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Full Length Research Paper

Comparative study related to physico-chemical properties and sensory qualities of tomato juice and cocktail juice produced from oranges, tomatoes and carrots

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Fruits and vegetables belong to an important class of foods that supply human diet with nutritive requirements including vitamins and minerals which are essential for normal body health and function. The study was carried out to determine the physico-chemical properties and sensory qualities of tomato juice and cocktail juice produced from oranges, tomatoes and carrots. Two varieties of tomatoes, known in Ghana as the Bolga and Ashanti varieties were processed into juices using the gravity method. Analysis such as total soluble solids, titratable acidity, lycopene, vitamins A and C were determined. Sensory analysis on both juices indicated that the Bolga variety was better preferred significantly ($p < 0.05$). Four cocktail juices were formulated in different ratios from a combination of carrots, tomatoes (Bolga) and two varieties of oranges, namely late Valencia and pineapple. The juices were subjected to physico-chemical analysis after which sensory evaluation of the products was conducted to determine the preferred blend. Parameters analyzed included among others titratable acidity, total soluble solids and vitamin C. It was established from the sensory evaluation results that the cocktail juice with a formulation ratio of 60% late Valencia orange variety, 20% carrots and 20% bolga tomatoes was the most preferred blend among the 4 formulations. Further sensory preference test was carried out to compare the attributes of the preferred cocktail with a cocktail juice on the market. The results indicated a significant difference ($p < 0.05$) in colour, flavour and mouth feel of the two products, whereas there were no significant differences ($p > 0.05$) in taste, aftertaste and overall acceptability of the two products.

Key words: Physico-chemical properties, sensory qualities, tomato juice, cocktail juice.

INTRODUCTION

Fruits and vegetables are generally defined as the edible plant structure of a mature ovary of a flowering or herbaceous plant that is eaten whole or in part, raw or cooked. Fruits develop from the ovary in the base of the flower and contain the seeds of the plant (Calbom and Keane, 1992). Vegetables may be defined as the fresh edible part of plants such as the root, stem or leaf which is either raw, cooked, canned or processed in some other way, provide suitable human nutrition (Belitz and Grosch, 1999). Fruits and vegetables usually have considerable amounts of vitamins and minerals and generally they contain little protein or fat and have low calorie content (Pamplona-Roger, 2003). Fruits and vegetables have high fiber content and they also contain natural colour pigments and as such are used as food colourants in food preparation to improve the sensory quality of foods (Tombak, 2000). Phytochemicals such as flavonoids, limonoids (prominent in orange) and lycopene

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(prominent in tomatoes), which are powerful antioxidants and also prominent in most fruits and vegetables (Negri, 1991), help in the prevention of arteriosclerosis, cardiovascular diseases and prostrate cancer (Trout, 1991).

Juices are obtained from a single fruit or from different kinds of fruits and vegetables (Tombak, 2000). A mixture of juices balances out certain nutrients which may not be present in a single fruit or vegetable. Beside adding body and improving the nutritive value, mixtures also compensate for the sourness or bitterness of a particular juice (Ihenkoronye and Nkoddy, 1985; Smith et al., 1997). Post harvest losses of Ghanaian fruits and vegetables occurring immediately after harvest, during distribution and marketing, are high. This is due to lack of proper packaging sheds with coolants, lack of cold storage facilities on the farms, increases in production without corresponding increase in demand, inadequate processing and improper handling (C. Ametepe, Vegetable Production and Export Association of Ghana, Accra, Ghana personal communication). The Ministry of Food and Agriculture in Ghana has estimated post-harvest losses to be 20 - 50% for fruits, vegetables, root and tubers and about 20 – 30% for cereals and legumes (Fiamor, 2009). Osei et al. (2010) also reported that the post harvest losses for oranges and tomatoes are 31 and 19%, respectively. In view of the lack of adequate processing and preservation mechanisms coupled with the perishable nature of fruits and vegetables such as tomatoes, farmers are compelled to sell their produce quickly to avoid high losses, thus putting them in a disadvantaged position of flooding the market with their produce at reduced prices (C, Ametepe, Vegetable Production and Export Association of Ghana, Accra, Ghana, personal communication).

In spite of the nutritional and health benefits of vegetable juices, they are not popular on the Ghanaian market. Even though there are some orange and pineapple fruit juices produced locally, most of the fruit juices and nectars found on the market are imported from United Kingdom, Spain, Egypt, South Africa and some Asian countries. Consumption of vegetables such as carrots and tomatoes has also been limited to the preparation of soup, stew and salad. The objectives of this research work were to select one variety (from two) of processed tomato juices through sensory evaluation as well as formulate and determine the physicochemical properties and sensory qualities of cocktail juices from tomatoes, oranges and carrots.

MATERIALS AND METHODS

Source of raw materials

The oranges (Late Valencia and Pineapple), carrots and two local varieties of tomatoes (Bolga and Ashanti varieties) were obtained from the Crop Research Institute at Kwadaso Agric, a suburb of Kumasi.

Table 1. Formulated ratios for the preparation of cocktail juices.

A1 – 70:20:10	Ratio of late valencia, tomatoes and carrots.
A2 – 60:20:20	Ratio of late valencia, tomatoes and carrots.
B1 – 70:20:10	Ratio of pineapple, tomatoes and carrots.
B2 – 60:20:20	Pineapple, tomatoes and carrots.

Additives

Sugar, salt and ginger were also obtained from the Kumasi central market. Plate 1 shows samples of the two varieties of raw tomatoes, varieties of oranges and carrots used in the preparation of juices.

Preparation of tomato Juices using the gravity method

Preparation of juice was based on the procedures outlined by Amankwah et al. (2006) and Smith et al. (1997) by modifying the time for heat treatment and the amount of additives put into the juice. Ripe and wholesome tomatoes were sorted out, weighed and washed with hot water to remove dirt, contaminants and also to facilitate pulping. The tomatoes were trimmed, cut and heated rapidly to a temperature above 82ºC for 5 min to inactivate pectinesterase promptly and enhance the juice extraction. The sliced tomatoes were then blended and hanged in a cheese cloth bag until the juice was extracted. Salt (1.25%), sugar (2%) and ginger (0.5%) by weight were added to the juice and allowed to simmer for 10 min. Finally the juices were poured into pre-sterilized containers and pasteurized. They were then cooled, bottled and stored in a box in a cool dark place to prevent loss of its colour in the presence of sunlight.

Preparation of cocktail juices

Oranges, tomatoes and carrots were washed, peeled and cut into reasonable pieces. The carrots were blanched at a temperature 80℃ for 10 min. Juices from the cut samples were extracted with the aid of an electric blender and filtered with the aid of cheese cloth to obtain a clear juice. Preliminary work was carried out to determine the yield, pH and Brix of three varieties of oranges. Two varieties of oranges, namely late Valencia and Pineapple were selected and used in the formulation of the four cocktail juices. The formulation ratios for the preparation of the cocktail juices are represented in Table 1.

In view of the fact that vegetable juices are not popular in Ghana and need to be introduced gradually on the market, the cocktail juices were formulated in such a way that the tomatoes and carrots had lower percentages.

Physicochemical analyses on raw tomatoes, processed tomato juices and cocktail juices

The moisture content, ash content and titratable acidity were determined based on official methods of analysis (AOAC, 1990). Total soluble solids were determined with handheld refractometer and the total solids were determined by subtracting the % moisture from 100%.

Lycopene, beta-carotene and vitamin C were determined using reversed phase HPLC (AOAC, 2003) and the Indophenol method (Nielsen, 2003) respectively. The pH was determined using a digital pH meter.

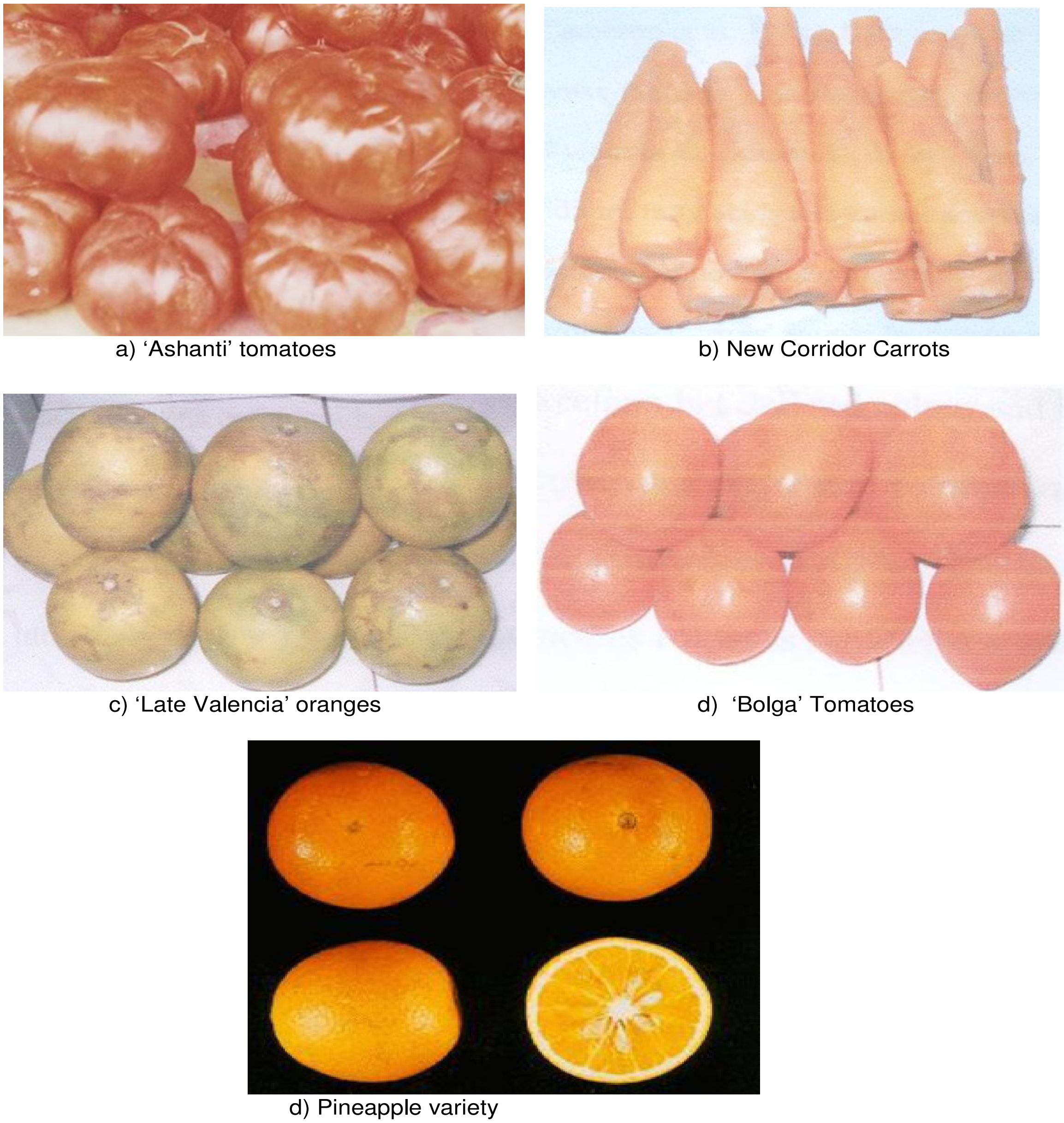

Plate 1. Raw samples for tomato and cocktail juices.

Sensory evaluation

Paired preference test was carried out on tomato juices from the two varieties using an untrained panel of forty (40). A paired preference test was carried out on the sensory parameters of the four formulated cocktail juices using a 7 point hedonic scale rangingfrom (1) like very much to (7) dislike very much. 50 untrained panelists comprising students and workers evaluated the products. Results of the sensory evaluation was subjected to statistical analysis using one way ANOVA and the t – test.

RESULTS AND DISCUSSSION

The physicochemical parameters of the raw varieties of tomatoes and the processed juices are shown in Table 2.

Effect of additives on total solids and ash content of tomato juices

As indicated in Table 2, the values of the total soluble solids of raw Bolga and Ashanti tomatoes were 4.00 and 5.50%, respectively, while that of the juices from Bolga and Ashanti varieties were 14 and 15% respectively, which compares well with literature values of 13 - 15% (Rawal, 2005). The difference in value between raw and processed juice may be attributed to the addition of salt, sugar and ginger extract during processing. There were

Table 2. Physicochemical composition of raw tomatoes and processed tomato juices.

Parameters	Raw tomatoes		Processed juices	
	Bolga	Ashanti	Bolga	Ashanti
Total soluble solids (%)	4.00 ± 0.02	5.50 ± 0.01	14.00 ± 0.00	15.00 ± 0.02
Titratable acidity (%)	3.53 ± 0.21	4.32 ± 0.04	5.52 ± 0.41	4.82 ± 0.08
pH	3.29 ± 0.01	3.12 ± 0.01	4.00 ± 0.02	4.30 ± 0.03
Moisture content (%)	88.19 ± 0.02	94.67± 0.01	75.37 ± 0.00	82.78 ± 0.03
Ash (%)	0.2 ± 0.01	0.24 ± 0.02	0.58 ± 0.00	0.76 ± 0.01
Lycopene (mg/100 g)	5.67	5.14	11.12	10.38
Vitamin A (IU)	600	450	510	359
Vitamin C (mg/100 g)	21.97	23.03	15.00	10.00

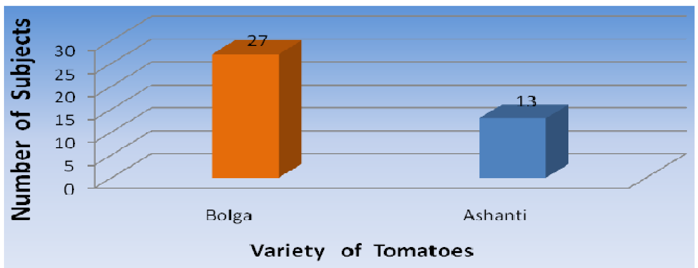

Figure 1. Paired preference test on the two processed tomato juices, sensory evaluation of processed tomato juices.

slight increases in the titratable acidity of the processed juices compared with the raw tomatoes. The determination of the titratable acidity was based on citric acid. An increase in temperature results in an increase in the citric acid as reported by Gould (1983). The increase is as a result of the oxidation of aldehydes and alcohols to acids during processing and consequently contributing to an increase in acidity (Gould, 1983).

Effect of processing on the lycopene content of tomato juices

There were high increases in the lycopene contents of the juices than the contents determined in the raw Bolga and Ashanti varieties. Processing of food may improve the bioavailability of lycopene and hence its concentration by breaking down cell walls, which weakens the bonding forces between lycopene and tissue matrix, thus making lycopene more accessible and enhancing the cisisomerization (Maguer and Shi, 2000). The lycopene content in the processed juice from Bolga tomato recorded the highest value of 11.2 mg/100 g as compared to the Ashanti variety (10.38 mg/100 g). These are within the range of 8.30 - 11.90 mg/100 g as reported by Markovi et al. (2003).The results obtained confirms work done by Barret and Garcia (2005) that increasing the temperature increases the bioavailability of lycopene. The increase in lycopene after processing is attributed to the fact that the trans isomers are converted to the cis isomers which are more bioavailable (Barret and Garcia, 2005).

The effect of processing on vitamins A and C

The moisture content, vitamins A and C of the processed juices were all lower than the amounts determined in the raw juices. The vitamin A content of the raw Bolga and Ashanti varieties decreased from 600 and 450 to 510 and 359IU respectively. It is evident that the amount of β-carotene decreases as temperature increases and this accounted for the decrease in vitamin A in processed juice. β-carotene is less stable as heat can convert it to neo-carotene which has no vitamin A activity (Shanna et al., 2002). The vitamin C content in raw Bolga tomatoes of 21.97 mg/100 g was slightly lower compared to that of the Ashanti tomatoes (23.03 mg/100 g) but compares well with 23.00 mg/100 g and 19.10 mg/100 g as reported by Gould (1983) and Pamplona Roger (2003), respectively. Upon processing both varieties recorded a decrease in Vitamin C content which is lost mainly due to oxidation (Moore, 1995). The processed Bolga tomatoes retained more of the vitamin C than the processed Ashanti tomatoes.

The paired preference test carried out on the sensory attributes of the juices is represented in Figure 1. The

Table 3. Physicochemical parameters of the raw fruit and vegetable juices.

Fruit/vegetable	Moisture (%)	Ash (%)	Total soluble solids (%)	pH	Titratable acidity (%)	Total solids (%)
Late Valencia	88.89	0.75	10.00	4.79	0.220	11.11
Pineapple	93.27	0.55	7.75	4.89	0.177	6.73
Carrot	89.68	0.88	4.00	5.87	0.053	10.32

Table 4. Physicochemical parameters of the formulated cocktail juices.

Product	pH	Titratable acidity (%)	Total solids (%)	Moisture (%)	Total soluble solids (%)	Vitamin C (mg/100 mg)
A1	4.82	0.83	7.22	92.78	10.50	30.08
A2	4.78	0.65	7.44	92.56	10.00	29.14
B1	4.96	0.33	9.28	90.72	10.10	31.20
B2	4.99	0.20	7.55	92.45	10.50	29.68

results indicated that 27 panelists preferred the Bolga variety as against 13 panelists for the Ashanti variety.The juice from the Bolga variety was preferred significantly than that from the Ashanti variety. The sensory attributes considered were colour, taste aroma, aftertaste and overall acceptability.

Table 3 shows the physicohemical analysis on raw fruit and vegetable juices. The titratable acidity of late Valencia was higher than that of the orange variety pineapple and carrots. The moisture contents of the raw fruit and vegetable juices indicated in Table 3 ranged between 89.68 and 93.27% and were within the range of 80 - 95% for fruit and vegetable juices (Kirk and Sawyer, 1997). The physicochemical parameters of the four formulated juices are shown in Table 4.

The ash content was also between 0.55 and 0.88% and were within the expected literature range of between 0.3 - 2% for fresh fruits and vegetables (Belitz and Grosch, 1999). The titratable acidity obtained ranged from 0.053 - 0.220%. The differences in the values could be attributed to the different stages of maturity of the fruit and vegetables since titratable acidity decreases with the maturity of a fruit (Kirk and Sawyer, 1997). The total solids and vitamin C content of B1 were higher than the other three products. A1 and B2 had the highest and lowest titratable acidity respectively with A1 also having a higher moisture content than all the other formulations. Product A2 had the lowest pH.

The analysis in Table 4 shows the pH of the formulated juices ranged between 4.78 and 4.99 which is within the range of 3 to 5 for fruit and vegetable juices (Harris et al., 1991). The optimum pH for the growth of most microorganisms is in the range of 6.6 to 7.5 (Bor et al., 1988). Most bacteria grow well over a range of pH of 6 to 9 (Atlas, 1994). Thus the low pH of the formulated juices would hinder the growth of most microorganisms. The vitamin C levels for carrots, tomatoes and oranges are 9.3 mg/100 g, 19.1 mg/100 g and 53.2 mg/100 g, respectively (Pamplona-Roger, 2003). The vitamin C levels of the formulated juices were higher than that in carrots and tomatoes but below that for oranges.

The mean scores of the sensory evaluation indicated in Figure 2 shows that product A2 was the most preferred in terms of taste, flavour and mouthfeel while B1 was the most preferred in terms of colour and aftertaste. To establish the most preferred product in terms of all the sensory parameters, an overall mean (Figure 3) which is a better indicator of product quality and acceptability for each product was determined (Desrosier, 1985). The smallest overall mean value of 2.69 for product A2 for all the sensory parameters confirmed the preference of A2 over all the other three products. A paired preference test (Figure 4) was carried out on the preferred blend and a cocktail juice already on the market. The components of C were oranges, pineapple and mangoes. Analysis of the mean values of the sensory parameters indicated significant differences ($p < 0.05$) in the colour, flavour and mouthfeel of the products. No significant differences ($p > 0.05$) existed between the taste, aftertaste and overall acceptability. The differences in the sensory parameters could be attributed to the different components of the two cocktail juices.

Conclusion

The Bolga tomato juice was preferred significantly than the Ashanti variety and was used in the formulation of the four cocktail juices. The cocktail juice produced from a blend of 60% orange (Late Valencia), 20% carrots and 20% tomatoes was the most preferred sample among the four formulations. The astringency and the soluble solids content influenced the acceptability of product A2.

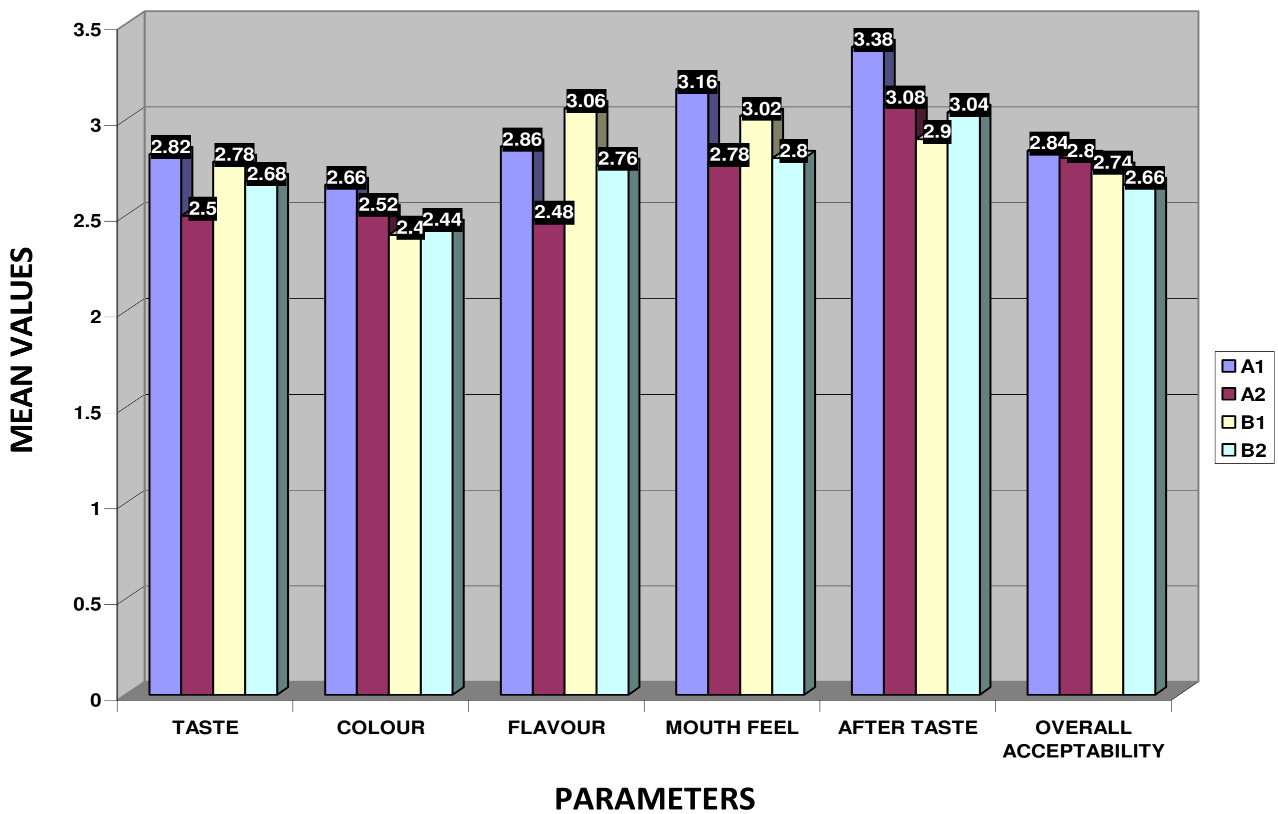

Figure 2. Mean values of sensory attributes of formulated products, sensory evaluation of formulated cocktail juices.

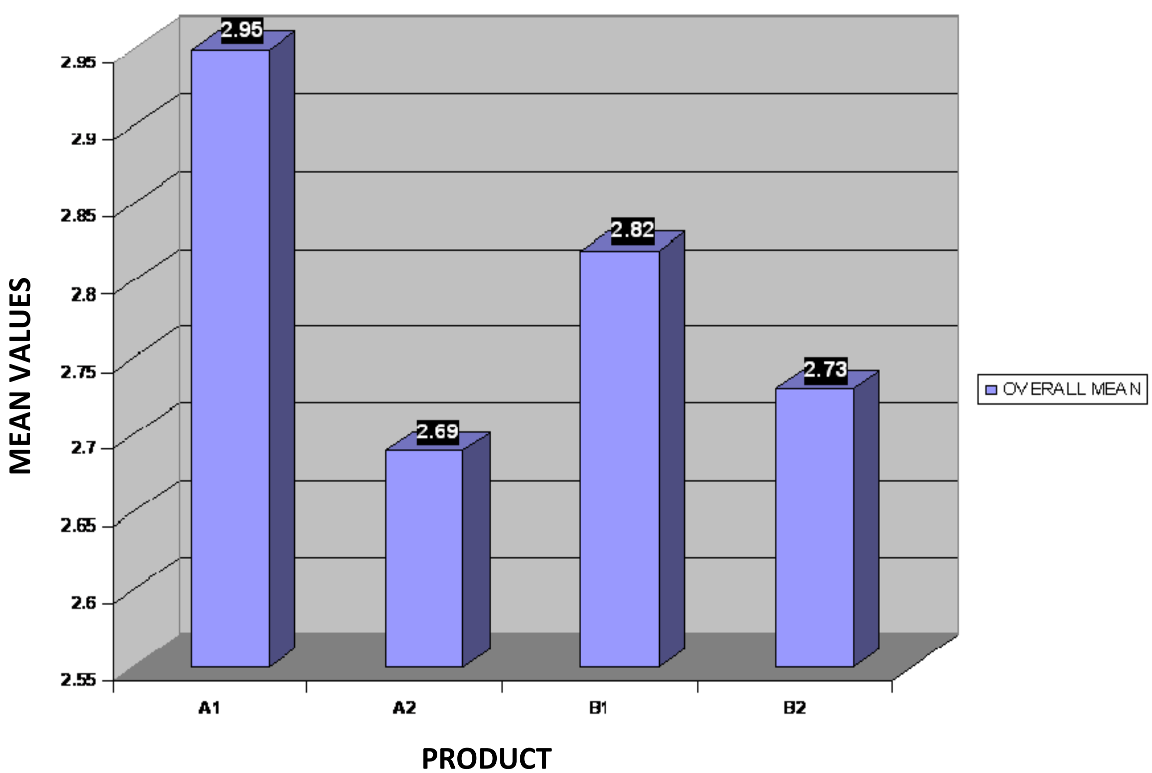

Figure 3. Overall mean score of all sensory parameters of products.

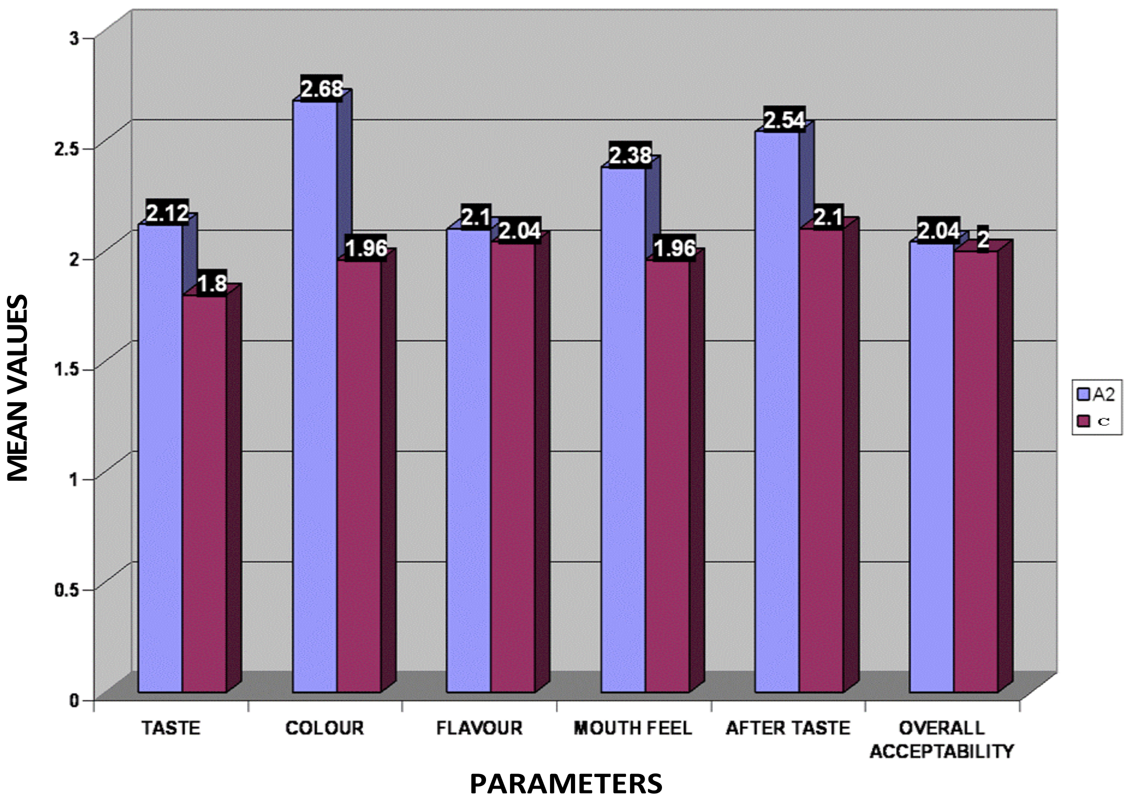

Figure 4. Mean values of sensory parameters of preferred blend (A2) and control (C).

REFERENCES

Amankwah EA, Ellis WO, Oldham JH (2006). Manufacture of tomato ketchup using the gravity method of concentration. J. Ghana Sci. Assoc. 8: 63-64.

AOAC (1990). Official Methods of Analysis of the Association of Official Analytical Chemists, 15 ed., AOAC, Virginia, USA.

AOAC (2003). Official Methods of Analysis of Association of Official Analytical Chemists International. In:Horwitz, W. (Ed.), 17th ed. AOAC Press, Arlington, VA, USA.

Atlas RM (1994). Principles of microbiology. 1st ed. p. 346.

Barret E, Garcia M (2005). Assessing Lycopene content in California processing tomatoes. J. Food Process. Preserv. 30: 66.

Belitz HD, Grosch W (1999). Food Chemistry. 2nd ed. Springer-Verlag, Berlin Heidelberg, 716: 723-724.

Bor SL, Jasper GW (1988). Commercial vegetable processing. 2nd ed. Guy Woodroof, NY, pp. 596-597.

Calbom C, Keane M (1992). Juicing for life. 4th ed. Avery Publishing Group, NY. pp. 46-49.

Desrosier NW (1985). The Technology of food preservation. 3rd ed. AVI Publishing Co., London. pp. 22-24.

Fiamor P (2009). The 2010 Budget for the Ghanaian economy: Prospects for the smallholder farmer. Retrieved from website, http://allafrica.com/stories/200911240782.html on May 03, 2010.

Gould WA (1983). Tomato production, processing and quality evaluation. 2nd ed. AVI Publishing, Inc. Westport, CT. pp. 268-272, 345-355.

Harris A, Key J, Silcocks B (1991). Dietary carotene. 3rd ed. Prenticehall Press, NY. pp. 63-68.

Ihekoronye A, Ngoddy P (1985). Integrated Food Science and Technology in The Tropics. 1st ed. Macmillan Publishers, London. 107: 137-140.

Kirk R, Sawyer R (1997). Pearson's Composition and Analysis of foods. 9th ed. Chemical Publishing Inc. New York. pp. 9-11.

Maguer M, Shi J (2000). Lycopene in tomatoes, chemical and physical properties affected by food processing. 4th ed. Chapman and Hall, NY. pp. 293-294.

Markovi D, Tilberry S, Valerie NX (2003). Nutr. Res. 26(11): 556-560.

Moore D (1995). Human Nutrition and Dietetic. 9th ed. Churchhill Livingstone Publishers, NY. pp. 335-339.

Negri F (1991). Vegetable and fruit consumption and cancer risk. Int. J. Cancer. 48: 350-354.

Nielsen SS (2003). Food analysis laboratory manual. Kluwer Academic/Plenum Publishers, NY. pp. 45-49.

Osei CK, Banful B, Nimoh F (2010). A study on postharvest loss management and women empowerment. Final report submitted to Ghana Agricultural Workers Union (GAWU) of the Trade Union Congress (TUC) of Ghana. p. 45.

Pamplona-Roger GD (2003). Healthy Foods. 1st ed. Marpa Artes Publications European Union. pp. 32: 264-267, 346-351.

Rawal S (2005). Tomato processing and production. 2nded. Academic press .Inc. San Diego. pp. 67, 85.

Shanna ME, Tilberry S, Valerie NX (2002). Effect of processing on vitamins and antioxidant activity of tomatoes. J. Food Sci. 37: 434-456, 543.

Smith DS, Cash JN, Nip WK, Hui YH (1997). Processing vegetables, science and technology pp. 397-403.

Tombak M (2000). Start Healthy Life. 2nd ed. Healthy life press inc. Korea. pp. 59-62.

Trout DL (1991). Vitamin C and Cardiovascular Risk Factors. American J. Clin. Nutr., 53: 322-325.