African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 7, Issue 3, 2024 (pp. 70-80)
www.abjournals.org

QUALITY EVALUATION OF GINGER-SPICED *HIBISCUS SABDARIFFA* DRINK SWEETENED WITH DATES AND SUCROSE

Adewole S. A.[1*], Lawal T. F.[2], Adeoye B. K.[2], Adewole O. A.[3],

Olusanya P. A.[4], Oyesiji O. O.[5], Adebiyi-Olabode A. O.[5], and Ukangwa N. A.[3]

[1]Department of Agriculture and Industrial Technology, Babcock University, Ilishan-Remo, Nigeria.

[2]Department of Nutrition and Dietetics, School of Basic Medical Sciences, Benjamin S. Carson (Snr.) College Health and Medical Sciences, Babcock University, Ilishan-Remo, Nigeria.

[3]Department of Biochemistry, School of Basic Medical Sciences, Benjamin S. Carson (Snr.) College Health and Medical Sciences, Babcock University, Ilishan-Remo, Nigeria.

[4]Department of Food Science and Technology, Obafemi Awolowo University, Ile Ife.

[5]Department of Food Science, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

[*]Corresponding Author's Email: adewoles@babcock.edu.ng

Cite this article:

Adewole S. A., Lawal T. F., Adeoye B. K., Adewole O. A., Olusanya P. A., Oyesiji O. O., Adebiyi-Olabode A. O., Ukangwa N. A. (2024), Quality Evaluation of Ginger-Spiced Hibiscus Sabdariffa Drink Sweetened with Dates and Sucrose. African Journal of Agriculture and Food Science 7(3), 70-80. DOI: 10.52589/AJAFS-DBZQHXBR

Manuscript History

Received: 14 Apr 2024

Accepted: 20 Jun 2024

Published: 16 Jul 2024

ABSTRACT: *Sweetening of Hibiscus sabdariffa drink (zobo) with sucrose is a major drawback on its health benefits. This research assessed the quality of ginger-spiced Hibiscus sabdariffa "zobo" drink sweetened with dates and sugar. Four samples of zobo drink were produced and the drink samples were assessed for physico-chemical properties, nutrient composition, antioxidant properties and sensory qualities. Data was analyzed using one-way analysis of variance (ANOVA) with Statistical Package for Social Sciences (SPSS) version 20.0 at P<0.05 and means were separated using Duncan Multiple Range Test. The pH was between 2.88 and 2.96 while °brix was 3-14.5 and titratable acidity was 0.78 - 0.83. The ranges for the nutrient composition are; moisture content (82.41% - 90.46 %), ash content (0.13%-0.68%), crude fiber (0.00% - 0.02%), fat content (0.18% - 0.92%), protein content (0.45%-2.41%), carbohydrate content (8.77% - 13.65%). Results for the antioxidant properties ranges; total flavonoid content (19.12 – 32.30 mg/ml), phenolic content (38.34 to 45.53 mg/ml), diphenyl picrylhydrazyl (60.90-65.12 %), ferric reducing antioxidant power (40.04 – 50.50 mg GAE/ml) and total reducing power (0.63 – 0.93 µg/ml). The sensory results showed that the samples were all acceptable in terms of colour, aroma and overall acceptability. However, there was preference for sample with 5 % dates and 5 % sucrose. Addition of dates to zobo is beneficial in terms of crude fibre, vitamin C, antioxidant activities and sensory qualities.*

KEYWORDS: Quality, Hibiscus sabdariffa, Antioxidant, Zobo, Physico-chemical, Nutritional.

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR

African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 7, Issue 3, 2024 (pp. 70-80)

www.abjournals.org

INTRODUCTION

Beverage consumption has become a crucial part of human life vogue and it is determined more by socials instead of nutritional factors. Though, some are consumed as a substitute in filling nutritional deficits likewise for their stimulating effects. Beverages are liquids other than water that are occasionally consumed to satisfy thirst (Friedrichsen *et al*., 2023). Advances in research in recent years have resulted in changes in the global beverage market. For example, some carbonated beverages may contain carcinogenic substances like benzene, which can form from the reaction between sodium benzoate (a chemical preservative) and ascorbic acid. Additionally, consumers might experience allergic reactions to sulphites, benzoates, and other chemicals (Walczak-Nowicka & Herbet, 2022). These have resulted in changes in consumption pattern from highly processed exotic beverages to more minimally processed products from natural ingredients with a reduced effect of chemical preservatives with all the attendant negative health consequences.

In Nigeria, the production of non-alcoholic beverages usually called "zobo" from *Hibiscus sabdariffa* is very popular. The "zobo" is usually sweetened with sugar and sometimes flavored with spices such as ginger or garlic, along with natural flavorings or artificial flavorings depending on the producers (Bolar & Aboaba, 2004). There are reports of health benefits of *H. sabdariffa* drink and Adeoye *et al*. (2019) demonstrated its potential in protecting against oxidative damage of pBR 322 DNA induced by Fenton reagent.

Utilization of fruits in food preparation while requiring sweet taste is a wise strategy to reduce the added sugar intake. Dates, the fruit of date plant (*Phoenix dactylifera L*) are ideal fruits to substitute added sugar in foods, and they play an important role in daily nutrition of many people in the arid regions (Jain, 2012). Dates are excellent raw materials for the production of value-added products such as medical and industrial ethanol, bakery yeast, single-cell protein as a fodder yeast, citric acid, and date flavored probiotic fermented dairy products (Aleid, 2011). Dates are rich in dietary fiber, phenolic compounds, minerals, vitamins and antioxidant compounds (Haris *et al*., 2023). It has been determined that date fruits have potent antioxidant and antimutagenic qualities (Siddiqi *et al*., 2020). Date fruits are considered one of the major sources of carbohydrate which include simple sugars like glucose, fructose and sucrose. The presence of insoluble fibers such as cellulose, hemicellulose, pectin and lignins in dates, reduces the chances of bowel cancer and increases cardiac vitality (Khalid *et al*., 2022). The current study aimed at evaluating the physicochemical, nutritional, antioxidant and sensory quality of ginger-spiced *Hibiscus sabdariffa* drink sweetened with dates and sucrose.

MATERIALS AND METHODS

Sample Collection and Preparation

Dried *Hibiscus sabdariffa* (Zobo) calyces, dates, sucrose and ginger were purchased from a local market at Agege, Lagos State. Equipment and materials that were used for the production of the drink were obtained from the Nutrition and Dietetics laboratory, Babcock University, Ilishan-Remo, Ogun State.

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR

African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 7, Issue 3, 2024 (pp. 70-80)

www.abjournals.org

Blends of Zobo drink

The table below showed the formulation of the various blends of zobo drink produced

Table 1: Zobo drink samples composition

Sample	Zobo (g)	Calyces	Ginger (g)	Sucrose (g)	Dates (g)	Water (ml)
A	75		6.75	-	-	1418.25
B	75		6.75	-	150	1268.25
C	75		6.75	150	-	1268.25
D	75		6.75	75	75	1268.25

Production of Zobo Drink

Zobo drink was produced using the method of Ezekiel *et al.* (2016) with a little modification. The dried zobo calyces were sorted to remove dirt and be washed twice with clean water. While ginger also was washed thoroughly with clean water before it was grated. The water containing zobo calyces and grated ginger was brought to a boil and allowed to boil for ten minutes. It was cooled at room temperature for 20 min before being sieved. Blended date was added and allowed to boil again for 2 minutes. The zobo drink was allowed to cool before it was filtered using muslin cloth and was bottled in washed bottles.

Analysis

Physicochemical Properties

pH was measured using pH meter, total sugar content was determined using refractometer and total titratable acidity was determined according to the method of Opara and Rexford (2021).

Nutritional Composition

Moisture, crude protein, crude fat, crude fiber, and total ash were determined by the methods of (Association of Official Agricultural Chemists (AOAC), 2012), carbohydrate was determined by difference. Vitamin C content of samples was determined using redox titration reported by (Tranter, 2016).

Total Flavonoid content: Flavonoid content of each sample was analyzed following the spectrophotometric method of Dewanto and Liu *(*2022). 1 ml of samples was mixed with 9 ml distilled water in a 10 ml volumetric flask. Then, 5 % $NaNO_2$ solution (0.3 ml) was added to the flask. After 5 mins, 10% $AlCl_3$ (0.3 ml) was added and at 6th minute, 1.0 M NaOH (2 ml) was added and thoroughly shaken. The samples were incubated in a Uniscope SM801A laboratory water bath at 45 °C for 45 min and thereafter the absorbance was measured on a spectrophotometer (JENWAY 6305, Staffordshire, UK) at 765 nm. The test was carried out in replicates. Reagent blank; containing 1 ml ethanol (instead of the extract) was concomitantly prepared and treated in the same manner as the samples. A calibration curve was prepared by repeating the same procedure for standard solutions of Quercetin (2 to 10 µg/ml, $R^2 = 0.986$). From the measured absorbance of the samples, the total flavonoid content was estimated from

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR

African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 7, Issue 3, 2024 (pp. 70-80)
www.abjournals.org

the Quercetin calibration curve and results were expressed as mg Quercetin Equivalent per gram (mgQE/g) of the sample on a dry weight basis. The test was carried out in triplicates.

Phenolic Content

The phenolic content of the sample was assayed by the modified method of Singleton *et al*. (1999). The assay is based on the reduction of Folin-Ciocalteu reagents (Phosphomolybdate and phosphotungstate) by the phenolic compounds present in the extract. The reaction mixture was made by mixing 0.5 mL of ethanolic solution of the sample (containing 100 µg/mL), 2.5 mL of 10 % aqueous solution of Folin-Ciocalteu reagent, and 2.5 mL of 7.5 % $NaHCO_3$ solution. Blank was concomitantly prepared by mixing 0.5 mL ethanol, 2.5 mL of 10 % aqueous solution of Folin-Ciocalteu reagent, and 2.5 mL of $NaHCO_3$ solution. The sample was incubated in a Uniscope SM801A laboratory water bath at 45 °C for 45 min and thereafter the absorbance was measured with a spectrophotometer (JENWAY 6305, Staffordshire, UK) at 765 nm. Standard solutions of gallic acid were taken through the same procedure and the absorbance values obtained were used to construct a standard calibration curve. The measured absorbance of a sample was used to extrapolate its phenolic content from the standard calibration curve. The phenolic content was then expressed as the gallic acid equivalent (mg of GA/g) of the sample. Each sample was analyzed in triplicate.

Antioxidant Properties of the *Hibiscus Sabdariffa* Drink

DPPH Free Radical Scavenging Activity

Free radical scavenging ability of the extracts was tested by DPPH radical scavenging assay as described by Blois (1958) The hydrogen atom donating ability of the plant extractives was determined by the decolorization of methanol solution of 2,2-diphenyl-1-picrylhydrazyl (DPPH). DPPH produces violet/purple color in methanol solution and fades to shades of yellow color in the presence of antioxidants. A solution of 0.1 mM DPPH in methanol was prepared, and 2.4 mL of this solution was mixed with 1.6 mL of extract in methanol at different concentrations (12.5–150 µg/mL). The reaction mixture was vortexed thoroughly and left in the dark at RT for 30 min. The absorbance of the mixture was measured spectrophotometrically at 517 nm. Butylated Hydroxyanisole (BHT) was used as reference. Percentage DPPH radical scavenging activity was calculated by the following equation:

% DPPH radical scavenging activity = $\{(A_0 - A_1)/A_0 \times 100$% DPPH radical scavenging activity=$\{(A0 - A1)/A0\} \times 100$ where A_0 is the absorbance of the control, and A_1 is the absorbance of the extractives/standard.

Ferric Reducing Antioxidant Power

The ferric reducing antioxidant power (FRAP) reagent was prepared by mixing 300 mM acetate buffer, 10ml TPTZ in 40 mM HCl and 20 mM FeCl3.6H2O in the proportion of 10:1:1 at 37°. Freshly prepared working FRAP reagent was pipetted using 1-5 ml variable micropipette (3.995 ml) and mixed with 5 µl of the appropriately diluted plant sample and mixed thoroughly. An intense blue color complex was formed when ferric tripyridyl triazine (Fe3+ TPTZ) complex was reduced to ferrous (Fe2+) form and the absorbance at 593 nm was recorded against a reagent blank (3.995 ml FRAP reagent+5 µl distilled water) after 30 min incubation at 37°. All the determinations were performed in triplicates. The calibration curve was prepared by plotting the absorbance at 593 nm versus different concentrations of FeSO4. The

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR

concentrations of FeSO4 were in turn plotted against concentration of standard antioxidant trolox. The FRAP values were obtained by comparing the absorbance change in the test mixture with those obtained from increasing concentrations of Fe3+ and expressed as mg of Trolox equivalent per gram of sample.

Sensory Qualities

Sensory evaluation of the samples was conducted using 15 panel members that are familiar with quality attributes of the sample drinks. Samples were presented using uniform containers coded with three digits. A 9-point hedonic scale as described by Ojo *et al*. (2022) was used ranging from like extreme (9) to dislike extreme (1). Each sample was rated for taste, aroma, color and overall acceptability.

Statistical Analysis

Data was analyzed using analysis of variance (ANOVA) using Statistical Package for Social Science (SPSS) version 20.0 software 2011 to test the level of significance at 5% probability ($p<0.05$). Results were expressed as mean values and standard deviation of two (2) determinations.

RESULTS

Physico-chemical Properties of Ginger-Spiced *Hibiscus sabdariffa* Drink Sweetened with Dates/Sucrose

The results for the physio-chemical properties of the drink samples are presented in Figure 1. The samples showed an acidic pH ranging from 2.88 - 2.96 which were significantly different ($p<0.05$). The ºbrix value for the samples ranged from 3 - 14.5 which were also significantly different. There was a significant difference in the total titratable acidity of the samples which ranged from 0.778 – 0.832.

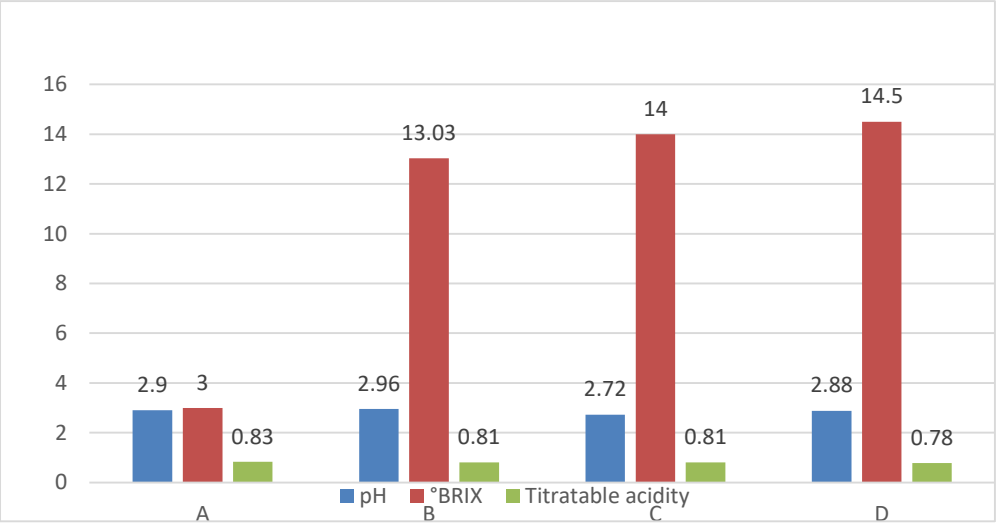

Fig. 1: Physicochemical properties of zobo samples sweetened with date and sucrose

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR

A: 75 g zobo and 6.75 g ginger

B: 75 g zobo, 6.75 g ginger and 150 g dates

C: 75 g zobo, 6.75 g ginger and 150 g Sucrose

D: 75 g zobo, 6.75 g ginger, 75 g dates and 75 g sucrose

Nutrient Composition of Ginger-spiced *Hibiscus sabdariffa* Drink Sweetened with Dates and Sucrose

The results for the nutrient composition of the samples are shown in Table 2. The results showed that there was significant difference at $p < 0.05$. The moisture content ranged between 82.41% and 90.46 % while the ash content of samples ranged from 0.13% – 0.68%. Crude fiber content ranged from 0.00% - 0.02% with no significant difference in samples B (10 % date), C (10% sucrose) and D (5% dates and 5% sucrose). There was a significant difference in the fat content of the samples which ranged from 0.18% - 0.92%. The protein content of the samples ranged from 0.45% - 2.41%. The samples were significantly different in the carbohydrate content which ranged from 8.77% - 13.65%. Sample A (0 % date and sugar) had highest moisture content but low values of other nutrients. The vitamin C content of the samples ranged from 2.05 – 3.11 mmol/l and was significantly different.

Table 2: Nutrient Composition of Ginger spiced *Hibiscus sabdariffa* Drink Sweetened with Dates and Sucrose

SAMPLE	A	B	C	D
Moisture content (%)	$90.47^{a} \pm 1.00$	$85.58^{b} \pm 1.00$	$83.59^{c} \pm 1.00$	$82.41^{d} \pm 1.00$
Protein (%)	$0.45^{d} \pm 1.00$	$2.06^{c} \pm 1.00$	$2.20^{b} \pm 1.00$	$2.41^{a} \pm 1.00$
Ash (%)	$0.13^{d} \pm 1.00$	$0.53^{c} \pm 1.00$	$0.67^{a} \pm 1.00$	$0.59^{b} \pm 1.00$
Fat (%)	$0.18^{c} \pm 1.00$	$0.74^{b} \pm 1.00$	$0.91^{a} \pm 1.00$	$0.92^{a} \pm 0.74$
Crude fiber (%)	$0.00^{b} \pm 1.00$	$0.02^{a} \pm 0.45$	$0.01^{a} \pm 0.45$	$0.01^{a} \pm 0.45$
Carbohydrate (%)	$8.77^{d} \pm 1.00$	$11.10^{c} \pm 1.00$	$12.61^{b} \pm 1.00$	$13.65^{a} \pm 1.00$
Vitamin C	$2.23^{c} \pm 1.00$	$3.11^{a} \pm 1.00$	$2.05^{d} \pm 1.00$	$2.40^{b} \pm 1.00$

Values with different superscripts in the same row are significantly different $P < 0.05$.

A: 75 g zobo and 6.75 g ginger

B: 75 g zobo, 6.75 g ginger and 150 g dates

C: 75 g zobo, 6.75 g ginger and 150 g Sucrose

D: 75 g zobo, 6.75 g ginger, 75 g dates and 75 g sucrose

Antioxidant Activity of *Hibiscus sabdariffa D*rink Sweetened with Dates and Sucrose

The results for the flavonoid and phenolic concentrations of each sample are shown in Figure 2 while Figure 3 showed the values for the antioxidant activities. There was a significant difference at $p < 0.05$ in total flavonoid content of the samples which ranged from 19.12 – 32.30 mg/ml while the total phenolic content ranged from 38.34 to 45.53 mg/ml. The DPPH of the samples were significantly different (60.90 – 65.12 %). FRAP of the samples ranged from 40.04 – 50.50 mg GAE/ml and there was no significant difference between samples B (10%

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR

date) and C (10% sucrose). There was a significant difference in TRP of the samples which ranged from 0.63 – 0.93 µg/ml.

Sensory Analysis of Ginger Spiced *Hibiscus sabdariffa* Sweetened with Dates and Sucrose

The results for the sensory analysis of the samples are shown in Table 3. It shows that there is a significant difference at $p < 0.05$ in the color, taste, aroma and overall acceptability of the samples. The color of the samples ranged from 7.60 – 8.03. The aroma of the samples ranged from 6.73 – 7.80. The taste of the samples ranged from 4.93 – 7.93. The overall acceptability of the sample ranged from 6.26 – 7.86. Sample D had the highest value for overall acceptability followed by sample C.

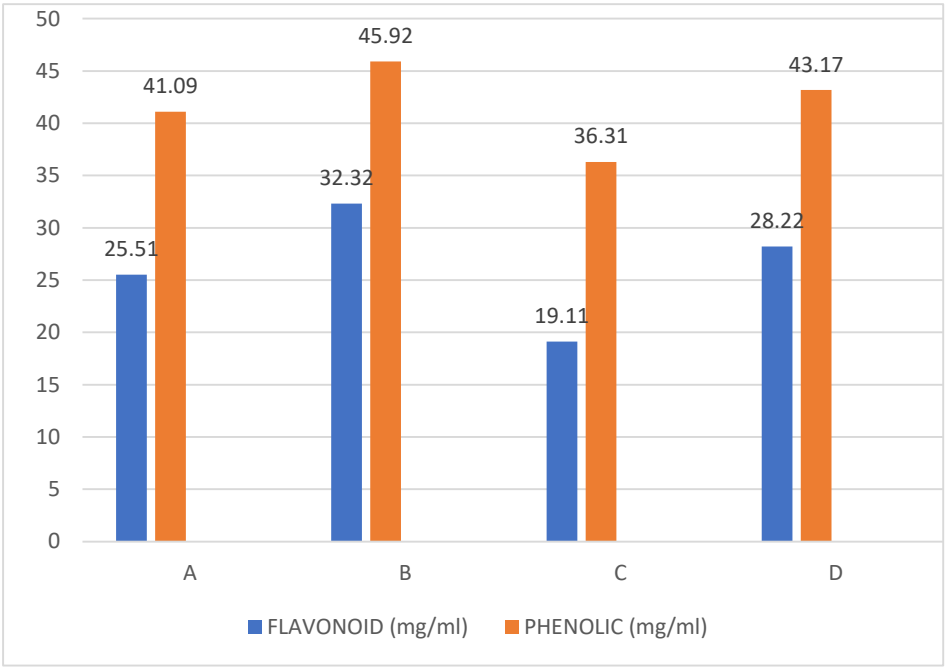

Fig 2: Antioxidant activity of *Hibiscus sabdariffa* drink sweetened with dates and sucrose

A: 75 g zobo and 6.75 g ginger

B: 75 g zobo, 6.75 g ginger and 150 g dates

C: 75 g zobo, 6.75 g ginger and 150 g Sucrose

D: 75 g zobo, 6.75 g ginger, 75 g dates and 75 g sucrose

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR

African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 7, Issue 3, 2024 (pp. 70-80)

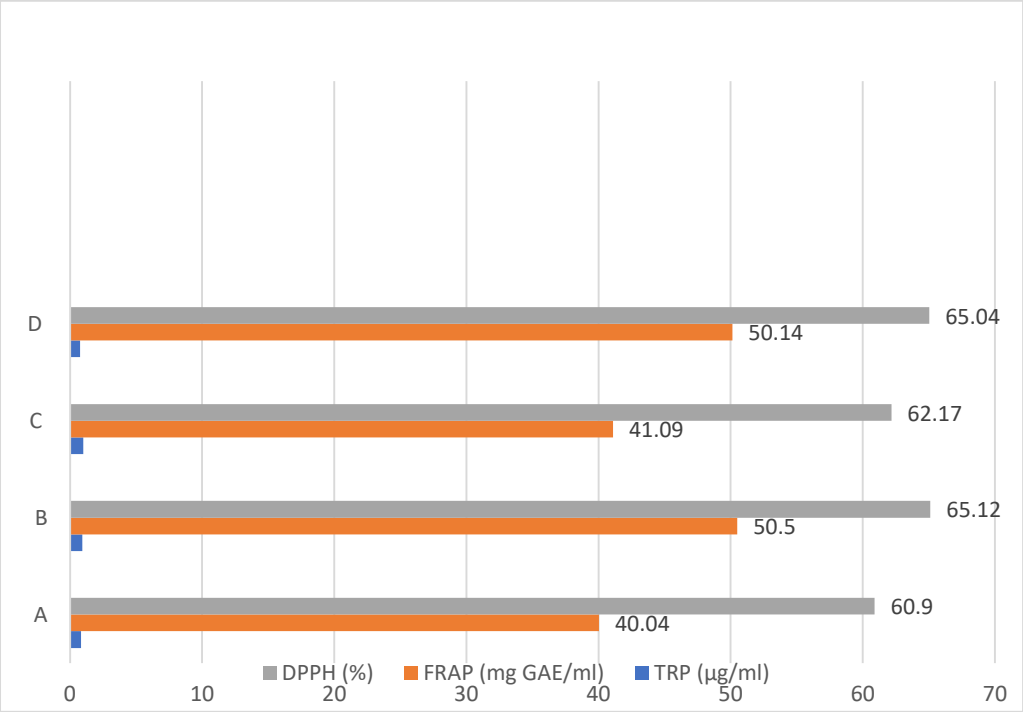

Fig 3: Antioxidant activity of *Hibiscus sabdariffa* drink sweetened with dates and sucrose

A: 75 g zobo and 6.75 g ginger

B: 75 g zobo, 6.75 g ginger and 150 g dates

C: 75 g zobo, 6.75 g ginger and 150 g Sucrose

D: 75 g zobo, 6.75 g ginger, 75 g dates and 75 g sucrose

Table 3: Sensory Analysis of Ginger-Spiced *Hibiscus sabdariffa* Sweetened with Dates and Sucrose

Sample	Colour	Aroma	Taste	Overall Acceptability
A	7.60^{d}	6.73^{d}	4.93^{d}	6.26^{d}
B	8.03^{a}	7.80^{a}	6.73^{c}	7.13^{c}
C	$7.8\ 0^{c}$	7.06^{c}	7.73^{b}	7.66^{b}
D	8.00^{b}	7.26^{b}	7.93^{a}	7.86^{a}

Values with different superscripts in the same column are significantly different $P < 0.05$.

A: 75 g zobo and 6.75 g ginger

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR

B: 75 g zobo, 6.75 g ginger and 150 g dates

C: 75 g zobo, 6.75 g ginger and 150 g Sucrose

D: 75 g zobo, 6.75 g ginger, 75 g dates and 75 g sucrose

DISCUSSION

The quality of ginger-spiced *Hibiscus sabdariffa* drink sweetened with dates was assessed. The results of the physico-chemical properties showed that there was significant difference in the samples at P<0.05. However, the pH (2.88 – 2.98) and the titratable acidity (0.778 – 0.832) of the samples were close while addition of date and sucrose produced a significant change in the °brix (3 – 14.5). The drink is a natural acidulant since its pH is between 2.88 -2.96 (Mohammed and Ismail, 2014.) and it is in agreement with the range (2.9 –3.0) reported by Mohammed and Ismail (2014) for zobo samples sweetened with pineapple. This experiment shows that there were significant changes in the nutrient composition of the zobo drink samples with addition of date and sucrose at P<0.05. The sample with the lowest protein content (0.45%) was sample A (0 % date and sucrose), followed by the sample B (2.06 %), while sample D (5 % date and 5 % sucrose) had the highest protein content (2.41 %). Osueke and Ehirim (2008) in a study on zobo with ginger, sugar and strawberry flavour and selected soft drink in Nigeria recorded a protein value ranging between 0.40 –2.40 % which is quite similar to the findings of this study. The lowest ash content was found in the sample A (0.13%), followed by samples B (0.53%) and D (0.59%). The highest ash content was found in sample C (0.67%). This simply signifies that the ash content of the samples increased with the addition of dates and sucrose. These values are lower than the 0.93% recorded by Ekanem (2018) for laboratory produced zobo drink fortified with spices and sugar. Sample A had the lowest carbohydrate content (8.77 %) this can be attributed to the fact that there was no addition of dates or sucrose to it. The highest carbohydrate was found in sample D (13.65%). Adeniji (2017) recorded 8.3 – 9.0% for zobo drink fortified with soybean which is lower than the value obtained in this study. The sample with the highest fat content was sampleD (0.92%) which is lower than 1.31% reported by Ekanem (2018). The vitamin C content of the sample ranged from 2.05% - 3.11%, with sample C being the lowest and sample B being the highest. The samples were significantly different at P<0.05 in antioxidant activity. The flavonoid content of the samples ranged from (19.11 mg/ml - 32.32 mg/ml), with Sample C (10 %) being the lowest and sample B (10 %) being the highest. The phenolic content of the samples ranged from 36.31 mg/ml - 45.92 mg/ml. The results of the antioxidant activity were different from what was reported for zobo samples spiced with ginger and zobo samples sweetened with sugar reported by Oboh (2011). The mean scores for the sensory analysis of the samples show that there was a significant difference at p<0.05 in the color, taste, aroma and overall acceptability of the samples. The color of the samples ranged from (7.60 – 8.03), sample A had the least rating while Sample B had the highest rating in color. The aroma of the samples ranged from (6.73 – 7.80). The taste of the samples ranged from (4.93 –7.93), sample D had the highest rating in taste. The overall acceptability of the sample ranged from (6.26 – 7.86). Sample D had the highest value in terms of overall acceptability followed by sample C. The least acceptable was sample A. Sample D was more acceptable due to the combination of dates and sucrose.

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR

CONCLUSION

Hibiscus sabdariffa drink (zobo) can be spiced with ginger and sweetened with dates. Difference produced in pH and titratable acidity by addition of dates and sucrose was not as wide as the ^{o}brix. Addition of dates and sucrose greatly increased the ^{o}brix of the zobo samples. The addition of dates and sucrose increased the ash content and carbohydrate content. The dates and sucrose reduced the moisture content of the zobo drink, whereas there was an increase in other nutrients. The dates greatly increased the vitamin C content of the drink. The phenolic and flavonoid content of the drinks as well as the antioxidant activity was also increased by the addition of dates. Consumption of *Hibiscus sabdariffa* drink sweetened with dates will be more beneficial in terms of higher crude fiber content, vitamin C., phenolic and flavonoid content. Dates improved the color and aroma of the drink while inclusion of the mixture of dates and sugar significantly improved the taste and made the drink to be more acceptable. The research prospects include determination of the microbial quality, and shelf-life stability of the drink and inclusion of possible additives to improve the overall quality and acceptance.

CONFLICT OF INTEREST

The authors declare no conflict of interests regarding the publication of this article.

REFERENCES

Adeniji, P. O. (2017). Nutritional, sensory and microbiological quality assessment of fortified Zobo drink: A home-prepared traditional Nigerian beverage. *Journal of Nutrition & Food Sciences*, 7(5). https://doi.org/10.4172/2155-9600.1000627

Adeoye, B. K., Oyewole, O. B., Idowu, M. A., Ademuyiwa, O., Obadina, A. O., Adaramola, F. B., Ani, I. F., & Ngozi, E. O. (2019). Protection against oxidative damage properties of Hibiscus sabdariffa drink (Zobo) and added natural food additives. *European Journal of Scientific Research*, 152(2), 153-162.

Aleid, S. M. (2011). Industrial biotechnology: Date palm fruit applications. In S. M. Jain, J. M. Al-Khayri, & D. V. Johnson (Eds.), *Date palm biotechnology* (pp. 675-709). Springer.

Al-Farsi, M., Alasalvar, C., Morris, A., Baron, M., & Shahidi, F. (2005). Comparison of antioxidant activity, anthocyanins, carotenoids, and phenolics of three native fresh and sun dried date (Phoenix dactylifera L.) varieties grown in Oman. *Journal of Agricultural and Food Chemistry*, 53, 7592-7599.

AOAC. (2012). *Association of Official Analytical Chemists International* (20th ed.). AOAC International.

Blois, M. S. (1958). Antioxidant determinations by the use of a stable free radical. *Nature*, 181, 1199-1200. https://doi.org/10.1038/1811199a0

Bolar, O., & Aboaba, O. O. (2004). Microbiological and physicochemical evaluation of some non-alcoholic beverages. *Pakistan Journal of Nutrition*, 3, 188-192.

Dewanto, V., Whu, Z., & Liu, R. H. (2022). Processed sweet corn has higher antioxidant activity. *Journal of Agricultural and Food Chemistry*, 50(17), 4959-4964.

Ekanem, J. O., Daniel, U. J., Akpan, B. C., & Akpan, E. A. (2018). Microbiological assessment and proximate composition of sorrel (Zobo) drinks sold in Ikot Ekpene metropolis, Akwa

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR

Ibom State, Nigeria. *Journal of Research in Forestry, Wildlife & Environment*, 10(4), 92-99.

Ezekiel, T., Solomon, L., Oforibika, A. G., & Daminabo, V. (2016). Nutritional, sensory and bacteriological quality of two varieties of locally prepared Zobo (Hibiscus sabdariffa) drink. *World Rural Observations*, 8(3), 99-104.

Friedrichsen, M., Waldréus, N., Milovanovic, M., Schaller, A. S., Jaarsma, P., & Jaarsma, T. (2023). The responsibility to quench thirst by providing drinks when a relative is dying: Spouses' experience in specialist palliative home care. *BMC Palliative Care*, 22(184), 1-10.

Haris, S., Alam, M., Galiwango, E., Mohamed, M. M., Kamal-Eldin, A., & Al-Marzouqi, A. H. (2023). Characterization analysis of date fruit pomace: An underutilized waste bioresource rich in dietary fiber and phenolic antioxidants. *Waste Management*, 163, 34-42. https://doi.org/10.1016/j.wasman.2023.03.027

Jain, S. M. (2012). Date palm biotechnology: Current status and prospective—an overview. *Emirates Journal of Food and Agriculture*, 24, 386-399.

Khalid, W., Arshad, M. S., Jabeen, A., Anjum, F. M., Qaisrani, T. B., & Rasul Suleria, H. A. (2022). Fiber-enriched botanicals: A therapeutic tool against certain metabolic ailments. *Food Science & Nutrition*, 10(10), 3203-3218. https://doi.org/10.1002/fsn3.2920

Mohammed, S. F., & Ismail, B. B. (2014). Comparison of two methods of preparation of Zobo drink on the survival of Bacillus species. *American Journal of Food Technology*, 9(4), 200-208.

Oboh, H. A., & Umoru, A. I. (2011). Total phenolics, vitamin C and free radical scavenging capacities of some Nigerian fruits. *Nigerian Journal of Biochemistry and Molecular Biology*, 26(1), 55-62.

Ojo, M. A., Ologunde, M. O., Alabi, O. D., Ohijeagbon, O. R., & Ojo, H. (2022). Evaluation of cocoyam soybean flour blends and sensory properties of the Amala dumpling. *Agriculture and Food Sciences Research*, 9(1), 44-49.

Opara, C. C., & Rexford, N. L. (2021). Production of wine from Zobo (Hibiscus sabdariffa) flower juice. *Journal of Biochemical Technology*, 3(4), 436-437.

Siddiqi, S. A., Rahman, S., Khan, M. M., Rafiq, S., Inayat, A., Khurram, M. S., Seerangurayar, T., & Jamil, F. (2020). Potential of dates (Phoenix dactylifera L.) as natural antioxidant source and functional food for healthy diet. *Science of The Total Environment*, 748, 141234. https://doi.org/10.1016/j.scitotenv.2020.141234

Singleton, V. L., Orthofer, R., & Lamuela-Raventos, R. M. (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *Methods in Enzymology*, 299, 152-178.

Tranter, R. (2016). Redox titration using iodine solution. *Vitamin C Titration Calculations*.

Vayalil, P. K. (2002). Antioxidant and antimutagenic properties of aqueous extract of date fruit (Phoenix dactylifera L. Arecaceae). *Journal of Agricultural and Food Chemistry*, 50(3), 610-617. https://doi.org/10.1021/jf010716t

Walczak-Nowicka, Ł. J., & Herbet, M. (2022). Sodium benzoate—Harmfulness and potential use in therapies for disorders related to the nervous system: A review. *Nutrients*, 14(7). https://doi.org/10.3390/nu14071497

Article DOI: 10.52589/AJAFS-DBZQHXBR
DOI URL: https://doi.org/10.52589/AJAFS-DBZQHXBR