



Phytochemicals and Vitamin Properties of Smoothie Flavoured with Mint Leaves Extract

A. T. Victor-Aduloju^{1*}, N. M. Nwanja¹, C. C. Ezegbe¹, K. S. Okocha¹
and T. A. Aduloju²

¹Department of Food Science and Technology, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.

²Department of Applied Science, Federal College of Dental Technology and Therapy, Trans-Ekulu, Enugu, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author ATVA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NMN and CCE managed the analyses of the study. Authors KSO and TAA managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJBCRR/2020/v29i730203

Editor(s):

(1) Dr. Prabakaran Nagarajan, Ohio State University, USA.

Reviewers:

(1) Sonali Dnyaneshwar Labhade, Savitribai Phule Pune University, India.

(2) Aman Verma, ICAR-Directorate of Groundnut Research, India.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/59156>

Original Research Article

Received 10 May 2020
Accepted 17 July 2020
Published 30 July 2020

ABSTRACT

This study was undertaken to assess the phytochemicals, vitamin A and vitamin C properties of different samples of smoothie produced from mixed tropical fruits flavoured with mint leaves extract. The smoothie was produced from three different fruits, (watermelon, apple and banana) then flavoured with mint leaf extract. The concentration of mint extract differs in each smoothie samples, ranging from 0-8% concentrate. The sample devoid of mint leaf extract served as control. The nine smoothie samples were examined for their phytochemical properties, vitamin A and vitamin C content. The study revealed that, the phytochemical content of different samples of smoothie gave these ranges: alkaloids (0.62-1.34%), saponin (1.07-1.46%), tannin (1.87-2.41%), phenol (0.02-0.41 mg/ml), flavonoid (1.62-3.33%), cyanogenic glycosides (0.00-0.05%). From the result, it was discovered that the phytochemical properties of the smoothie increases with increased mint leaf concentrate. The vitamins content of the samples ranges from; vitamin A (466-642 IU), vitamin C (9.30-10.83 mg/100 ml). The smoothie sample with high contents of mint extract are potentially good source of phytochemicals and vitamins.

*Corresponding author: E-mail: at.victoraduloju@unizik.edu.ng, yemtop2013@gmail.com;

Keywords: Fruit smoothie; extract; vitamins; mint leaves; properties.

1. INTRODUCTION

The nutritional and health benefits of continuous consumption of adequate amount of fruits and vegetables are generally well recognized. Due to seasonal gluts and postharvest losses, fruits are yet to become readily available throughout the year especially in developing countries. Countries with less attention to effective postharvest handling and storage facilities can record as high as 65% loss of fruits produced [1]. Fruits with high acidic content have a limited scope for table consumption though they are rich in functional ingredients. Nevertheless, the desires for freshness, health consciousness and diversity in consumer taste have recently led to the emergence of "fruit smoothie" [2]. Fruits and vegetables are essential nutrients that promote the body growth. They are great source of vitamins, minerals and fiber [3]. A diet rich in fruits and vegetables can promote eye health, lower blood pressure, prevent the risk of heart diseases, stroke, cancer, and digestive problems [4,5 and 6]. Eating fruits like banana, apples and watermelon may even promote weight loss [7]. Good consumption of smoothie could contribute to healthy diets in this face of Corona virus (COVID-19) pandemic by boosting the immune system.

A variety of smoothie can be prepared depending on availability of seasonal fruits and the taste of the consumers. For example there is Dennis Goodman's spinach and mango smoothie, Matt Fitzgerald's spiced sweet potato and almond smoothie, Steve Redzikowski's coconut smoothie, Curtis Stones's mango-pineapple smoothie, Jason Adams's green tea, banana and blueberry smoothie and banana-chard smoothie. Smoothie are thick in consistency and are normally consumed fresh or preserved for short periods by storing in refrigerator or freezing. It can be prepared without adding any sweetener, acidulant and preservatives [8].

Mentha spicata L. (Mint leaves) are common name for member of the Labiate (Laminaceae family). It is a large family of annual or perennial herbs and widely grown all over the world to reap its herbal characteristics [9]. It is generally refers to as spearmint leaves. Mint leaf is cultivated globally for its use as flavoring in foods and also as fragrance in soap production [10]. It is one of the most important and common in the world coming after vanilla and citrus flavours [11]. Mint leaves are more popular in India and mainly

cultivated in the southern parts of Himalaya and Northern parts of Nigeria. This leaf is very beneficial to man's health as it contains significant amount of micronutrients, vitamins, antioxidants, phytochemicals and fiber content that may help protect the body against degenerative diseases and micronutrients malnutrition [12].

In Nigeria, mint leaves on visual inspection look so much like scent leaves. Igbo tribes called it Nchanwu while Yoruba called it Ewe mint. The leaves are arranged in opposite pairs on the main stalk and the leaves from these two herbs look very much alike. But scents and tastes of mint and scent leaves are not the same at all. In Northern part of Nigeria, mint leaves is locally called "Naa na a". Mint leaves are a popular herb that people can use fresh or dried in many dishes and infusions. Manufacturers of toothpaste, chewing gum, candy, biscuit and beauty products often use mint leaf or oil [13]. Using fresh mint in smoothie can help to add flavour while reducing the sodium and sugar intake. Mint leaves contain a complex mixture of bioactive compounds covering exhibiting different biological properties and activities. It is used for various diseases such as allergies, stomach upset, indigestion, muscle and nerves pain, flatulence, depression-related anxiety and common cold [14].

There is no single fruit or vegetable that can provides all the nutrients that we need to be healthy so there is a need to have smoothie made of different fruits and vegetables. This study aimed at accessing the phytochemicals and vitamins properties of smoothie production flavoured with mint leaves extract.

2. MATERIALS AND METHODS

2.1 Source of Raw Materials

The raw materials used for the production of smoothie are fresh ripe fruit of *Citrullus lanatus* (Watermelon), *Malus domestica* (Apple) and *Musa acuminata* (Banana). The fruits and fresh leaves of *Mentha spicata L.* (mint leaves) were purchased from Stanel Farmer's market in Awka South Local Government Area of Anambra state, Nigeria.

2.2 Smoothie Production

The fresh fruits of watermelon, apple and banana were sorted, thoroughly washed under tap water

and peeled with knife and diced. The diced fruits and vegetables were weighed and combined using the blending ratio shown in Table 1 on an electronic weighing scale and blended together with mint leaves extract using an electric smoothie maker Binatone BLS-330. All smoothie samples were prepared without addition of water, sugar and citric acid.

2.3 Preparation of Mint Leaf Extract

Exactly, 90 g of the dried mint leave sample was extracted with 900 ml of distilled water in 1L capacity conical flask. The mixture was stirred vigorously with a magnetic stirrer and then allowed to stand for 48 h. It was filtered using Whatman filter paper lined funnel into a conical flask and the filtrate was concentrated using a rotary evaporator, freeze-dried and kept refrigerated.

2.4 Phytochemical Analysis

Briefly, approximately 12.5 g of the edible portions of each sample were added to 50 mL of the solvent (water or 100% ethyl acetate) and homogenized in a shaker (125 rpm) at 30°C for 1 h. The extracts were filtered under vacuum through JP41 filter paper for the removal of remaining particles and the residues were re-extracted with 50 mL of the same solvent and filtered under the same conditions. The extracts were pooled and when necessary, they were concentrated under vacuum at 40°C and stored at 70°C. The extractions were done in triplicate. The entire procedure was conducted in the dark.

The extracts of different samples of smoothie were screened for their phytochemical contents according to standard methods of [15,16,17 and 18].

2.5 Determination of Vitamins

2.5.1 Vitamin A determination

The amount of vitamin A in the sample was determined using the method described by [19]. A quantity, one gram, of the sample was weighed and macerated with 20 mls of n-hexane in a test tube for 10 minutes. Then 3mls of the upper hexane extract was transferred into a dry test tube in triplicates and evaporated to dryness.

Following this, 0.2 ml of acetic anhydride chloroform reagent was added and 2 ml of 50% trichloroacetic acid (TCA) in chloroform was also added. The absorbance was taken at 15 seconds and 30 seconds intervals at 620 nm.

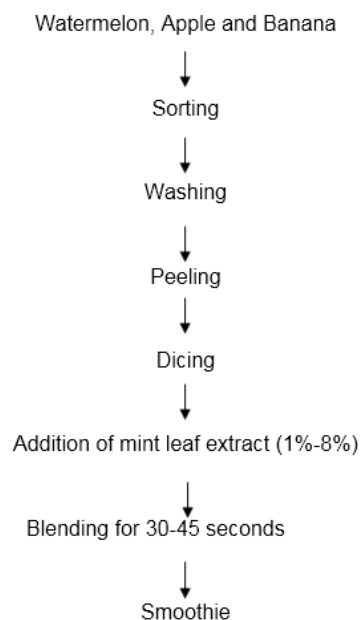


Fig. 1. Flowchart of smoothie production flavoured with mint leaf extract

2.5.2 Vitamin C determination

The vitamin C content of each fresh juice, obtained by pressing well-pulped fruit and filtering, was determined using the 2, 6-dichlorophenol-indophenol (DCIP) titration method [20]. The ascorbic acid concentration was calculated by comparison with the standard solution of ascorbic acid (1 mg/100 ml) and the results were expressed as mg ascorbic/100 ml of fresh weight.

2.6 Statistical Analysis

The data obtained were analyzed according to a completely randomized design with three replicates. Data was subjected to one way analyses of variance and the differences between means was computed by Duncan's multiple range tests using Statistical Packages for Social Sciences (SPSS) version 23. Significant differences were accepted at $P < 0.05$.

Table 1. Blending ratio of fruits (g)

Samples	Watermelon(g)	Apple(g)	Banana(g)	Mint extract (%)	Total(%)
SM	50	25	25	0	100
SM1	25	50	24	1	100
SM2	25	23	50	2	100
SM3	47	25	25	3	100
SM4	25	25	46	4	100
SM5	25	45	25	5	100
SM6	44	25	25	6	100
SM7	25	25	43	7	100
SM8	25	42	25	8	100

3. RESULTS AND DISCUSSION

3.1 Phytochemicals

The effect of mint leaves extract on the phytochemical content of smoothie produced from the blends of watermelon, apple and banana is shown in Table 2. The result showed a significant increase ($P<0.05$) in the tannin and saponin content of the smoothie as the level of concentration of leaves extract in the smoothie increased. The sample prepared with 5% mint leaves extract had the highest tannin of 2.41 ± 0.01 . The smoothie samples prepared with 4% and 5% of leaf extract had the same saponin content of 1.31 ± 0.01 . Tannin is one of the major active compound found in plant based medicine. It is used for wine, fruit juice and beer clarification in food in industries. They also serve as antioxidants in beverages as well as possessing antiviral, antibacterial and anti-tumor activity [21].

Similar increase was observed in the flavonoid and alkaloid content of the formulated smoothie. They significantly ($P<0.05$) increased with increasing concentration of mint leaves extract. The sample devoid of mint extract (SM) had the lowest value of 0.62 ± 0.01 for alkaloid. The highest quantities of flavonoid were obtained in SM8 (3.33 ± 0.01) while there was no significant different in the value obtained for sample SM4 and SM5 (Table 2). According to literature, alkaloids have a wide range of pharmacological activities including anti-malarial, anti-cancer, anti-bacterial, anti-hyperglycemic activities [22].

The phenol and cyanogenic glycoside content of the developed product was generally low with values varying from 0.02-0.41 mg/mL and 0.00-0.05% respectively. The phenolic content of SM8 was high (0.41 ± 0.01) and significantly different ($P<0.05$) from all the samples. The result also showed that these phytochemical significantly ($P<0.05$) increased with the increasing level of

addition of mint leaves extract. Cyanogenic glycoside value of sample SM6 and SM7 are not significantly different also SM2 and SM3 are of the same value of 0.02. The control had no value for cardiac glycoside. The presence of cardiac glycosides evaluate the use of smoothie in the management of heart related diseases. Cardiac glycosides as natural cardio active drugs used in the treatment of congestive heart failure and cardiac arrhythmia [23]. Other study reported the trend of increase in phenolic content of smoothie with increase in addition of Moringa leaves [24]. Phytochemicals are known to confer certain health benefits. Polyphenolic compounds including phenolic and flavonoid compounds are parts of bioactive components in food which promoting properties such as anti-inflammatory, antidiabetic and antihypertensive properties [25].

The secondary metabolites and other chemical constituents of medicinal plants account for their medicinal value. Cardiac glycosides are naturally cardio active drugs used in the treatment of congestive heart failure and cardiac arrhythmia. The phytochemical are naturally found in plants and are responsible for providing colour, aroma, and flavour to fruits and vegetables [26].

3.2 Vitamins

The effect of mint leaves extract addition on the vitamin content of smoothie produced from the blends of banana, apple and watermelon is shown in Table 3.

3.2.1 Vitamin A

A significant ($P<0.05$) increase was observed in the vitamin A content of the formulated smoothie as the level of addition of mint extract increased. The vitamin A content ranged from 466.00 to 584.67IU. The smoothie sample flavoured with 3% mint leaves extract (SM3) had the highest vitamin A value of 642.00 ± 1.73 IU while the

Table 2. Phytochemical properties of smoothie

Sample	Tannin	Saponin	Alkaloid	Flavonoid	Phenol	C. Glycoside
SM	1.87 ^g ± 0.01	1.07 ^h ± 0.01	0.62 ^l ± 0.01	1.62 ^h ± 0.01	0.02 ^h ± 0.00	0.00 ^g ± 0.00
SM1	2.12 ^e ± 0.00	1.14 ^g ± 0.00	0.74 ^h ± 0.01	2.41 ^g ± 0.00	0.06 ^g ± 0.01	0.01 ^f ± 0.00
SM2	2.12 ^e ± 0.00	1.21 ^f ± 0.00	0.80 ^g ± 0.01	2.48 ^f ± 0.01	0.09 ^f ± 0.00	0.02 ^e ± 0.00
SM3	2.02 ^f ± 0.01	1.27 ^e ± 0.04	0.90 ^f ± 0.03	2.53 ^e ± 0.05	0.14 ^e ± 0.02	0.02 ^e ± 0.00
SM4	2.00 ^f ± 0.00	1.31 ^d ± 0.01	0.94 ^e ± 0.01	2.61 ^d ± 0.11	0.16 ^{de} ± 0.01	0.03 ^d ± 0.00
SM5	2.41 ^a ± 0.01	1.31 ^d ± 0.01	0.99 ^d ± 0.00	2.63 ^d ± 0.00	0.18 ^d ± 0.01	0.34 ^c ± 0.00
SM6	2.35 ^b ± 0.00	1.36 ^c ± 0.01	1.07 ^c ± 0.01	2.87 ^c ± 0.01	0.28 ^c ± 0.02	0.04 ^b ± 0.00
SM7	2.23 ^c ± 0.01	1.41 ^b ± 0.01	1.12 ^b ± 0.01	2.96 ^b ± 0.01	0.32 ^b ± 0.00	0.04 ^b ± 0.00
SM8	2.20 ^d ± 0.00	1.46 ^a ± 0.01	1.34 ^a ± 0.00	3.33 ^a ± 0.01	0.41 ^a ± 0.01	0.05 ^a ± 0.00

Values are represented as means ± standard deviation of three replicates. Data in the same column bearing different superscript differed significantly ($P < 0.05$).

Keywords: SM= 50%Watermelon, 25%Apple, 25%Banana(Control), SM1= 25%Watermelon, 50%Apple, 24%Banana with 1% Mint Leaf Extract, SM2= 25%Watermelon, 23%Apple, 50%Banana with 2% Mint Leaf Extract, SM3= 47%Watermelon, 25%Apple, 25%Banana with 3% Mint Leaf Extract, SM4= 25%Watermelon, 25%Apple, 46%Banana with 4% Mint Leaf Extract, SM5= 25%Watermelon, 45%Apple, 25%Banana with 5% Mint Leaf Extract, SM6= 44%Watermelon, 25%Apple, 25%Banana with 6% Mint Leaf Extract, SM7= 25%Watermelon, 25%Apple, 43%Banana with 7% Mint Leaf Extract, SM8= 25%Watermelon, 42%Apple, 25%Banana with 8% Mint Leaf Extract

control (SM) had the lowest value of 466.00±1.73 IU. The RDA for vitamin A is within the range of 300-1300 IU [27]. Vitamin A helps with healthy mucous membranes, skin, vision, and bone growth.

3.2.2 Vitamin C

The vitamin C content of the samples ranged from 9.30-10.83 mg/100 ml with sample SM3 having the highest value of 10.83± 0.01 mg/100 ml while sample devoid of mint leaves extract (SM) had the least value of 9.30± 0.00 mg/100 ml.

The result showed that a significant difference ($P < 0.05$) existed among all the samples. Other study reported that the vitamin C content of freshly prepared orange juice was 41.4 mg/100 ml [28]. The vitamin C content obtained in this study was higher than 0.21- 0.68 mg/100 ml for smoothie produced from banana pulp and orange juice [29]. The Vitamin C is an important antioxidant that boost immune system. It also help with iron absorption for health and the proper formation of collagen. Its deficiency includes fragility to blood capillaries gum decay, scurvy [30].

Table 3. Vitamin A and vitamin C properties of smoothie samples

Samples	Vitamin A(IU)	Vitamin C(mg/100 ml)
SM	466.00 ^l ± 1.73	9.30 ^l ± 0.00
SM1	491.00 ^h ± 0.00	9.41 ^h ± 0.01
SM2	508.00 ^g ± 1.73	9.60 ^g ± 0.01
SM3	642.00 ^a ± 1.73	10.83 ^a ± 0.01
SM4	527.30 ^f ± 1.15	9.72 ^f ± 0.01
SM5	541.00 ^e ± 1.73	9.86 ^e ± 0.01
SM6	565.00 ^d ± 1.73	10.02 ^d ± 0.01
SM7	601.67 ^b ± 1.15	10.67 ^b ± 0.02
SM8	584.67 ^c ± 0.58	10.28 ^c ± 0.01

Values are represented as means ± standard deviation of three (3) replicates. Data in the same column bearing different superscript differed significantly ($P < 0.05$).

Keywords: SM= 50%Watermelon, 25%Apple, 25%Banana(Control), SM1= 25%Watermelon, 50%Apple, 24%Banana with 1% Mint Leaf Extract, SM2= 25%Watermelon, 23%Apple, 50%Banana with 2% Mint Leaf Extract, SM3= 47%Watermelon, 25%Apple, 25%Banana with 3% Mint Leaf Extract, SM4= 25%Watermelon, 25%Apple, 46%Banana with 4% Mint Leaf Extract, SM5= 25%Watermelon, 45%Apple, 25%Banana with 5% Mint Leaf Extract, SM6= 44%Watermelon, 25%Apple, 25%Banana with 6% Mint Leaf Extract, SM7= 25%Watermelon, 25%Apple, 43%Banana with 7% Mint Leaf Extract, SM8= 25%Watermelon, 42%Apple, 25%Banana with 8% Mint Leaf Extract

4. CONCLUSION

The study concluded that smoothie prepared with watermelon, apple, banana and mint leaves extract led to the production of highly nutritious juices. Also, the smoothie prepared with the highest mint leaves extract have highest phytochemicals.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Kader AA. Increasing food availability by reducing postharvest losses of fresh produce. 2005;682:2169-2176.
- Keenan DF, Brunton NP, Mitchell M, Gormley R, Butler F. Flavour profiling of fresh and processed fruit smoothies by instrumental and sensory analysis. International Food Research Journal. 2012;45(1):17–25
- Chang SK, Alasalvar C, Shahidi F. Review of dried fruits: Phytochemicals, antioxidant efficacies and health benefits. Journal of Functional Foods. 2016;21:113-132.
- Zhang X, Shu X, Xiang Y, Yang G, Li H, Gao J, Cai H, Gao Y, Zheng W. Cruciferous vegetable consumption is associated with a reduced risk of total and cardiovascular disease mortality. American Journal of Clinical Nutrition. 2011;94:240-246.
- Ferdinand KC, Patterson KP, Taylor C, Fergus IV, Nasser SA, Ferdinand DP. Community-based approaches to prevention and management of hypertension and cardiovascular disease. The Journal of Clinical Hypertension. 2012;14(5):336-343.
- Slavin JL, Lloyd B. Health benefits of fruits and vegetables. Advances in Nutrition: An International Review Journal. 2012;3(4): 506-516
- Yokoyama Y, Nishimura K, Barnard ND, Takegami M, Watanabe M, Sekikawa A, Okamura T, Miyamoto Y. Vegetarian diets and blood pressure: A meta-analysis. Jama Internal Medicine. 2014;174(4):577-587.
- Balaswamy K, Prabhakara Rao PG, Nagender A, Narsing Rao G, Sathiya Mala K, Jyothirmayi T, Math RG, Satyanarayana A. Development of smoothie from selected fruit pulp/juices. International Food Research Journal. 2013;20(3):1181-1185.
- Dattatreya M, Kadam RK, Goyal KK, Manoj KG Thin layer convective drying of mint leaves. Journal of Medicinal Plant Research. 2011;5(2):164-170
- Tarhan S, Telcil I, Tuncay MT, Polatii H. Product quality and energy consumption when drying peppermint by rotary drum dryer. Industrial Crops and Product Journal. 2010;32(3):420-427.
- Arslan D, Ozcan MM, Menges HO. Evaluation of drying methods with respect to drying parameters, some nutritional and colour characteristics of peppermint. Journal of Energy Conservation Management. 2010;51(12):2769-2775.
- Gayatri N, Mruntyanjay S, Rajani KS. Antioxidant potential and nutritional values of vegetables: A review. Research Journal of Medicinal Plants. 2014;8:50-81.
- Bajaj S, Urooj A, Prabhasankar P. Antioxidant properties of mint (*Mentha spicata* L.) and its application in Biscuits. Current Research in Nutrition and Food Science. 2016;4(3):209-216.
- Abdelrazzq-Al T, Ghazi-Al K, Adnan M. Comparative response of essential oil composition, antioxidant activity and phenolic contents spearmint (*Mentha spicata* L) under protected soilless vs. open file conditions. Advances in Environmental Biology. 2013;7(5):902-910.
- Trease GE, Evans WC. A text book of pharmacognosy, 15th edition. Academic press, London; 2002.
- Ebrahimzadeh MA, Pourmorad F, Bekhradnia AR. Iron chelating activity screening, phenol and flavonoid content of some medicinal plants from Iran. African Journal of Biotechnology. 2008;32:43-49.
- Tiwari P, Kumar B, Kaur M, Kaur G, Kaur H. Phytochemical screening and Extraction: A review. Internationale Pharmaceutica Scientia. 2011;1(1):98–106.
- Boakye AA, Wireko-Manu FD, Agbenorhevi JK, Oduro I. Antioxidant activity, Total phenols and phytochemical constituents of four under-utilised tropical fruits. International Food Research Journal. 2015;22(1):262-26.
- Achikanu CE, Eze-Stephen PE, Ude CM, Ugwuokolie OC. Determination of the vitamin and mineral composition of common leafy vegetables in South Eastern

- Nigeria. International Journal of Current Microbiology and Applied Sciences. 2013; 2(11):347-353.
20. AOAC. Vitamins and other nutrients. In: Association of official analytical chemists, editor. Official methods of analysis of the association of official analytical chemists international. Maryland: United States of America. 1998;16-17.
 21. Khanbabee K, Van-Ree T. Tannins: Classification and definition. Natural Product Reports. 2001;18(6):641-649.
 22. Ezeonu CS, Ejikeme CM. Qualitative and quantitative determination of phytochemical content of indigenous nigerian softwood. New Journal of Science. 2016;4(3):1-9.
 23. Ganpiseti R, Chandluri P, Lakshmi BVS. Swami PA. Cardiac glycosides uses in heart. World Journal of Pharmaceutical and Medical Research. 2016;2(5):1-10.
 24. Taiwo AA. Nutritional, antioxidant and quality acceptability of smoothie supplemented with *Moringa oleifera* leaves. Beverages. 2018;4(4):104-1120
 25. Zlabur JS, Dobricevic N, Pliestic S, Galic A, Bilic DP, Voca S. Antioxidant potential of fruit juice with added chokeberry powder (*Aronia melanocarpa*). Molecules. 2017;22(12):2158.
 26. Miglio C, Chiavaro E, Visconti A, Fogliano V, Pellegrini N. Effects of different cooking methods on nutritional and physicochemical characteristics of selected vegetables. Journal of Agriculture and Food Chemistry. 2005;56(1):139-147.
 27. Usman OG, Ameh UE, Alifa ON, Ameh MU, Vitamin and mineral evaluation of mixed fruit jam from blends of pineapple, orange and sourplum. Pakistan Journal of Food Sciences. 2015;25(3):137-143.
 28. Mequanint T, Moges G, Tessma M, Mehretu S. All solid-state iodide selective electrode for iodimetry of iodized salts and vitamin C. Oriental Journal of Chemistry. 2012;28(4):1547-1555.
 29. Surya PC, Shanta P Development of smoothies from banana pulp and orange juice. International Journal of Applied Research. 2015;1(9):261-263.
 30. Bender DA. Nutritional biochemistry of the vitamins. Second edition. New York and London: Cambridge University Press. 2009;30-76.

© 2020 Victor-Aduloju et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/59156>