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# Nutritional Composition of Locally Produced Zobo Ginger and Tamarind Drinks in Birnin Kebbi Nigeria

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**ABSTRACT**
Locally produced plant-based drinks contribute to beverage choice and small-scale food economies, but their nutritional composition can vary with raw materials and processing. This study assessed proximate composition and selected micronutrients in zobo (Hibiscus sabdariffa), ginger (Zingiber officinale) and tamarind (Tamarindus indica) drinks prepared in Birnin Kebbi, Nigeria. Twenty-seven formulations were examined: 12 zobo, 12 tamarind and three ginger drinks. Ash, moisture, lipid, crude protein and carbohydrate were determined in triplicate using procedures based on Association of Official Analytical Chemists methods. Vitamin C was measured by iodine titration, while iron and zinc were measured by atomic absorption spectrophotometry. Results were reported as mean ± standard deviation and compared by one-way analysis of variance. The largest moisture value was 93.443% in ZC2 and the smallest was 30.247% in TP2. Crude protein ranged from 0.880% to 4.340%; lipid from 0.047% to 2.620%; ash from 0.027% to 2.900%; and carbohydrate from 1.233% to 66.953%. The reported analyses showed formulation-associated variation in most parameters, although ash and protein were not significant among the three ginger formulations. Vitamin C, iron and zinc also varied across the drink matrices.
**Keywords**: zobo; ginger; tamarind; proximate composition; vitamin C; minerals

## INTRODUCTION

Plant-based beverages are consumed for hydration, flavour and the nutrients contributed by their source materials. In Nigeria, zobo made from roselle calyces, ginger drinks and tamarind beverages are prepared in homes and small-scale settings and are sold alongside industrial beverages. Their formulas often include sugar, fruit ingredients, spices and water. The final composition therefore reflects the plant ingredients and the preparation choices used in each batch. Research on locally prepared beverages has described nutritional and sensory differences among formulations, including zobo drinks containing fruit

ingredients and tamarind-based beverages (Adelekan et al., 2014; Adeola & Aworh, 2010; Olayemi et al., 2011).

Proximate analysis gives a broad description of moisture, ash, lipid, protein and carbohydrate. For a drink, moisture is expected to constitute a major share, while ash provides an estimate of inorganic residue. Carbohydrate values may be particularly sensitive to added sugar, plant solids, dilution and the calculation method. These measurements do not by themselves establish the bioavailability of nutrients or the amount consumed in a serving. Micronutrient assays such as vitamin C, iron and zinc add information, but their interpretation depends on validated methods and units appropriate to the beverage matrix.

Zobo is prepared from dried Hibiscus sabdariffa calyces and may be combined with ginger, citrus or other ingredients. Prior Nigerian studies have evaluated its composition and the effects of processing or formulation (Bamishaiye et al., 2011; Olayemi et al., 2011). Tamarind pulp provides a distinct acidic beverage base and has been used to develop improved drinks with sensory assessment (Adeola & Aworh, 2010). Ginger is both a source ingredient and a flavouring. More recent work on plant-based drinks has emphasized that nutrient, flavour and processing characteristics vary with both botanical source and processing technique (Xie et al., 2023).

Comparative data across zobo, ginger and tamarind formulations prepared in Birnin Kebbi are limited. This study examined the proximate composition and selected micronutrient measurements of 27 locally prepared drink formulations, documenting the composition and comparing measured values among the formulations.

## MATERIALS & METHODS

Study area and samples. Ingredients were purchased from Birnin Kebbi Central Market and transported to the Microbiology laboratory of Waziri Umaru Federal Polytechnic, Birnin Kebbi. The study included 27 drink samples: 12 zobo formulations, 12 tamarind formulations and three ginger formulations. The zobo and tamarind formulations included individual spices at different stated quantities, a combined-spice formulation, and controls with or without sodium benzoate. Ginger formulations were ginger with lemon, ginger with sodium benzoate, and ginger without those additives. Sample codes follow the formulation scheme used in the study.

Preparation. For zobo, 100 g of dried roselle calyces were cleaned, rinsed and boiled in 2 L water for 20 min; the extract was strained, cooled and sweetened. Improved formulations included specified spice additions and other ingredients reported in the study, followed by cooling and bottling. Ginger drinks were produced by washing and blending fresh ginger with water, filtering the extract and adding sugar; lemon juice or sodium benzoate distinguished the improved formulations. Tamarind drinks were prepared by boiling rinsed tamarind in water, cooling, straining and sweetening; spice formulations used clove, dried ginger, dried pepper or a combined spice addition.

Analytical procedures. Proximate composition followed AOAC procedures (AOAC, 2003). Ash was determined by incineration, moisture by oven drying, lipid by Soxhlet extraction, protein by Dumas analysis using a nitrogen-to-protein factor of 6.25, and carbohydrate by difference. Iron and zinc were measured after dry ashing by atomic absorption spectrophotometry. Vitamin C was determined by iodine titration with starch indicator. The results tables report three replicate measurements as mean ± standard deviation.

Statistical analysis. One-way analysis of variance (ANOVA) was conducted using SPSS version 30, with statistical significance set at $p < 0.05$.

## RESULTS

The results showed wide numerical variation within each beverage group (Table 1). In zobo, moisture ranged from 62.447% in ZG3 to 93.443% in ZC2. Ash ranged from 0.050% in ZC1 to 2.900% in the unspiced control Z−. Lipid ranged from 0.047% in ZP3 to 2.620% in ZG1, while crude protein ranged from 0.880% to 4.340%, with the latter recorded for ZG2. Carbohydrate ranged from 1.233% in ZC2 to

35.057% in ZG3. ANOVA indicated $p < 0.001$ for each proximate parameter across the 12 zobo formulations.

Among the three ginger drinks, moisture ranged from 42.047% in G− to 84.730% in GL. Carbohydrate ranged from 13.560% in GL to 55.817% in G−. Lipid was low in all three formulations (0.107–0.217%). ANOVA indicated significant differences in moisture, lipid and carbohydrate, but not in ash ($p = 0.354$) or protein ($p = 0.277$). Tamarind drinks showed moisture values from 30.247% in TP2 to 88.890% in TG2. Carbohydrate ranged from 9.043% in TG2 to 66.953% in TP2. Tamarind ash values ranged from 0.027% to 2.093%, lipid from 0.080% to 0.987%, and protein from 1.017% to 2.327%. ANOVA indicated p values of 0.001 or lower for all five tamarind proximate parameters.

**Table 1. Proximate composition of the 27 beverage formulations (mean ± SD, % as reported)**

| Drink | Code | Ash | Moisture | Lipid | Protein | Carbohydrate |
|---|---|---|---|---|---|---|
| Zobo | ZC1 | 0.050 ± 0.010 | 88.130 ± 0.010 | 2.047 ± 0.006 | 3.353 ± 0.254 | 6.427 ± 0.254 |
| Zobo | ZC2 | 0.480 ± 0.010 | 93.443 ± 0.025 | 1.790 ± 0.030 | 3.053 ± 0.870 | 1.233 ± 0.875 |
| Zobo | ZC3 | 0.253 ± 0.015 | 88.413 ± 0.006 | 0.470 ± 0.010 | 3.930 ± 0.875 | 6.933 ± 0.895 |
| Zobo | ZG1 | 1.100 ± 0.020 | 86.110 ± 0.020 | 2.620 ± 0.020 | 3.780 ± 0.242 | 6.390 ± 0.262 |
| Zobo | ZG2 | 1.693 ± 0.012 | 89.330 ± 0.424 | 0.870 ± 0.030 | 4.340 ± 0.364 | 3.527 ± 0.396 |
| Zobo | ZG3 | 1.447 ± 0.021 | 62.447 ± 0.015 | 0.170 ± 0.010 | 0.880 ± 0.430 | 35.057 ± 0.430 |
| Zobo | ZP1 | 0.187 ± 0.031 | 89.683 ± 0.015 | 1.190 ± 0.020 | 2.770 ± 0.671 | 6.170 ± 0.714 |
| Zobo | ZP2 | 0.770 ± 0.020 | 92.850 ± 0.020 | 0.430 ± 0.356 | 0.880 ± 0.430 | 5.070 ± 0.449 |
| Zobo | ZP3 | 1.333 ± 0.015 | 86.543 ± 0.015 | 0.047 ± 0.021 | 1.163 ± 0.254 | 10.907 ± 0.247 |
| Zobo | ZX | 1.007 ± 0.015 | 90.490 ± 0.364 | 0.497 ± 0.015 | 1.313 ± 0.865 | 6.693 ± 1.174 |
| Zobo | Z+ | 0.317 ± 0.015 | 90.340 ± 0.252 | 0.130 ± 0.020 | 2.563 ± 0.451 | 6.650 ± 0.651 |
| Zobo | Z− | 2.900 ± 0.010 | 85.150 ± 0.113 | 0.563 ± 0.015 | 0.880 ± 0.430 | 10.507 ± 0.467 |
| Ginger | GL | 0.200 ± 0.245 | 84.730 ± 0.026 | 0.120 ± 0.020 | 1.457 ± 0.254 | 13.560 ± 0.358 |
| Ginger | G+ | 0.197 ± 0.021 | 54.943 ± 0.015 | 0.107 ± 0.015 | 1.310 ± 0.440 | 43.443 ± 0.436 |
| Ginger | G− | 0.030 ± 0.020 | 42.047 ± 0.025 | 0.217 ± 0.025 | 1.890 ± 0.502 | 55.817 ± 0.507 |
| Tamarind | TC1 | 0.963 ± 0.038 | 81.627 ± 0.015 | 0.757 ± 0.015 | 1.747 ± 0.435 | 14.887 ± 0.445 |
| Tamarind | TC2 | 0.043 ± 0.015 | 55.267 ± 1.847 | 0.940 ± 0.010 | 1.310 ± 0.440 | 42.240 ± 2.072 |
| Tamarind | TC3 | 0.177 ± 0.015 | 79.457 ± 0.015 | 0.750 ± 0.010 | 2.200 ± 0.460 | 17.433 ± 0.445 |
| Tamarind | TG1 | 0.070 ± 0.010 | 73.537 ± 0.015 | 0.207 ± | 1.310 ± 0.440 | 24.877 ± 0.465 |

| Drink | Code | Ash | Moisture | Lipid | Protein | Carbohydrate |
|---|---|---|---|---|---|---|
| | | | | 0.025 | | |
| Tamarind | TG2 | 0.063 ± 0.021 | 88.890 ± 0.020 | 0.987 ± 0.015 | 1.017 ± 0.254 | 9.043 ± 0.220 |
| Tamarind | TG3 | 0.103 ± 0.015 | 72.410 ± 0.010 | 0.640 ± 0.010 | 1.747 ± 0.435 | 25.100 ± 0.445 |
| Tamarind | TP1 | 0.043 ± 0.021 | 83.360 ± 0.010 | 0.533 ± 0.015 | 1.163 ± 0.254 | 14.900 ± 0.252 |
| Tamarind | TP2 | 0.837 ± 0.015 | 30.247 ± 0.021 | 0.360 ± 0.010 | 1.603 ± 0.254 | 66.953 ± 0.240 |
| Tamarind | TP3 | 2.093 ± 1.146 | 51.893 ± 0.025 | 0.080 ± 0.017 | 2.327 ± 0.254 | 43.607 ± 1.256 |
| Tamarind | T+ | 0.250 ± 0.010 | 33.893 ± 0.025 | 0.150 ± 0.020 | 1.603 ± 0.254 | 64.103 ± 0.250 |
| Tamarind | T− | 0.027 ± 0.015 | 58.600 ± 1.169 | 0.090 ± 0.026 | 1.163 ± 0.254 | 40.120 ± 1.351 |
| Tamarind | TX | 0.113 ± 0.015 | 35.157 ± 0.015 | 0.093 ± 0.025 | 2.037 ± 0.248 | 62.600 ± 0.279 |

Selected micronutrient results also varied. Vitamin C was reported between 110.75 and 193.63 µmol/L in zobo, 4.58 and 43.12 µmol/L in tamarind, and 65.59 and 86.54 µmol/L in ginger. Zinc values were reported from 0.127 to 0.310 mg/L in zobo, 0.120 to 0.443 mg/L in tamarind and 0.140 to 0.157 mg/L in ginger. Iron ranged from 0.027 to 1.170 mg/L in zobo, 0.033 to 1.627 mg/L in tamarind and 0.137 to 0.553 mg/L in ginger. The reported ANOVA results indicated differences among formulations.

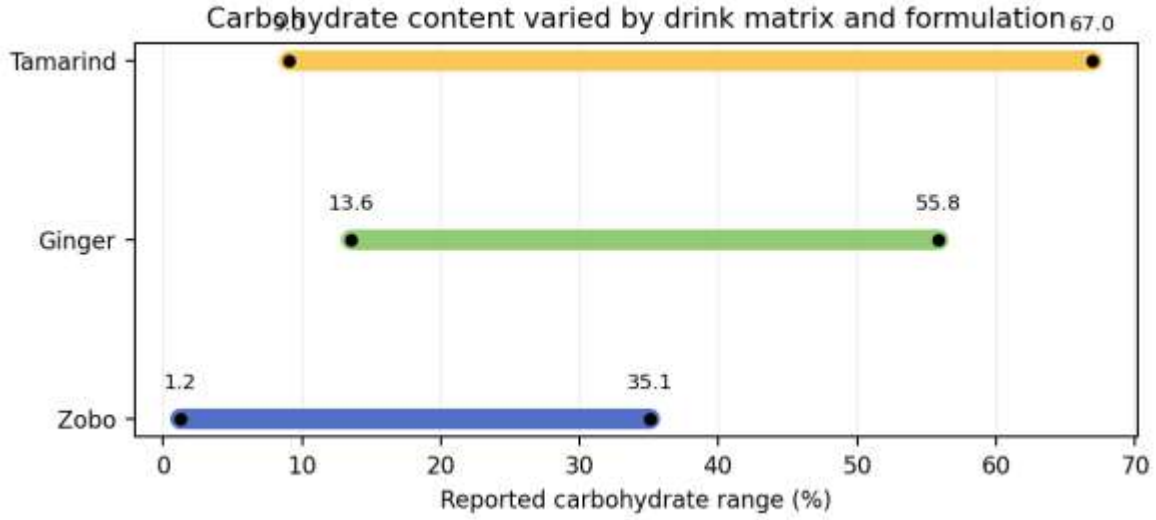


Figure 1. Carbohydrate ranges across beverage groups; points indicate the minimum and maximum formulation means.

**DISCUSSION**

The main result is not a single nutritional profile shared by all three drinks, but substantial formulation-level variation. This pattern is consistent with the dependence of beverage composition on plant source, ingredient proportions and processing noted in work on locally prepared drinks and plant-based beverages

(Adeola & Aworh, 2010; Xie et al., 2023). The data support reporting each formulation separately rather than treating "zobo," "ginger" or "tamarind" as compositionally uniform categories.

Moisture was the dominant proximate component in most formulations, as expected for aqueous drinks. The unusually broad range within both zobo and tamarind may reflect differences in extraction, water addition or concentration, although the present design cannot identify which factor caused the variation. Moisture and carbohydrate are mathematically related when carbohydrate is calculated by difference. The reported values generally reflect this relationship: formulations with lower moisture often have higher calculated carbohydrate. This makes it especially important to confirm the basis and calculation sheets before comparing values across studies.

The carbohydrate values were notably high in some formulations, including TP2, T+ and TX for tamarind and G− for ginger. Because carbohydrate was estimated by difference, the reported values include added sucrose and represent the residual fraction after subtracting moisture, ash, lipid and protein.

Protein and lipid values varied by formulation. The highest reported protein value was 4.340% in ZG2, while the highest lipid value was 2.620% in ZG1. Several other formulations had lipid values below 0.2%.

Vitamin C results varied across formulations, and the iron and zinc measurements also differed among beverage groups. Earlier work has examined vitamin C in Hibiscus drinks and the influence of processing conditions (Bamishaiye et al., 2011).

The reported analyses indicated significant differences among most formulations. Within the ginger group, ash and crude protein were not significantly different, whereas moisture, lipid and carbohydrate differed significantly.

Comparisons with published nutritional studies should be made only after aligning beverage recipes, extraction ratios, sweetener levels, analytical methods, and reporting basis. Studies of fruit-enhanced zobo and tamarind beverage development demonstrate that formulations and sensory characteristics can differ (Adelekan et al., 2014; Adeola & Aworh, 2010). Such literature provides context, not a direct benchmark, unless the sample and analytical bases match. The current dataset is most useful as a formulation-specific baseline for further validation in Birnin Kebbi.

## CONCLUSIONS

The locally produced zobo, ginger and tamarind formulations had varied proximate composition and selected micronutrient concentrations. Standardized recipes, ingredient-to-water ratios and processing procedures would support more consistent product composition. Further studies may measure total sugars directly, use independent production batches, report serving-level nutrient values and examine sensory and microbiological properties.

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