from the sensory analysis revealed that in general the blood orange-cabbage juice was only highly rated in the sweetness sensory attribute as compared with late Valencia orange. The late Valencia on the other hand performed better in the orange fruity scent, sourness, tooth-itching and the orange colour sensory attribute. Both varieties of orange when blended with cabbage had virtually equal ratings in terms of their clarity. The physicochemical properties of the juice blends showed significant differences ($p< 0.05$) between the formulations (OPT A and OPT B) and their controls with the exceptions of the ash content where no significant differences existed. There was a significant increase ($p< 0.05$) in the total soluble solids and pH whiles a decreased was observed in the total solids and titratable acidity.The minerals such as zinc, iron, potassium and calcium in the cabbage-orange juice blends had higher values than the two orange varieties used and therefore contributed significantly in both optimums. A significant increase ($p< 0.05$) in all the minerals analysis and the beta carotenes were established whereas a significant decrease ($p< 0.05$) in the vitamin C contents of the blends was also observed in comparison to the amounts in the two orange varieties.

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