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Nutrient Composition, Antinutritional Factors and Contribution of Enriched Dry Guinea Corn (Sorghum sp) Leaf Extract to Nutrient Intake of Nigeria Consumers

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Abstract. Dietary diversity and consumption of indigenous food and feedstuff is being promoted as a means of tackling micronutrient deficiency. Some refreshing drinks are being fortified as voluntary vehicle of micronutrients. Dry guinea corn (Sorghum sp) leaf usually extracted with water and consumed as refreshing drink was therefore enriched with β-carotene and analysed for nutrient composition, antinutritional factors and contribution to nutrient intake of consumers using standard methods of analysis of AOAC. The leaf extracts contained between 0.4-1.3g protein, 0.3-0.5g ash, 1.9-2.6g total soluble sugar, and yielded 80.7–109.3 kcal of energy /100g dry sample. The mineral content of the pure extracts ranged between 27.7–236.7mg sodium, 12.0–150.0mg potassium, 3.5-19.3mg calcium, 14.3-276.7mg magnesium, 2.0-130mg phosphorus and 0.5-2.5mg zinc /100g sample. There was significant reduction ($p<0.05$) in values of all the minerals in the enriched extracts except for water extracts. Vitamin composition of both pure and enriched extracts ranged between 5.3-22.3mg ascorbic acid and 147.5-182.4 μg β-carotene with significant differences in their values ($p< 0.05$). The levels of antinutritional factors of the extracts were low and could not constitute any form of mal-absorption. Extracts' nutrient contribution to % RDAs of consumers were between 1.0- 4.0 % iron, 4.7-14.7% zinc, 8.1-34.3% ascorbic acid, and 15.3-18.2% β-carotene. The extracts can be good vehicle for β-carotene fortification.

Keywords: Guinea corn leaf extract, Enrichment, Nutrient composition, Antinutritional factors, Nutrient contribution.

1. Introduction

Sorghum and millet are the principal sources of energy, protein, vitamins and minerals for millions of the poorest people in Africa, Central America, and Southern Asia. They are grown in harsh environments where other crops grow or yield poorly [1]. In 1994, sorghum ranked fifth among the most important cereal crops of the world after wheat, rice, maize, and barley in both total area planted and production [2]. In Western Africa, Nigeria has emerged as a pioneer in the industrial utilization of sorghum. Grain sorghums, also known as millet or Guinea Corn is grown for grain, forage, syrup and sugar; and industrial uses of stems and fibres. Its stalks are used as animal feed, and is an important summer fodder where temperatures are high and rainfall insufficient for corn [2]; [3]). Parched seed are used as coffee substitutes or adulterants [4]. Curacao natives drink the leaf decoction for measles [4]. Guinea corn dry leaf (*Poporo*) had been extracted and used as tonic or refreshing drink by local people in the Western part of Nigeria, and was found to be rich in β-carotene and ascorbic acid [5]; but there is no literature report on the use of the leaf extracts as vehicle for micronutrient enrichment. It is therefore the objective of this study to investigate the nutrient composition of pure and β-carotene-enriched dry guinea corn leaf extracts and ascertain its suitability as vehicle for vitamin A enrichment.

2. Materials and Methods

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Dry guinea corn leaf, carboxyl methyl cellulose (CMC), sodium benzoate, vanilla flavour, sugar and carrots were purchased at Sango Market, Ibadan. Different samples of guinea corn leaf extracts were prepared by weighing 50g of partially pulverized dry leaf and soaked with [5]:

Sample A: $1dm^3$ of distilled water, boiled for about 15 minutes, left for 24 hours and then sieved. The sieved extract was divided into three portions and treated as follows: A_1: 100ml of sieved, boiled distilled water leaf extract (Pure water extract). A_2: To 100ml of the pure extract of A was added 1g of carboxyl methyl cellulose (CMC), 1g of sodium benzoate, 2ml vanilla, 16g sugar; blended and homogenized using a warring blender/ homogeniser. A_3 - To 100ml of pure extract of A was added 1g of carboxyl methyl cellulose (CMC), 1g of sodium benzoate, 2ml vanilla, 16g sugar and 50ml of carrot extract; blended and homogenized using a warring blender/homogeniser.

Sample B: $1dm^3$ of ethanol-water mixture in the ratio 1:1 (V/V) left for 24 hours, and then sieved. Various samples were then prepared from the extracts as follows: B_1: 100ml sieved extract of ethanol-water mixture (Pure ethanol-water extract). B_2: 100ml sieved extract of ethanol-water mixture, 1g CMC, 1g sodium benzoate, 2ml vanilla 16g sugar; and treated as A_2 above. B_3: 100ml sieved extract of B, 1g CMC, 1g of sodium benzoate, 2ml vanilla, 16g sugar, 50ml carrot extract; and treated as A_3 above.

Sample C: $1dm^3$ of ethanol and left for 24 hours and then sieved. Various samples were then prepared from the extracts as follows: C_1: 100ml sieved extract of ethanol, (Pure ethanol extract). C_2 : 100ml sieved extract of C, 1g CMC, 1g sodium benzoate, 2ml of vanilla, 16g sugar; and treated as A_2 above. C_3: 100ml extract of C, 1g CMC, 1g Sodium benzoate, 2ml vanilla, 16 sugar and 50ml carrot extract; and treated as A_3 above.

Sample D: $1dm^3$ ethanol-water mixture (1:1) boiled for about 15 minutes, then left for 24 hours and sieved. The following samples were then prepared from the extracts as follows: D_1: 100ml of sieved extract of D. D_3: 100ml of sieved extract of D, 1g CMC, 1g sodium benzoate, 2ml vanilla, 16g sugar, 50ml carrot extract, and treated as A_3 above [5]. D_2 could not be prepared because of rate and extent of evaporation of warmed mixture, leaving small quantity of the extract after 24 hours.

The various extracts prepared were then analysed for crude protein, lipid and fibre, ash, gross energy and anti-nutritional factors using the methods of Association of Official Analytical Chemists [6]. Potassium and sodium were determined using flame photometric method [7]. Phosphorus was determined by vanado-molybdate colorimetric method [8]. Calcium, magnesium, iron, manganese, zinc and copper were determined using atomic absorption spectrophotometric method [9]. Vitamin C was determined by titration with 2, 6-dichlorophenol-indophenol solution; and β-carotene determined through Ultra violet (UV) absorption measurement of the extracts at 328nm. Oxalates were determined by preparing standard solutions of oxalic acid and the absorbance read on spectrophotometer (Spectronic20) at 420nm. The absorbance of the extracts was also read and amount of oxalate estimated. Phytate was determined by titration with ferric chloride solution. The tannin content was determined using Griffiths and Jones method [10]. Saponin was also determined by comparing the absorbance of the extracts with that of standard at 380nm [11].

3. Results and Discussion

The proximate composition of dry guinea corn leaf and enriched extracts is as shown in Table 1. The values obtained for proximate and mineral composition of the extracts were lower than those obtained by Adepoju, [5]. This variation might be due to seasonal variation in nutrient composition of the samples. Except for crude fibre, all other parameters studied were significantly different ($p < 0.05$), with boiled water extract (A_1) having highest value of crude protein, ash, and sugar; while ethanol extract (C_1) had highest value for crude lipid and total solid. Water extract (A_1) had the lowest value of total solid and boiled ethanol-water extract (D_1) had highest value of pH. Boiled water extract (A_1) had the lowest pH value showing the extract to be acidic in nature. The pH of all the extracts was acidic. This can be advantageous in keeping quality of the extracts, as many microorganisms do not thrive well in acidic medium.

The crude protein content of the extracts was generally low and insignificant. Cold, ethanol-water and ethanol extracts had the lowest protein value while boiled water extract had the highest value. The low protein value of the dry leaf extract presupposes the fibrous nature of the leaf protein. The crude lipid content

of the leaf extracts was too low and negligible, and Low or no lipid content is characteristic of most refreshing drinks. Non of the extracts contained any crude fibre, indicating that the fibre components of the dry leaf were majorly insoluble ones. Warm water extract (A_1) recorded the highest value of ash, followed by boiled ethanol-water extract (D_1). Cold ethanol-water (B_1) and cold ethanol extracts (C_1) had lowest ash value. Ethanol extract had highest gross energy, followed by boiled ethanol-water extract, while boiled water extract had the lowest value. The low gross energy recorded for boiled water extract can be an advantage for its suitability as a drink for the obese.

Table 1: Chemical Composition of Pure and enriched Guinea corn Dry Leaf Extracts (g / 100g)*

Para	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	D_1	D_3
C. P.	1.3 ± 0.03	1.3 ± 0.01	1.1 ± 0.01	0.4 ± 0.01	0.6 ± 0.02	0.7 ± 0.04	0.4 ± 0.01	0.6 ± 0.02	0.6 ± 0.02	0.7 ± 0.01	0.6 ± 0.04
C. L.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. F.	0.0	0.0	.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ash	0.5 ± 0.02	0.5 ± 0.02	0.5 ± 0.03	0.3 ± 0.03	0.3 ± 0.03	0.4 ± 0.03	0.3 ± 0.04	0.3 ± 0.01	0.3 ± 0.02	0.4 ± 0.02	0.4± 0.01
S. S.	2.6 ± 0.03	2.7 ± 0.05	2.5 ± 0.05	2.3 ± 0.02	2.2 ± 0.04	2.1 ± 0.01	2.1 ± 0.03	2.0 ± 0.02	2.0 ± 0.02	1.9 ± 0.05	2.1 ± 0.02
T. S.	7.7 ± 0.03	8.2 ± 0.03	7.9 ± 0.02	11.6± 0.02	12.1± 0.03	11.9± 0.05	12.2± 0.02	12.0± 0.02	12.1± 0.02	11.8± 0.05	11.8± 0.03
*G E	8.7 ± 0.01	8.0 ± 0.01	8.0 ± 0.01	106.5 ±0.01	104.74 ± 0.01	105.9 ±0.03	109.3 ± 0.3	108.8 ±0.2	109.3 ±0.00	108.6 ±0.0	109.2 ±0.1
pH	3.8	3.7	3.8	4.2	4.3	4.3	4.5	4.2	4.3	4.6	4.5

*n = mean of three determinations,
*G. E. = Gross Energy (Kcal/100g).
Para = parameter, C. P. = Crude Protein, C. L. = Crude Lipid, C. F. = Crude Fibre, S. S. = Soluble sugar, T. S. = Total solids.

Table 2: Mineral Composition of Pure and Enriched Guinea corn Dry Leaf Extracts (mg/100g) *

	A1	A 2	A 3	B1	B2	B3	C_1	C_2	C_3	D_1	D_3
Na	223.0± 30.60	236.7± 11.60	216.7± 11.60	27.7 ± 1.2	32.0± 0.10	27.0 ± 2.0	32.7± 0.60	37.7± 1.20	33 ± 2.00	37± 2.00	41± 2.00
K	123.0± 11.60	150.0± 20.0	113.3± 5.80	16.0 ± 2.0	17.7 ± 1.2	12.0 ± 1.00	19.3 ±2.20	24 ± 1.00	21.3± 2.2	16 ± 1.00	21 ± 1.00
Ca	17.0 ± 0.60	19.3 ± 1.50	17.0 ± 1.50	4.1 ± 0.3	4.4 ± 0.1	3.5 ± 0.7	4.2 ± 0.10	4.4± 0.10	4.0 ± 0.10	3.8 ± 0.1	4.2± 0.10
Mg	210.0± 10.00	276.7± 10.00	250 ± 10.00	14.3 ± 1.5	20.7 ±1.5	16.0 ± 2.0	25 ± 2.00	29 ± 2.00	24.3± 1.20	21.3 ±0.6	24.3 ±0.6
P	130.0± 20.00	110 ± 20.00	90.0 ± 20.00	2.0 ± 0.1	2.2 ± 0.1	1.7 ± 0.2	3.6 ± 0.50	2.8± 0.50	2.5 ± 0.10	3.1± 0.30	2.9± 0.30
Fe	0.4 ± 0.01	0.4 ± 0.01	0.4 ± 0.01	0.1 ± 0.01	0.2 ± 0.02	0.2 ± 0.02	0.2 ± 0.02	0.2± 0.01	0.2 ± 0.02	0.2± 0.02	0.2± 0.02
Zn	2.2 ± 0.30	2.5 ± 0.16	1.9 ± 0.15	0.8 ± 0.06	0.5 ± 0.12	0.9 ± 0.20	0.7 ±0.15	1.1± 0.28	1.3 ± 0.15	1.0± 0.15	0.8± 0.15

*n = mean of three determinations.

There was significant decrease ($p< 0.05$) in the protein content of the warm water extracts (A_2 and A_3) as well as that of warm ethanol-water extract (D_3), while there were significant increase in protein values for the other extracts (B_2, B_3, C_2, C_3) compared with their ordinary extracts. This increase was more pronounced in the cold ethanol-water extract enriched with carrot extract (B_3), showing the carrot extract's contribution to the crude protein content of the extract. There was no significant difference ($p> 0.05$) in values obtained for the crude lipid content of all the extracts compared with their pure ones. All the preparations were devoid of crude fibre. There was no significant improvement in the ash content of the preparations except the cold ethanol-water extract enriched with carrot extract (B_3). Also, there was no significant difference ($p>0.05$) in the total sugar, and the pH of the preparations from hot water extracts (A_2 and A_3); however, there was slight

increase in values of total solid of these preparations. Warm water extracts preparations had higher total sugar compared with other preparations while ethanol extract enriched with carrot extract had the least value (C_3).

The result of mineral composition of the extracts is as shown in Table 2. The warm water extract (A_1) was rich in sodium, potassium, magnesium and phosphorus, but very low in calcium, iron and copper. The ethanol (C_1) and ethanol-water extracts (B_1 and D_1) were extremely poor solvents for extracting these minerals. There was significant increase in the sodium, potassium, calcium and magnesium content of extract without carrot extract (A_2) ($p< 0.05$). The observed increase in these minerals might have resulted from additives / preservative added to this extract. Except magnesium, there was significant decrease in the value of these minerals in extract enriched with carrot extract (A_3). This might have resulted from dilution of this extract with carrot extract. Table 3 shows the result of vitamin composition of pure and enriched dry guinea corn leaf extracts. Ethanol-water extracts had highest value of β-carotene while warm water extracted water soluble vitamins better than other solvents. The leaf extract can be a good source of meeting part of the dietary requirements of the vitamins studied.

The levels of antinutritional factors in pure and enriched extracts are as shown in Table 4. The extracts were devoid of trypsin inhibitors, and this might be an advantage for their consumption without fear of interference with protein digestibility. Warm water extracts ($A_1 - A_3$) had highest levels of all the antinutritional factors studied followed by cold ethanol-water extracts ($B_1 - B_3$) while boiled ethanol-water extracts (D_1, D_2) had lowest values, indicating that heating reduces the level of some antinutritional factors in foods [12]. Added ingredients seemed to increase the level of the antinutritional factors, especially phytates. The levels of all the antinutritional factors studied were very low and insignificant to cause any hindrance to nutrient absorption from other foods. The extracts can contribute between 1.0 – 4.0% iron, 4.7 – 14.7% zinc, 8.1 – 34.3% ascorbic acid and 15.2 – 18.2% β-carotene to % Recommended Dietary Allowances of consumers [13]. Warm water extracts will contribute more minerals and ascorbic acid while Ethanol-water extracts would contribute more to β-carotene intake of consumers.

Table 3: Vitamin composition of pure and enriched dry guinea corn leaf extracts (mg/100g)*

Samples	β-Carotene (μ/100g)	Riboflavin	Niacin	Ascorbic Acid
A_1	152.4 ± 0.04	0.06 ± 0.02	0.36 ± 0.02	22.3 ± 0.01
A_2	147.5 ± 0.42	0.05 ± 0.01	0.03 ± 0.01	21.8 ± 0.03
A_3	151. ± 0.01	0.11 ± 0.02	0.30 ± 0.02	21.7 ± 0.03
B_1	174.8 ± 0.05	0.04 ± 0.01	0.22 ± 0.22	7.33 ± 0.05
B_2	167.3 ± 0.80	0.03 ± 0.01	0.17 ± 0.01	6.4 ± 0.01
B_3	179.9 ±0.02	0.02 ±0.00	0.26 ± 0.02	7.15 ± 0.06
C_1	163.7±0.03	0.01 ± 0.00	0.15±0.02	6.17±0.04
C_2	159.9±0.52	000	0.19± 0.04	7.15±0.03
C_3	164.9 ± 0.05	0.01± 0.00	0.12 ± 0.02	6.62 ± 0.04
D_1	179.1± 0.01	0.03 ± 0.01	0.16 ± 0.01	5.26 ± 0.02
D_3	182.4 ± 0.02	0.01 ± 0.00	0.14 ± 0.01	5.52 ± 0.02

*n = mean of three determinations.

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Table 4: Antinutritional Factors in Pure and Enriched Guinea Corn Dry Leaf Extracts (mg / 100g) *

Sample	Phytates	Oxalates	Saponins	Tannins
A_1	14.7 ± 1.10	3.3 ± 0.12	4.4 ± 0.25	2.0 ± 0.31
A_2	17.3 ± 1.10	2.8 ± 0.10	4.6 ± 0.10	2.2 ± 0.16
A_3	13.7 ± 1.50	3.4 ± 0.20	4.9 ± 0.20	1.8 ± 0.12
B_1	14.0 ±1.00	2.7 ± 0.67	2.4 ± 0.10	4.2 ± 0.12
B_2	11.7 ± 1.20	2.4 ± 0.20	2.7 ± 0.10	4.6 ± 0.12
B_3	14.0 ± 1.00	2.0 ± 0.07	3.2 ± 0.10	4.2 ± 0.12
C_1	8.0 ± 1.00	1.8 ± 0.10	2.4 ± 0.10	6.0 ± 0.29
C_2	5.3 ± 1.50	1.6 ± 0.20	1.8 ± 0.10	6.1 ± 0.25
C_3	9.7 ± 0.60	2.0 ± 0.30	2.2 ± 0.10	5.9 ± 0.20
D_1	6.0 ± 1.00	2.3 ± 0.10	1.8 ± 0.10	6.8 ± 0.23
D_3	2.7 ± 0.60	1.2 ± 0.10	1.3 ± 0.20	6.7 ± 0.20

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