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Value-Added Zobo Drink with Date Juice

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Abstract.
Hibiscus sabdariffa L., also known as edible roselle, belongs to the *Malvaceae* family and is native to West Africa. In Nigeria, its dried petals are processed by boiling and filtration into a non-alcoholic beverage called Zobo. Commercial Zobo often includes artificial sweeteners that improve its taste. As a result, local food science needs new formulations with natural and health-beneficial sweeteners. The research objective was to produce a Zobo drink with different blends of date fruit juice as a natural sweetener, as well as evaluate its proximate, physicochemical, and sensory properties.

The control Zobo drink (Zcon) involved an artificial sweetener. The ratios of Zobo to date juice were 90:10 (ZD10), 80:20 (ZD20), 70:30 (ZD30), 60:40 (ZD40), and 50:50 (ZD50). The samples underwent proximate and physicochemical analyses, as well as a sensory assessment on a nine-point hedonic scale.

The physicochemical analysis showed that Sample ZD50 with the 50:50 ratio had the highest pH (3.5) and sugar content (9.5°Bx) while the control sample had the lowest pH (2.5) and sugar content (0.9°Bx), with all samples showing significant ($p \geq 0.05$) differences. The proximate analysis also showed a wide range of results ($p \geq 0.05$). The control sample demonstrated the highest moisture content (97.0%) whereas Sample ZD50 had the highest ash and lipid content of 0.8 and 4.8%, respectively. Sample ZD50 also had the highest protein (2.23%) and crude fiber content (2.49%). Sample ZD40 with the 60:40 ratio had the highest carbohydrate content. In terms of mouthfeel and taste ($p \geq 0.05$), the control sample demonstrated the highest scores while the lowest score belonged to Sample ZD10 with the lowest proportion of date juice. The best results for general acceptance belonged to the control, followed by ZD40 (60:40) and ZD50 (50:50).

Date juice proved to be an effective sweetener that improved the nutritional profile of Zobo. However, the sensory analysis showed that consumers preferred the control sample with the artificial sweetener.

Keywords. *Hibiscus sabdariffa*, roselle, drinks, sweetener, *Phoenix dactylifera*, phytochemicals, chemical composition, physicochemical analysis, sensory analysis, quality

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Пищевая ценность традиционного напитка «зобо» с финиковым соком

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Аннотация.
Розелла (*Hibiscus sabdariffa* L.) принадлежит к семейству мальвовых и произрастает в Западной Африке. В Нигерии ее высушенные лепестки путем кипячения и фильтрации перерабатывают в безалкогольный напиток «зобо». В состав «зобо» входят искусственные подсластители, которым требуется натуральная альтернатива. Цель исследования заключалась в изучении влияния финикового сока, используемого в качестве подсластителя, на физико-химические и органолептические свойства напитка «зобо».

В контрольный образец (Zcon) вносился искусственный подсластитель. В экспериментальных образцах соотношение «зобо» и финикового сока составляло 90:10 (ZD10), 80:20 (ZD20), 70:30 (ZD30), 60:40 (ZD40) и 50:50 (ZD50). Образцы были подвергнуты компонентному и физико-химическому анализу, а также органолептической оценке по девятибалльной гедонистической шкале.

Физико-химический анализ показал, что образец ZD50 с соотношением «зобо» и финикового сока 50:50 имел самые высокие значения pH (3,5) и содержания сахара (9,5°Bx), тогда как контрольный образец имел самые низкие значения – 2,5 и 0,9°Bx соответственно. Все образцы демонстрировали значимые различия ($p \geq 0,05$). Самое высокое содержание влаги было обнаружено в контрольном образце (97,0 %), золы (0,8 %) и липидов (4,8 %) – в образце ZD50. Образец ZD50 продемонстрировал самые высокие результаты по содержанию белка (2,23 %) и сырой клетчатки (2,49 %). Образец ZD40 с соотношением «зобо» и финикового сока 60:40 имел самое высокое содержание углеводов. Контрольный образец получил самые высокие баллы за вкус и комплексное ощущение во рту вкуса, запаха, фактуры и консистенции ($p \geq 0,05$). Самую низкую оценку получил образец ZD10 с наименьшей долей финикового сока. Наилучшие результаты получил контрольный образец, за которым следовали образцы ZD40 (60:40) и ZD50 (50:50).

Финиковый сок оказался эффективным подсластителем, который повысил питательные свойства традиционного напитка «зобо». Однако органолептический анализ показал, что потребители предпочли контрольный образец с искусственным подсластителем.

Ключевые слова. *Hibiscus sabdariffa*, розелла, напитки, подсластитель, *Phoenix dactylifera*, фитопрепараты, химический состав, физико-химический анализ, органолептическая оценка, качество

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Introduction

People have been using plants as food source throughout millennia. Numerous studies prove that fruits and vegetables prevent and/or treat chronic diseases, including cancer, diabetes, cardiovascular disease, and obesity [1–3]. Many common food items, including grains, roots, fruits, vegetables, and natural beverages are of plant origin [4, 5]. Natural juice and beverages are produced by pressing mature fruits or tapping soft fruits, inflorescences, and stems to obtain sap. Plant-based foods and drinks are free of salt, sugar, and saturated fats, which helps to prevent some chronic health issues [6]. The market is currently flooded with soft drinks, which are mainly carbonated waters. In fact, alcohol drinks are responsible for only 0.5% of the total volume [6]. However, it is soft drinks that cause obesity, diabetes, and stroke. They contain phosphoric, malic, citric, and tartaric acids, which damage the surface of teeth and

result in a variety of dental issues as well as osteoporosis [6]. Naturally blended fruit juice or drinks can be a good alternative to carbonated soft drinks.

Hibiscus sabdariffa L., or edible roselle, belongs to the *Malvaceae* family. It is an annual tropical shrub with red or green inflated edible calyces. The shrub can be 0.5–0.3 m in height and has a powerful tap root [7]. This crop was first discovered in India and then introduced into other parts of the world, such as Central America, West Indices, and Africa [8]. The calyces are red, dark red, and green [8]. Roselle leaves, seeds, flowers, and roots are edible, but the red calyces are the most useful part of the plant [salami]. Roselle calyces are utilized in the production of many food products, including beverages, jams, and sauces. In Nigeria, it is mainly found in the northern regions, where dried petals are boiled and filtered to produce a beverage popularly called Zobo [9]. Roselle drink has gained global popularity as a refreshing medicinal drink. This drink has a characteristic taste. Sweeteners and spices give it a relish and appetite-promoting flavor. It contains a reasonable amount of natural carbohydrates, minerals, and essential vitamins and serves as a good source of vitamin C [10]. In this respect, Zobo is a promising substitute for soft drinks and fruit juice as it contains some of the major constituents of a typical soft drink or fruit juice and has gained popularity and acceptance across Nigeria and beyond [11]. Millions of people consume it daily, particularly young population, who treat it as a cheap and relaxing alternative non-alcoholic beverage in social gatherings [12]. However, the bland taste of Zobo is a challenge to drink producers, who started to add artificial sweeteners into its formulation. As natural foodstuffs are gaining more popularity, Zobo needs natural options to improve its taste, mouthfeel, and overall acceptability.

The date palm (*Phoenix dactylifera* L.) is the oldest fruit crop that can serve as a natural sweetener. It is rich in medicinal bioactive and functional substances, including polyphenols, flavonoids, carotenoids, phytosterols, phytoestrogens, vitamins, and minerals [4, 13]. The date palm belongs to the *Arecaceae* family and originates in Mesopotamia (now Iraq) [14]. It is considered one of the most ancient and basic staple foods in Southwest Asia and North Africa [4]. In Nigeria, it is mostly consumed in the northern parts of the country, where it is called *Dabino*. It is also known to have religious and cultural significance [15]. Dates contain a high amount of carbohydrates (total sugar: 44–88%) and dietary fiber, thereby making it a good source of vitamins and macro-nutrients, such as potassium, iron, magnesium, and calcium [16]. Dates contain more than 3000 calories per kilogram and 70% carbohydrates (mostly sugars). The date pulp consists of 60–65% sugar, 2.5% fiber, 2% protein, and ≤ 2% fat, as well as minerals and protein substances [17]. Dates contain phytochemicals, e.g., carotenoids, phenolics, and flavonoids. Dietary antioxidants prevent degenerative diseases, e.g., cardiovascular or neurological conditions, cancer, and gastric ulcers. Oxidative stress is one of the most prevalent factors in the etiology of chronic diseases [18].

Ready-to-serve drinks are refreshing beverages that can be consumed without dilution [19]. This type of fruit beverage contains at least 10% fruit juice and 10–15% total soluble solids, as well as a trace amount of acid [4, 19]. When heated in an open environment, fruit juices tend to lose flavor, vitamins, and color during processing. Boiling destroys all their nutrients. Different techniques could be used to concentrate fruit juices. The global market is in constant search for fruit juice concentrates that would retain the original color, flavor, and vitamins. Presumably, Zobo fortified with date fruit juice is free of all the disadvantages associated with artificial sweeteners while providing more vitamins and minerals

Study objects and methods

Materials. The local variety of matured dried red roselle calyces (Fig. 1), the date palm fruits, and the Joccy sweetener were purchased from the Eke-Onunwa market in Owerri, Imo State, Nigeria. The authentication and validation of the samples were performed by Mr. Felix Nwafor at the Department of Crop Science, Federal University of Technology, Owerri. The samples were then taken to the Department of Food Science and Technology, Federal University of Technology, Owerri, for further processing and use.

Producing the Zobo/date drink. The roselle calyces were sorted, washed, and weighed (300 g). They were boiled in 4 L of water for 10 min, allowed to cool, and filtered using a sterile muslin cloth. The dried dates were deseeded, weighed (850 g), and soaked in water (1800 mL) for 8 h. The slurry was then wet-milled, mixed with extra water (1200 mL), boiled for a few seconds, and filtered through muslin cloth. The date juice was obtained from the filtrate. The Zobo drink and the date fruit juice were blended in different ratios of of 90:10, 80:20, 70:30, 60:40, and 50:50 and labeled as samples

a b

Figure 1. Roselle calyces

Рисунок 1. Чашечки розеллы

Figure 2. Zobo/date drink samples

Рисунок 2. Образцы напитка «зобо» с финиковым соком

ZD10, ZD20, ZD30, ZD40, and ZD50, respectively (Fig. 2). The control was prepared using Joccy artificial sweetener and labeled as Zcon. Figure 3 shows a flowchart of the Zobo/date juice production process.

Analytical measurements. ***Proximate analysis.*** The samples underwent a chemical analysis to determine their nutritional composition according to the standard methods described by the Association of Official Analytical Chemists [20].

Determining the moisture content. For the moisture content test, 10 g of each sample was measured into a crucible of particular weight, and the resulting weight was calculated. The crucible was put into a moisture extraction oven at 105°C for 3 h. The dried samples were cooled in desiccators and weighed. After re-drying, they were cooled and re-weighed. The process was repeated until a constant weight was obtained. The difference in weight before and after drying was recorded as moisture content, %.

$$\text{Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \qquad (1)$$

where W_1 is the initial weight of the empty crucible, g; W_2 is the weight of the crucible together with the undried sample, g; and W_3 is the weight of the crucible together with the dried sample, g.

Determining the ash content. To calculate the ash content, 10 g of each sample was weighed into a crucible and heated in a moisture extraction oven at 100°C

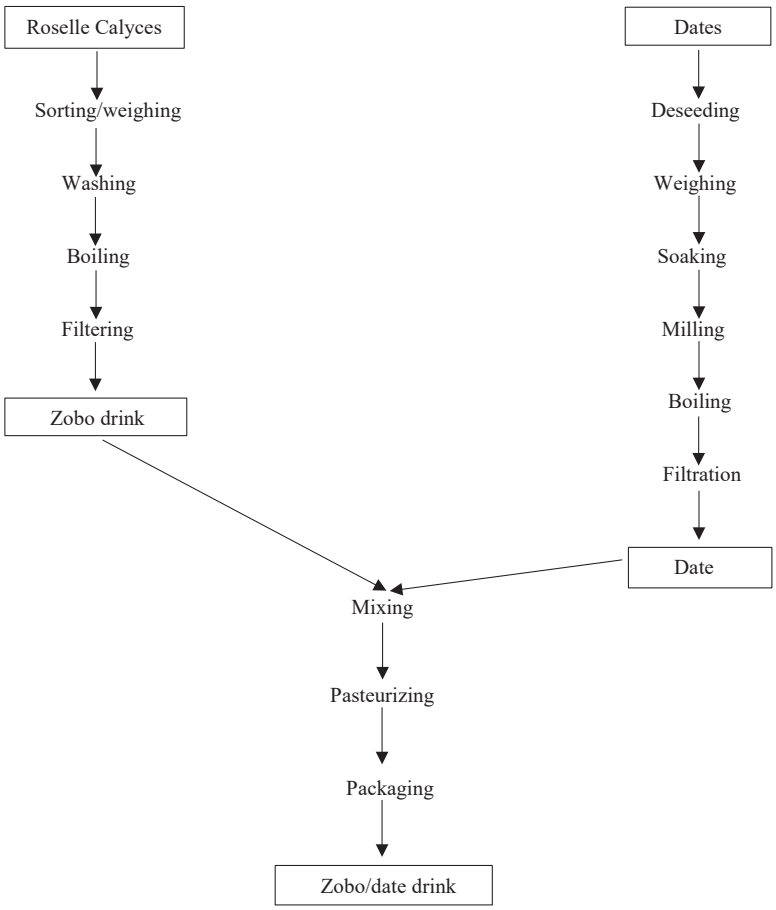

Figure 3. Zobo/date drink production: flowchart

Рисунок 3. Блок-схема технологии производства напитка «зобо» с финиковым соком

for 3 h before being transferred into a muffle furnace with a temperature of about 550°C where it stayed until it turned white and became free of carbon. The samples were then removed from the furnace, cooled in a desiccator, and reweighed. The weights of the residues were calculated as ash content, %.

$$\text{Ash} = \frac{Weight\ of\ ash}{Weight\ of\ sample} \times 100 \quad (2)$$

Determining the fat content. To determine the fat content, we applied the Werner-Schmid method, also known as Solubilisation extraction method. We weighed 10 g of each sample into an extraction tube with 10 mL of water and concentrated HCl. After that, we placed the tubes into a boiling water bath with occasional shaking until the solid particles dissolved, and the mix changed color. The samples were then taken off the water bath and cooled rapidly, followed by adding 10 mL alcohol along with 30 mL of diethyl ether. After a vigorous mixing, it was allowed to separate, and the ether layer went into a pre-weighed Soxhlet flask. The extraction was repeated twice with 25 mL of dim ethyl ether and collected in the same flask. After the solvent evaporated, the residual fat was dried in an oven at 100°C for 45 min until constant weight.

Determining the crude protein, %. The formol titration method helped to determine the protein content. Since the samples were liquid, 10 mL of each sample was added to a mix of 0.5 mL 0.5% phenolphthalein and 0.4 mL neutral saturated potassium oxalate. The mix was left to settle for a few minutes before adding 0.1M NaOH to neutralize the mix and give it its standard pink color. After a few minutes, we added 2 mL of formalin. The mix was allowed to stand for few minutes before being titrated with 0.1M NaOH until it became light pink. The process was repeated for the blank using water.

$$\text{Crude protein} = 1.7(V_1 - V_2) \quad (3)$$

where V_1 is the initial volume of the sample, mL; V_2 is the final volume of the sample, mL.

Determining the crude fiber. We mixed 2 g of each sample with 200 mL of 1.25% H_2SO_4 solution in a conical flask and boiled for 30 min. The solution and the content were poured into a Buchner funnel and filtered through muslin cloth, which was secured with an elastic band. The residue was washed with hot water to free the acid. After that, we scooped the residue into a conical flask and mixed with 200 mL of 1.25% NaOH solution. Each sample was boiled for 30 min before being transferred to the Buchner funnel and filtered. The residues obtained were put in a clean dried crucible and dried in a moisture extraction oven until constant weight. Subsequently, we put the dried residues into a muffle furnace where they turned into ash. The samples were cooled in desiccators and weighed to calculate the crude fiber percentage, %.

$$\text{Fiber} = \frac{W_1 - W_2}{W_3} \times 100 \quad (4)$$

where W_1 is the weight of the sample before incineration, g; W_2 is the weight of sample after incineration, g; W_3 is the weight of original sample, g.

Determining the carbohydrate content. The carbohydrate content, %, was estimated using the equation below:

$$\text{Carbohydrate} = 100 - (\%\ Moisture + \%\ Protein + \%\ Fat + \%\ Cruder\ fiber) \quad (5)$$

Physicochemical analysis. *Determining pH and Brix.* The pH of the samples was analyzed physiochemically using a pH meter (Mettler Toledo, U.S.A). We used a portable digital refractometer to determine the Brix/total soluble sugar values.

Titratable acidity. To determine the titratable acidity, we employed the colored indicator method in its must and wine variant [21]. A cleaned and dried 10 mL pipette was used to draw up 10 mL of the samples and discharge it into a 250 mL beaker. After that, we added three drops of phenolphthalein to the samples in the beaker and filled it with water. Next, 0.1M NaOH solution was slowly titrated into the sample and water solution with a 500 mL burette until the endpoint was reached, and the phenolphthalein indicator changed from colorless to pink. The difference between the initial and final volume readings of the burette was recorded to determine the amount of NaOH used for titration. The titratable acidity, %, percentage was calculated as in Eq. (6).

$$\text{Titratable acidity} = \frac{\text{N}(\text{NaOH}) \times 75 \times 100}{V \times 1000} \quad (6)$$

where N is the normality of NaOH; V the volume of sample, mL.

Sensory evaluation. The sensory evaluation of the experimental Zobo/date drink samples followed the descriptive free sorting technique. The panel consisted of 10 men and 10 women. Four of the panelists were certified wine connoisseurs from the Nigerian Bottling Company. The remaining panelists were randomly selected from the students and staff of the Department of Food Science and Technology, Federal University of Technology, Owerri, to be trained in the evaluation of sensory attributes using conventional juice purchased from the supermarket. The sensory profile included color, taste, flavor, mouthfeel, and overall acceptability using a nine-point hedonic scale: like extremely (9), like very much (8), like moderately (7), like slightly (6), neither like nor dislike (5), dislike slightly (4), dislike moderately (3), dislike very much (2), dislike extremely (1). The sensory evaluation was conducted in duplicates.

Statistical analysis. All the data from triplicate measurements were subjected to a one-way analysis of variance (ANOVA) and subsequently represented

as mean ± standard deviation (SD). The statistical probability was set at $p < 0.05$ (95% confidence level); the mean separation was implemented by Fisher's LSD (Least Significant Difference). The data were processed using Overall, Minitab® 21.0 (Minitab, LLC, PA, USA).

Results and discussion

Proximate composition. Proximate composition determines the quality of raw materials and is often the basis for establishing the nutritional value and overall acceptability of products. Table 1 shows that no progressive decrease in moisture content occurred as the proportion of date juice increased. The highest moisture content of 97.00% was recorded in the control sample (Zcon). The blend with the highest proportion of date fruit (ZD50) had the lowest moisture content of 89.00%. Both measurements showed a significant difference ($p \leq 0.05\%$). All the other samples except ZD10, which had the lowest percentage of date juice, showed significant difference in moisture content. The ash content showed that the sample with the highest date fruit content (ZD50) had the highest ash content and was significantly different ($p \leq 0.05\%$) from the control sample (Zcon) with its 0.13%. The ash content increased together with the date proportion because dates are a good source of minerals [22]. The trend also occurred in other nutritional contents as the sample with the highest date juice percentage (ZD50) had the highest fiber, fat, and protein contents of 2.49, 4.8, and 2.23%, respectively. The control sample had the lowest amount of other nutrient composition ($p \leq 0.05\%$) in relation to other samples. However, the control sample (Zcon) received better results in terms of fiber content than sample ZD10 ($p \leq 0.05$). All the samples demonstrated significant difference ($p \leq 0.05$) for carbohydrates. This fact could be attributed to the date fruit juice, which was reported to be rich in carbohydrates [16].

Zobo drink is attributed with antioxidant, antihypertensive, antihyperlipidemic, anticancer, antibacterial, hepatoprotective, antistress, antidiuretic, antispasmodic, and antidiarrheal effects [6]. It is also known to alter metabolism, reduce obesity, and inhibit accumulation of fat in the liver. The recommended daily intake of roselle is 1.5 g [7]. Roselle has a very good safety record, with no known side effects. Despite the rising popularity of Zobo as a nutritional and healthy drink, one of the obstacles to its large-scale commercial production is its short shelf life [6, 23]. Calyces are the major source of contamination because the fungi and bacteria they contain cause the drink to decay [24]. Other sources of contamination include the poor hygiene of other components, i.e., water, sweeteners, and preservatives, as well as contaminated equipment, packaging, countertops, hands and clothes of employees, inadequate storage, etc. [23]. However, these sources provide less contamination than calyces [24, 25].

Physicochemical composition. The physicochemical analysis detected a slight increment in pH with the increasing proportion of date juice. The scores ranged from 3.4 to 2.5 ($p \leq 0.05$) from sample to sample. However, samples ZD40 and ZD20 with 40 and 20% of date juice, respectively, showed no significant difference ($p \leq 0.05$). The control sample (Zcon) had the lowest pH while the sample with the highest amount of date juice (ZD50) demonstrated the highest pH. The obtained results corresponded with the pH of Zobo drink reported by Adesokan *et al.* [26].

The Brix content of a sample represents the total soluble solid content. In this research, it showed a progressive increase following the increase in the date juice, ranging from 9.5 to 0.9 ($p \leq 0.05$). Dates are known for their large sugar content, hence their use in this study as a natural sweetener. As expected, an upward trend in the Brix values accompanied the increase in the date juice proportion. Sample ZD50 with the greatest percentage of date juice had the highest Brix content. The titratable acidity content of the drink was calculated as a percentage (%) of tartaric acid content, which ranged from 0.043 ± 0.01 to 0.0158 ± 0.01. Titratable acidity is most useful in determining acid content for sensory description. A titration of sorts occurs in the mouth of the consumer, where basic saliva meets the

Table 1. Proximate compositions (%) of Zobo-date drink samples: mean values

Таблица 1. Результаты компонентного анализа (%) образцов напитка «зобо» с финиковым соком: средние значения

Samples	Moisture	Ash	Fiber	Lipid	Protein	Carbohydrates
Zcon	97.0^{a}	0.13^{d}	0.73^{e}	0.7^{e}	1.19^{e}	0.20^{e}
ZD10	96.3^{ab}	0.30^{cd}	0.44^{f}	1.6^{c}	2.04^{c}	0.68^{d}
ZD20	95.3^{c}	0.40^{bc}	1.31^{c}	1.8^{b}	2.13^{b}	0.94^{c}
ZD30	94.1^{d}	0.30^{cd}	1.26^{d}	1.2^{d}	1.29^{d}	0.62^{d}
ZD40	91.4^{e}	0.50^{b}	1.64^{b}	1.0^{d}	1.29^{d}	4.56^{a}
ZD50	89.2^{f}	0.80^{a}	2.49^{a}	4.8^{a}	2.23^{a}	1.72^{b}
LSD	**0.398**	**0.119**	**0.039**	**0.398**	**0.397**	**0.012**

Means that do not share the same letter down columns are significantly different ($p > 0.05$).

Средние значения в столбце, отмеченные разными буквами, имеют существенные различия ($p > 0,05$).

Table 3. Sensory analysis of Zobo-date drink

Таблица 3. Органолептический анализ образцов напитка «зобо» с финиковым соком

Samples	Color	Flavor	Taste	Mouthfeel	General acceptability
Zcon	6.650^{abc}	7.050^{a}	8.400^{a}	7.650^{a}	8.000^{a}
ZD10	7.000^{ab}	5.000^{b}	3.400^{e}	3.750^{c}	3.900^{d}
ZD20	5.750^{c}	5.100^{b}	4.350^{d}	4.650^{bc}	4.600^{cd}
ZD30	7.550^{a}	5.000^{b}	4.950^{cd}	4.550^{b}	4.950^{bc}
ZD40	6.700^{abc}	5.650^{b}	5.650^{bc}	5.250^{b}	5.800^{b}
ZD50	6.450^{bc}	5.250^{b}	6.150^{b}	5.500^{b}	5.700^{b}
LSD	**1.83**	**1.69**	**1.63**	**1.78**	**1.73**

Means that do not share the same letter down columns are significantly different ($p > 0.05$).

Средние значения в столбце, отмеченные разными буквами, имеют существенные различия ($p > 0{,}05$).

Table 2. Physicochemical properties of Zobo-date drink samples: mean values

Таблица 2. Физико-химические свойства образцов напитка «зобо» с финиковым соком: средние значения

Samples	pH	Brix°	Total titratable acidity, %
Zcon	2.5^{e}	0.9^{f}	0.0168^{b}
ZD10	2.7^{d}	2.0^{e}	0.0019^{d}
ZD20	3.1^{b}	3.9^{d}	0.0030^{c}
ZD30	2.9^{c}	5.3^{c}	0.0030^{c}
ZD40	3.2^{b}	8.0^{b}	0.0428^{a}
ZD50	3.4^{a}	9.5^{a}	0.0016^{d}
LSD	**0.398**	**0.398**	**0.0003978**

Means that do not share the same letter down columns are significantly different ($p > 0.05$).

Средние значения в столбце, отмеченные разными буквами, имеют существенные различия ($p > 0{,}05$).

drink or food, and salivation increases. The results showed a significant difference ($p \leq 0.05$) between ZD10 and Zcon, whereas the results for ZD20, ZD10, and ZD50 were not significantly different ($p \leq 0.05$).

Much work has been done to increase the utilization of roselle and make available the unique nutrients it has to offer. Our findings were similar to those published by Fasoyiro *et al.*, who produced a fruit-flavored roselle drink using orange, apple, and pineapple to flavor it [7]. Their analysis revealed the following: pH = 3.12–3.62, titratable acidity = 1.90–2.30%, total soluble solids (Brix value) = 9.33–10.43°Bx, moisture content = 78.24–9.63%, carbohydrates = 6.31–14.60%, protein = 0.47–0.94%, ash = 0.33–1.14%, fiber = 0.24–3.62%, fat = 0.02–1.14%. Banoke *et al.* successfully preserved Zobo by using the Kola nut of the Abata and Gbanja species [27]. The nut arrested the growth of microbes responsible for fermentation during storage. Adesokan *et al.* examined the quality attributes of Zobo blended with ginger and garlic extracts as preservatives [26]. The fortified Zobo drink was rich in ascorbic acid (vitamin C) while the pH stayed within the accepted range of 2.19–3.62 [7]. The beneficial properties of date palm fruits have also triggered a lot of studies. Bahraimian *et al.* optimized the enzymatic extraction of sugar from dates [28]. Before the extraction, they reported the following measurements: pH = 5.95, seed-to-pulp ratio = 7.6/92.4, total fiber = 8.39%, total sugar = 72.70%, moisture content = 16.63%, and pectin content as ca-pectate = 0.48%. After the enzymes were used on the fruit, the pH reached 7.5, and the total sugar increased by 3.33%. According to Echegaray *et al.*, dates are a good source of vitamins, including thiamine, riboflavin, niacin, folate, vitamin A, and vitamin K, as well as essential minerals, such as calcium, iron, phosphorus, sodium, potassium, magnesium, and zinc [22].

Sensory analysis. The sensory analysis showed a considerable appreciation for the control sample (Zcon) in all parameters, with Z50 and Z40 having the same sensory appeal and being followed closely by Z30. A higher proportion of date juice not only improved the nutrient composition, but also had almost the same sensory appeal as the drink with an artificial sweetener. The color evaluation showed significant differences ($p \leq 0.05$) between the samples, with the mean scores for the color ranging from 7.550 to 5.750. Sample ZD30 with 30% of date juice had the highest score (7.550) while the lowest score of 5.750 belonged to sample ZD20. Date juice gave Zobo a lighter shade of purple than is appealing to the eyes. The control (Zcon) had the highest mean flavor score (7.050), which could be attributed to the fact that the sweetener had a pineapple flavor, thus giving it a pleasant aroma. The scores for taste and mouthfeel showed significant differences ($p \leq 0.05$) among samples, with the control sample (Zcon) recording the highest mean scores of 8.40 and 7.650, respectively. In terms of general acceptability, the control sample (Zcon) prepared with an artificial sweetener was significantly different ($p \leq 0.05$) from other samples, with a mean score of 8.00.

Conclusion

Incorporating date fruit juice into Zobo drink improved its color and general acceptability: samples ZD40 and ZD50, which had a reasonably high proportion

of date juice, received better sensory scores compared to the samples with lower proportions. In addition, the experimental Zobo-date fruit drink had physicochemical and proximate properties similar with the conventional Zobo that contained an artificial sweetener. The idea behind the experimental Zobo-date drink was to eliminate the use of artificial sweeteners from Zobo production. This research was a preliminary study that ushered in a series of other questions. This work merely examined the superficial nutritional composition of Zobo drinks blended with date juice. This study provides no information on how the microstructure of Zobo is affected by blending with date juice. It also failed to determine whether date juice had any effect on the microbial composition of Zobo and human metabolism. The study did not cover the phytochemical and metabolic composition of the drink. The research prospects include the phytochemical composition of individual raw materials in comparison with their corresponding blends in the drink, its antioxidant and metabolic capacity, microbial quality, shelf-life stability, and possible additives to improve the overall quality and acceptance.

Contribution

Both authors contributed equally to the conceptualization, methodology, analysis, writing, and editing of this manuscript.

Conflict of interest

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

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Авторы заявляют об отсутствии конфликта интересов.

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