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Influence of location on chemical composition of Tamba grain (*Eleusine coracana*)

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Target audience: *Animal nutritionist, Food scientist and Feed millers*

Abstract

The study was conducted between April and September, 2018 to determine the influence of location on chemical composition of Tamba grains (Eleucine coracana). Three samples were sourced from each study location: Todi, Ganawuri, Bokkos, Zabir, Bogoro, Rinji, Tulai and Nabardo in central Nigeria. Specifically, proximate analysis, essential amino acid, non-essential amino acid, mineral composition and anti-nutrient were assessed. Data generated were subjected to analysis of variance. Overall mean dry matter, crude fiber, protein, ether extract and ash contents were 92.40±0.05, 3.76±0.04, 7.96±0.07, 1.87±0.08 and 2.78±0.06 %, respectively. In addition, the mean essential amino acid content: methionine, arginine, tryptophan, threonine, histidine, isoleucine, leucine, lysine, valine, phenyl-alanine were 2.58±0.05, 2.88±0.05, 0.60±0.02, 3.31±0.06, 2.18±0.02, 3.82±0.08, 10.21±0.65, 1.52±0.12, 5.09±0.10 and 5.23±0.16 g/100g, respectively. On the other hand, the mean non-essential amino acid content: proline, tyrosine, cysteine, alanine, glycine, glutamic-acid, serine and aspartic-acid were 4.59±0.13, 2.21±0.03, 0.65±0.11, 6.64±0.35, 2.50±0.05, 18.98±0.39, 3.92±0.09, 7.20±0.09 g/100g, respectively. Mineral contents; namely iron, sodium, potassium, magnesium, calcium, copper, zinc, manganese, Sulphur, phosphorus and cobalt were 2.60±0.06, 71.66±0.57, 162.54±2.57, 46.24±0.65, 26.25±1.08, 0.94±0.03, 1.50±0.08, 0.90±0.05, 0.92±0.11, 161.35±5.15, 0.34±0.07 mg/g while anti-nutrient content: flavonoid, alkaloid, tannin, saponin, oxalate and phytic acid were 1.71±0.14, 0.99±0.07, 26.56±1.13, 0.89±0.14, 7.61±0.65 and 20.13±0.94 µg/g. Except moisture content, dry matter content, Leucine, Lysine and Alanine, significant variation was observed in all the other parameters. Generally, the study revealed that location had strong effect on nutrition composition of Tamba grain. Therefore, the use of Tamba grain for humans and animals (if cost effective) should take cognizance of source of grains.

Key words: *Tamba grain, Proximate composition, Amino acid profile and Location*

Description of Problem

The world population and in particular countries in Africa, will continue to depend on cereal grains (1). With an estimate of 30% of the total population of Africa suffering from chronic hunger and malnutrition, looking into ways of salvaging food crisis remains a challenge to all stakeholders in and outside the region. The global food crisis with its severe impact on food security in Africa including feeds available to domestic animals has been attributed to various factors. These factors include rising prices of food, energy and oil, declining outputs, growing scarcities worldwide, civil unrest, loss of agricultural land due to draught, floods, storms and erosion resulting from climate change. Others are: increasing world population and decline in arable land, little investment in agricultural sector, low spending on agricultural research and development, rapid migration from the countryside to cities, lack of purchasing power, and of appreciation of traditional indigenous foods (2, 3). On the contrary, there is enormous potential for growth in Agriculture in sub-Saharan Africa due to abundant natural resources (3) such as cheap labour, favorable climatic condition, etc. To address the threatening situation, it would require countries in sub-Saharan Africa to look inwards to indigenous foods especially those neglected due to influx of the western counterparts into the continent.

Finger millet is a staple food in many African and South Asian countries. It is also considered a helpful famine crop, as it could be stored for lean years (4). The seed is storable for a long period maintaining an edibility and viability for even up to 10 years if stored dry. The grain is readily digestible, highly nutritious and versatile: it can be cooked like rice, ground to make porridge or flour or used to make cakes (5). Sprouted grains are recommended for infants and the elderly. Finger millet is also used to make liquor ("arake" or "areki" I Ethiopia) and beer, which yields by-products used as livestock feed (4). In Daffo, Bokkos Local Government area, Ganawuri and many other villages in Plateau State; Zabir, Bogoro, Zool, Nabordo, Rinji in Bauchi State; and Todi in Gombe State (Across the Guinea Savannah region) of Nigeria, finger millet is used in making local drinks "kunu" and variety of local dishes. No wonder people living in these areas are so fit and healthy. This study aimed at assessing locational effects on the chemical composition of Tamba grain.

Materials and Methods

Study Area

The finger millet (*Eleusine coracana*) samples used in this study were procured from Gombe, Bauchi and Plateau States, specifically Todi, Ganawuri, Bokkos, Zabir, Bogoro, Rinji, Tulai and Nabordo (Figure 1) they are located between longitude 8˚00ˈ to 12˚ 00ˈ North and latitude 8˚ 00ˈ to 12˚30ˈ East (Hassan, 2010). The climate is generally characterized by two well defined seasons, rainy (April-October) and dry (Nov-March). The total mean rainfall in the region is 700-1400mm. The mean temperature ranges between 18^0C and 28.50^0C. The highest temperatures are observed from March, to May and the lowest, January and December. Highest relative humidity of 99% is observed in August and the lowest of 57% in February (6).

Soil types

The soil is generally clayey and acidic (pH 4.6-5.6) in Plateau State (7) while it is predominantly clay-loam in Bauchi South and mostly sandy loam textured and slightly acidic (mean pH of water 5.55) in Gombe. The soils are low in nitrogen, sodium, calcium and organic carbon, medium in phosphorus, high in potassium and magnesium and, generally neither saline nor sodic (8).

Vegetation

Much of the Plateau is grass-land and farms, punctuated by rocky hills and occasional small patches of indigenous arboreal vegetation and re-afforested areas. However, wooded valleys remain in the south east, a sort of montane vegetation. Thus the generally montane vegetation of the Plateau has been altered by scattered mining operations that exploit the rich deposits of tin, columbite, and tantalite (7). Bauchi and Gombe States span two distinctive vegetation zones (Sudan and Sahel Savanna). The Sudan savanna covers the southern parts of both states where the vegetation gets richer and thicker southwards especially along the water sources. Towards the northern parts, the vegetation (Sahel) is less uniform; trees and grasses are shorter and thinner, including isolated shrubs (9).

Sample Collection

Whole grain samples (the black seeded variety) were purchased directly from farmers who cultivated the crop for two years (2016 and 2017) at different locations in the States namely: Bokkos and Ganawuri in Plateau State; Rinji, Tulai, Nabordo, Bogoro and Zabir in Bauchi state; and Todi in Gombe state based on availability. The grains were identified at Bauchi State Agricultural Development Programmes as finger millet *Eleusine coracana*. The collected seeds were manually winnowed, stones and debris handpicked and further cleaned by passing sample through a series of sieves using a sieving equipment called “The Clipper”. The grain samples obtained from each farmer for the two seasons were mixed thoroughly and replicated into three for nutritional/chemical analysis. Each replicate was ground using a cyclotee 1093 sample mill (Tecator, Hoganas, Sweden).

Chemical Analysis

The analyses involving proximate, amino acids and phytochemical evaluations were carried out at Abubakar Tafawa Balewa University, Bauchi and Yobe State University Damaturu, laboratories.

Proximate Analysis

The analyses entail the determination of moisture, crude protein (CP), ether extracts (EE), crude fibre (CF) and ash while nitrogen free extracts were calculated by difference following the methods outlined by (10).

Determination of amino acid profile

The Amino acid profile was determined using methods described by (11). The sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Applied Biosystems PTH Amino Acid Analyzer before calculating the different amino acid values.

Mineral assay

The minerals were determined from solutions obtained by first dry ashing the defatted sample flour at 55^{0}C. The residue was dissolved in 10ml of 50% nitric acid solution and made up to a final volume of 25ml using distilled water. The individual minerals (Zn, Fe, Cu, Mn, Na, Mg and Ca) were then determined using Atomic Absorption Spectrophotometer, Spectrr AA 220, USA varian. Phosphorous was determined using the phosphovanado molybdate method of (12). This method was designed to minimize the loss of sulphur during digestion (13).

Determination of Phytochemicals

The Tannin content was determined with Folin-Denis Spectrophotometric method (14). Alkaloid was determined using the gravimetric method of (15). Trypsin inhibitory activity (TIA) was determined using the spectro photometric method described by (16). Phytate was determined according to the method of (17). Oxalate was determined using the titration technique described by (18, 19).

Data Analysis

Data generated were subjected to one - way analysis of variance (ANOVA) using the general linear model (GLM) procedure of (20). Significant differences where it exist among the means were compared using the Duncan multiple range test (DMRT) of the same software.

Results

The proximate analysis of Tamba grains sourced from different locations are presented in Table 1.The overall mean percentage dry matter, crude fibre, protein, lipid and ash were 92.4, 3.76, 1.87, 2.77 and 75.7 %, respectively. There was significant effect of location on crude fibre, protein, lipid, ash content ($P<0.001$) and total carbohydrate ($P<0.05$). Samples from Bokkos, Bogoro, Tulai, Todi and Rinji had the highest crude fibre, protein, lipid, ash content and total carbohydrate values of 4.03±0.06, 8.63±0.20, 2.21±0.03, 3.30±0.13 and 76.92±02.1 %, respectively. The least corresponding values however were recorded in Zabir and Bogoro (3.49±0.02 and 3.49±0.07 %) Ganawuri (7.62±0.12 %), Rinji for both crude protein and ash content (1.27±0.08 and 2.45±0.03 %) and Todi (72.30±0.22%). A non-significant influence of location on dry matter was however observed. The overall mean (essential amino acid contents) methionine, arginine, tryptophan, threonine, histidine, isoleucine, leucine, lysine, valine and phenyl-alanine were 2.58±0.05, 2.88±0.05, 0.60±0.02, 3.31±0.06, 2.18±0.02, 3.82±0.08, 10.21±0.65, 1.52±0.12, 5.09±0.10 and 5.23±0.16g/100g, respectively (Table 2).Significant influence of location on methionine, arginine, tryptophan, isoleucine, valine and phenyl-alanine ($P<0.001$), threonine and histidine ($P<0.05$) was noticed (Table 2). Ganawuri had the highest values (table 2) for methionine, tryptophan, threonine, isoleucine, valine and phenyl-alanine while Zabir (for methionine, isoleucine and Phenyl-alanine), Bokkos (for both tryptophan and threonine) had recorded the least (2.97±0.02, 0.75±0.02, 3.55±0.03, 4.50±0.02, 5.73±0.00 and 6.27±0.06 g/100g vs 2.21±0.05, 3.25±0.08, 3.60±0.05, 0.50±0.03, 2.86±0.35 g/100g. For arginine and histidine, samples from Nabardo and Bokkos had the highest whereas the least values were observed in Tulai and Zabir (3.16±0.06 and 2.26±0.02g/100g vs 2.58±0.00 and 2.09±0.02g/100g). The non-significant effect of location on Leucine and lysine was however observed.

The overall mean (non-essential amino acid acid contents) proline, tyrosine, cysteine, alanine, glycine, glutamic acid, serine and aspartic acid were 4.59, 2.21, 0.65, 6.64, 2.50, 18.98, 3.92 and 7.20g/100g respectively. Significant effect of location on proline, tyrosine and cystine ($P<0.01$) and glycine, glutamic acid, serine and aspartic acid ($P<0.001$) was observed (Table 3). Ganawuri grains had the highest values for proline, tyrosine, glutamic acid, serine and aspartic acid while Zabir recorded the lowest (5.45±0.03, 2.41±0.00, 22.00±0.09, 4.48±0.03 and 7.71±0.05 g/100g vs 3.59±0.18, 2.06±0.00, 16.05±0.015, 3.33±0.09 and 6.39±0.03 g/100g) respectively. Samples from Rinji and Ganawuri were observed to have the highest for cystine and glysine whereas those of Todi and Tulai recorded the least (1.73±0.63 and 2.88±0.04 g/100g vs 0.06±0.00 and 2.17±0.01 g/100g). Non-significant effect of location was observed as regards alanine. The overall mean mineral content namely: iron, sodium, potassium, magnesium, calcium, copper, zinc, manganese, Sulphur, phosphorus and cobalt were 2.60, 71.66, 162.54, 46.24, 26.25, 0.94, 1.50, 0.90, 0.92, 161.35 and 0.34mg/kg, respectively (Table 3). The effect of source on the mean mineral contents were all significant ($P<0.001$), Zabir had the highest for potassium, calcium, copper and sulphur while the least values for calcium and copper were observed in Rinji and Bokkos (181.66±0.89, 270±0.42, 1.12±0.10 and 1.80±0.05mg/kg vs 255.89±0.74 and 0.80±0.05mg/kg respectively). Tulai, however, had the least values for sodium and sulphur (69.14±0.04 and 0.42±0.03mg/kg respectively). Todi also had the least values for iron, potassium and cobalt (2.23±0.09, 149.02±0.12 and 0.01±0.00mg/kg, respectively). Highest values for Iron, zinc and phosphorous were recorded in Bokkos (3.02±0.04mg/kg), Nabardo (2.27±0.03mg/kg) and Bogoro (187.11±0.06mg/kg) while the lowest of 2.23±0.09, 1.03±0.03 and 129.42±0.52mg/kg were recorded in Todi, Ganawuri and Tulai, respectively. Tamba grains from Todi had the highest values for

Sodium (76.02±0.013mg/kg) and Manganese (1.20±0.07mg/kg) and those of Ganawuri had the highest for magnesium (50.79±0.37mg/kg) and cobalt (0.87±0.02mg/kg) while samples from Tulai, Ganawuri, Bogoro and Nabardo recorded the least (69.14±0.04, 0.50±0.04, 42.93±0.48 and 20.13±0.00mg/kg, respectively).

The overall mean (antinutrient content) flavonoids, alkaloids, tannins, saponins, oxalates and phytic acids were 1.71, 0.99, 26.56, 0.89, 7.61 and 20.13mg/kg, respectively (Table 5). Significant influence of location was observed on all anti-nutrient contents ($P<0.001$). Highest Alkaloid (1.46±0.17mg/kg) and Oxalate (12.82±0.22mg/kg) were observed in Todi whereas the least corresponding values were recorded in Tulai, (0.66±0.16 mg/kg) and Bokkos (4.19±0.19). Highest flavonoid was recorded in samples from Bogoro (2.39±0.22 mg/kg) and the lowest value in grain samples from Rinji (0.94±0.07 mg/kg). Samples from Nabardo were found to contain highest value of tannins (34.90±1.52 mg/kg) while the least was found in grains from Bokkos (19.66±0.05 mg/kg). Furthermore, highest concentration of phytic acid was observed in grains from Nabardo (26.68±0.82 mg/kg) and the least value recorded in sample from Rinji (13.90±0.44 mg/kg).

Discussion

The overall mean proximate composition observed in the current study is similar to the report by (21). The authors recorded values of 5.58±0.21, 7.94±0.06, 2.51±0.11, 8.42±0.05, 2.51±0.06 and 73.32±0.23 g for moisture, crude fat, ash content, crude protein, crude fiber and carbohydrate, respectively. Similarly, (22) reported average values of 8.2, 2.7, 1.8, 83.3 and 3.5 g for protein, ash, fat, total carbohydrate and crude fiber. In addition, overall means of 1.83 g (crude fat), 7.21 g (crude protein), 2.84 g (total ash), 77.07 g (carbohydrate), 7.71 g (crude fiber), 11.05 g (moisture) and 322.15 Kcal/100g (energy) for six genotypes of finger millet (Afeso, Gulu-E, FMV-1, KNE-479, KNE-1034 and Nyaikuro) were reported by (23). The non-significant effect of location on moisture content of Finger millet observed in the current study agrees with the study of (24) on millet species (Finger, Proso, Foxtail, Little, Kodo, Barnyard and Pearl millets), milled rice and wheat. However, (25) reported significant variation in moisture composition of processed (boiled, roasted, soaked and fermented grains) and unprocessed Tamba grains. More recently, (26) also detected significant difference in moisture content of six Nepalese finger millet varieties (Dalle, Kabre, Okhale, GPU-0025, GE-5016 and GE-0116). The varied crude fiber, protein and lipid, ash content and total carbohydrate observed in the present study agree with the report of (27) who observed significant difference in proximate composition of Finger and Pearl millets flours and attributed this to the genetic structure of the two millet species. But in contrast, (28) stressed that location and year of growth (environmental variance) were factors affecting the concentrations of each nutrient in the proximate composition of cereal grains. It was affirmed (29) that a greater percentage of the differences among cultivars of millets specifically, were due to an interaction of cultivar with the environment.

Table 1: Average percentage proximate composition of Tamba grain as influenced by location

Parameters	Overall mean±S.E	Todi	Gamawuri	Bokkos	Zabir	Bogoro	Rinji	Tulai	Nabardo	LOS
Dry matter	92.40±0.05	92.59±0.02	92.20±0.01	92.25±0.01	92.33±0.19	92.27±0.30	92.37±0.12	92.65±0.01	92.56±0.03	NS
Crude fiber	3.76±0.04	$3.77±0.04^{b}$	$3.78±0.01^{b}$	$4.03±0.06^{a}$	$3.49±0.02^{c}$	$3.49±0.07^{c}$	$4.02±9.10^{a}$	$3.73±0.03^{b}$	$3.75±0.03^{b}$	***
Crude protein	7.96±0.07	$8.17±0.07^{a}$	$7.62±0.12^{b}$	$7.67±0.11^{b}$	$8.30±0.08^{a}$	$8.36±0.20^{a}$	$7.72±0.17^{b}$	$7.72±0.05^{b}$	$8.13±0.04^{a}$	***
Crude lipid	1.87±0.08	$2.06±0.12^{ab}$	$2.18±0.19^{ab}$	$1.41±0.03^{cd}$	$1.74±0.26b^{c}$	$2.02±0.09^{ab}$	$1.27±0.08^{d}$	$2.21±0.03^{a}$	$2.03±0.09^{ab}$	***
Ash content	2.78±0.06	$3.30±0.13^{a}$	$2.55±0.03^{de}$	$2.72±0.02^{cd}$	$2.70±0.01^{cd}$	$2.79±0.02^{c}$	$2.45±0.03^{e}$	$3.02±0.06^{b}$	$2.61±0.01^{de}$	***
Total Carbohydrate	76.08±0.12	$75.30±0.22^{c}$	$76.08±0.24^{abc}$	$76.43±0.06^{ab}$	$76.10±0.49^{abc}$	$75.60±0.32^{bc}$	$76.92±0.21^{a}$	$75.97±0.04^{bc}$	$76.23±0.10^{ab}$	*

LOS = Level of significance, * = $P<0.05$, *** = $P<0.001$ and NS = Non-significant. Means in row with different superscripts vary significantly. All means values are in percentage.

Table 2: Average essential amino acid composition as influenced by location

Parameters	Overall mean±S.E	Todi	Ganawuri	Bokkos	Zabir	Bogoro	Rinji	Tulai	Nabardo	LOS
Methionine	2.58±0.05	$2.70±0.02^{bc}$	$2.97±0.02^{a}$	$2.49±0.04^{d}$	$2.21±0.05^{f}$	$2.53±0.05^{d}$	$2.60±0.05^{cd}$	$2.37±0.03^{e}$	$2.78±0.03^{b}$	***
Arginine	2.88±0.05	$3,07±0.03^{a}$	$2.81±0.11^{b}$	$2.69±0.06^{bc}$	$3.16±0.06^{a}$	$2.81±0.06^{b}$	$2.79±0.04^{b}$	$2.58±0.00^{c}$	$3.16±0.06^{a}$	***
Tryptophan	0.60±0.02	$0.61±0.02^{bc}$	$0.75±0.02^{a}$	$0.50±0.03^{e}$	$0.53±0.01^{de}$	$0.58±0.00^{cd}$	$0.56±0.02^{cd}$	$0.60±0.02^{c}$	$0.66±0.02^{b}$	***
Threonine	3.31±0.06	$3.40±0.02^{a}$	$3.55±0.03^{a}$	$2.86±0.35^{b}$	$3.16±0.10^{ab}$	$3.27±0.03^{a}$	$3.38±0.04^{a}$	$3.40±0.04^{a}$	$3.42±0.06^{a}$	*
Histidine	2.18±0.02	$2.19±0.02^{abc}$	$2.22±0.02^{ab}$	$2.26±0.02^{a}$	$2.09±0.02^{c}$	$2.19±0.02^{abc}$	$2.11±0.04^{bc}$	$2.17±0.07^{abc}$	$2.17±0.04^{abc}$	*
Isoleucine	3.82±0.08	$4.06±0.04^{b}$	$4.50±0.02^{a}$	$3.71±0.02^{cd}$	$3.25±0.08^{f}$	$3.91±0.09^{bc}$	$3.69±0.08^{d}$	$3.47±0.04^{e}$	$3.97±0.11^{b}$	***
Leucine	10.21±0.65	12.84±0.03	6.83±3.36	10.51±0.07	9.04±0.06	8.26±3.33	11.17±0.10	9.98±0.12	13.04±0.08	NS
Lysine	1.52±0.12	1.27±0.00	1.58±0.01	1.50±0.02	1.33±0.03	2.41±0.96	1.36±0.06	1.40±0.02	1.34±0.05	NS
Valine	5.09±0.10	$5.55±0.03^{a}$	$5.73±0.00^{a}$	$4.83±0.05^{c}$	$4.27±0.16^{d}$	$5.14±0.06^{b}$	$4.89±0.05^{c}$	$4.73±0.03^{c}$	$5.35±0.09^{a}$	***
Phenyl-alanine	5.23±0.16	$5.79±0.06^{b}$	$6.27±0.06^{a}$	$5.08±0.06^{c}$	$3.60±0.05^{e}$	$5.21±0.15^{c}$	$5.14±0.10^{c}$	$4.73±0.06^{d}$	$5.97±0.650^{b}$	***

LOS = Level of significance, * = $P<0.05$, *** = $P<0.001$ and NS = Non-significant. Means in a row with different superscripts vary significantly. All means values are in g / 100g

Table 3: Average non-essential amino acid composition as influenced by location

Parameters	Overall mean± S.E	Todi	Ganawuri	Bokkos	Zabir	Bogoro	Rinji	Tulai	Nabardo	LOS
Proline	4.59±0.13	4.80±0.07^{abc}	5.45±0.03^{a}	4.61±0.61^{bc}	3.59±0.18^{d}	4.70±0.03^{abc}	4.50±0.14^{bc}	4.06±0.11^{cd}	5.01±0.07^{ab}	**
Tyrosine	2.21±0.03	2.24±0.00^{bc}	2.41±0.00^{a}	2.12±0.06^{cd}	2.06±0.00^{d}	2.24±0.00^{bc}	2.18±0.06^{bcd}	2.15±0.09^{bcd}	2.30±0.06^{ab}	**
Cystine	0.65±0.11	0.06±0.00^{b}	0.48±0.00^{b}	0.48±0.00^{b}	0.36±0.00^{b}	0.44±0.04^{b}	1.73±0.63^{a}	0.60±0.00^{b}	0.48±0.00^{b}	**
Alanine	6.64±0.35	7.58±0.04	6.40±1.68	4.73±2.13	5.69±0.29	7.33±0.07	7.03±0.10	6.57±0.09	7.81±0.04	NS
Glycine	2.50±0.05	2.64±0.02^{b}	2.88±0.04^{a}	2.26±0.04^{d}	2.47±0.04^{c}	2.42±0.05^{c}	2.39±0.01^{c}	2.17±0.01^{d}	2.74±0.04^{b}	***
Glutamic-acid	18.98±0.39	20.29±0.27^{c}	22.00±0.09^{a}	17.91±0.17^{f}	16.05±0.15^{h}	18.92±0.31^{d}	18.43±0.23^{e}	17.32±0.25^{g}	20.94±0.23^{b}	***
Serine	3.92±0.09	4.25±0.05^{b}	4.48±0.03^{a}	3.64±0.05^{cd}	3.33±0.09^{e}	4.10±0.08^{b}	3.76±0.07^{c}	3.46±0.11^{de}	4.31±0.04^{ab}	***
Aspartic-acid	7.20±0.09	7.44±0.03^{bc}	7.71±0.05^{a}	7.50±0.04^{ab}	6.39±0.03^{f}	7.23±0.10^{cd}	7.05±0..07^{d}	6.74±0.12^{e}	7.55±0.09^{ab}	***

LOS = Level of significance, *** = P<0.001, ** = P<0.01 and NS = Non-significant. Means in a row with different superscripts vary significantly. All means values are in g/100g

Table 4: Average mineral composition as influenced by location

Parameters	Overall mean± S.E	Todi	Ganawuri	Bokkos	Zabir	Bogoro	Rinji	Tulai	Nabardo	LOS
Iron	2.60±0.06	2.23±0.09^{c}	2.51±0.01^{b}	3.02±0.04^{a}	2.89±0.07^{a}	2.92±0.03^{a}	2.48±0.06^{b}	2.48±0.06^{b}	2.27±0.03^{c}	***
Sodium	71.66±0.57	76.02±0.13^{a}	69.34±0.39^{d}	72.79±0.22^{b}	69.56±0.34^{cd}	70.07±0.03^{cd}	70.58±0.72^{c}	69.14±0.04^{d}	75.75±0.38^{a}	***
Potassium	162.54±2.57	149.02±0.12^{e}	168.35±0.83^{b}	156.93±0.83^{c}	181.66±0.89^{a}	181.35±0.89^{a}	154.93±0.69^{d}	158.60±0.50^{c}	149.50±0.25^{e}	***
Magnesium	46.24±0.65	47.85±0.55^{b}	50.79±0.37^{a}	44.03±0.58^{c}	43.06±0.56^{c}	42.93±0.48^{c}	43.68±0.31^{c}	50.51±0.31^{a}	47.03±0.03^{b}	***
Calcium	26.25±1.08	260.64±0.39^{b}	261.40±0.26^{b}	256.46±1.33^{c}	270.61±0.42^{a}	270.03±0.03^{a}	255.89±0.74^{c}	261.59±0.21^{b}	261.33±0.33^{b}	***
Copper	0.94±0.03	1.00±0.01^{a}	0.89±0.00^{b}	0.80±0.05^{c}	1.12±0.10^{a}	1.10±0.06^{a}	0.98±0.00^{b}	0.86±0.01^{b}	1.01±0.03^{a}	***
Zinc	1.50±0.08	1.13±0.06^{e}	1.03±0.03^{e}	1.46±0.15^{c}	1.77±0.02^{b}	1.76±0.03^{b}	1.30±0.05^{cd}	1.22±0.06^{de}	2.27±0.03^{a}	***
Manganese	0.90±0.05	1.20±0.07^{a}	0.50±0.04^{c}	0.84±0.01^{b}	1.09±0.01^{a}	1.10±0.00^{a}	0.79±0.02^{b}	0.53±0.02^{c}	1.11±0.10^{a}	***
Sulphur	0.92±0.11	0.56±0.24^{cd}	0.43±0.02^{d}	0.73±0.04^{bc}	1.80±0.05^{a}	1.77±0.01^{a}	0.86±0.01^{b}	0.42±0.03^{d}	0.82±0.02^{bc}	***
Phosphorus	161.35±5.16	185.30±1.72^{a}	129.50±0.74^{c}	144.45±1.39^{b}	181.47±6.34^{a}	187.11±0.06^{a}	146.95±1.35^{b}	129.42±0.52^{c}	186.63±0.68^{a}	***
Cobalt	0.34±0.07	0.01±0.00^{e}	0.87±0.02^{a}	0.11±0.01^{d}	0.39±0.02^{c}	0.40±0.02^{c}	0.08±0.01^{d}	0.82±0.02^{b}	0.01±0.00^{e}	***

LOS = Level of significant and *** = P<0.001. Means in a row with different superscripts vary significantly. All means values are in mg/ g

Table 5: Average anti-nutrient composition as influenced by location

Parameter	Overall mean±S.E	Todi	Ganawuri	Bokkos	Zabir	Bogoro	Rinji	Tulai	Nabardo	LOS
Flavonoid	1.71±0.14	2.27±0.09^{a}	1.22±0.12^{b}	0.96±0.10^{b}	2.33±0.05^{a}	2.39±0.22^{a}	0.94±0.07^{b}	1.26±0.20^{b}	2.29±0.17^{a}	***
Alkaloid	0.99±0.07	1.46±0.17^{a}	0.71±0.03^{c}	0.82±0.11^{c}	1.02±0.02^{bc}	1.06±0.13^{abc}	0.79±0.04^{c}	0.66±0.16^{c}	1.40±0.23^{ab}	***
Tannin	26.56±1.13	34.08±0.82^{a}	27.32±0.45^{b}	19.66±0.05^{c}	26.33±0.60^{b}	24.68±1.20^{b}	19.76±0.27^{c}	25.76±0.66^{b}	34.90±1.52^{a}	***
Saponin	0.89±0.14	0.52±0.04^{b}	0.42±0.02^{b}	1.96±0.01^{a}	0.51±0.28^{b}	0.51±0.28^{b}	1.86±0.11^{a}	0.43±0.02^{b}	0.80±0.53^{b}	***
Oxalate	7.61±0.65	12.82±0.22^{a}	8.01±0.26^{b}	4.19±0.19^{d}	5.68±0.74^{cd}	6.36±0.15^{bc}	4.24±0.27^{d}	8.28±1.15^{b}	11.42±1.19^{a}	***
Phytic-acid	20.13±0.94	23.41±0.47^{b}	25.82±0.53^{a}	13.93±0.14^{d}	18.18±0.34^{c}	17.82±0.56^{c}	13.90±0.44^{d}	24.27±0.42^{b}	26.68±0.82^{b}	***

LOS = Level of significant and *** = P<0.001. Means in a row with different superscripts vary significantly. All means values are in mg/ g

The overall mean of essential amino acid composition of Tamba grain observed in the present finding is similar to 1.82 g/100g (methionine), 4.17 g/100g (arginine), 3.11 g/100g (threonine), 2.07 g/100g (histidine), 3.29 g/100g (isoleucine), 10.65 g/100g, (leucine), 2.15 g/100g (lysine), 5.00 g/100g (valine) and 4.90 g/100g (phenyl-alanine) reported by (21). (30) recorded corresponding mean values of 2.3, 3.9, 4.2, 2.4, 4.4, 11.5, 2.8, 6.0 and 5.6 g/100g in Pearl millet. The mostly significant variation in essential amino acid composition of Tamba grains by location observed in the present study agreed with the work of (31) who reported a great variability in nutrient contents of some selected cereal grains (maize, wheat and finger millet) obtained from different part of the world (Argentina, Brazil, China, Ukraine and United States) and attributed this to variations in soil type. (24) also found similar variation on amino acid profile of some millet species (Finger, Proso, Foxtail, Little, Kodo, Barnyard and Pearl millets), milled rice and wheat. The authors noticed that millet species had higher levels of sulphur containing amino acid (methionine and cysteine) than milled rice whose digestibility is affected by tannin. Working on three varieties of Finger millets (U-15, P-224 and local varieties) in different agro-ecological zones of Kenya (Kiboko, Kakamega and Alupe), they reported significant effect of phosphorus fertilizer on total protein content (and hence amino acid) of finger millet. Earlier reports of (32) also indicate variation in amino acid composition of different varieties of finger millets (Hamsa, Purna, HPW 83-4, HPB 20-5 and HPB 26-6) cultivated at varied regions of India. (33) confirmed that the proportion of each amino acid (with exception of leucine) in millet grain differed between sites but not between varieties. The overall average non-essential amino acid composition reported in the current observation is lower than 6.8, 1.2, 8.8, 22.1, 5.3 and 8.7 g/100g for proline, cystine, alanine, glutamic acid, serine and aspartic acid respectively (30). The significant difference observed in non-essential amino acid composition of Tamba grain conforms to the work of (34) on the same crop. Working on four millet species (Fox-tail, Proso, Pearl and Finger millets), (35) observed significant difference in non-essential amino acid profile and attributed it to varied genetic constitution of the grains. (36) however observed non-significant difference in amino acid profile of Black Finger millet obtained from different location of Plateau State (Sho, Vom and Whos). Similarly, (37) detected non-significant variation in non-essential amino acid composition of white and yellow defatted fox tail millet flours. (38) recorded the effect of geographic location on the composition of non essential amino acid (except alanine) in millet grains. The overall mean mineral composition obtained are generally higher than those reported by (21) for iron, sodium, potassium, magnesium, zinc and phosphorus. However, the authors recorded higher values for calcium and copper. Furthermore, (36) recorded lower values of 1.8×10^{-2}g/100g(iron), 1.5×10^{-2}g/100g(sodium), 5.4×10^{-1}g/100g(potassium), 1.74×10^{-1}g/100g(magnesium), 4.0×10^{-1}g/100g(calcium), 2.9×10^{-2}g/100g(manganese) and 2.8×10^{-1} g/100g (phosphorus). The significant effect of location on mineral composition observed in the present study agrees with the report of (36). Contrary to the present finding, (23) reported non-significant variation in mineral composition of different varieties of Finger millet (Ateso, Gulu-E, FMV-1, KNE-479, KNE-1034 and Nyaikuro) grown at Katangi in Machakos county of Kenya. The concentrations of micro minerals in finger millet grain differed among growth location with cultivar and environmental effect accounting for 72% of total variance observed (39). The largest single contributor to variation in concentration of micro minerals in cereals grain was location and the environment that differs from year to year at a location (40). The overall mean anti-nutrient composition values recorded in the current observation are lower than 322.40, 20.52, 144.45 and 614.65 µg/g for tannin, oxalates, flavonoid and phytic acid, respectively (26). The significant variation observed in anti-nutrient composition of Tamba grain as observed in the present study is in agreement with the report of (23) who detected considerable difference in tannin, ferulic acid, p-hydroxybenzoic acid, sinapic acid, syringic acid and tanilic acid among six varieties of Finger millet (Ateso, Gulu-E, FMV-1, KNE-479, KNE-1034 and Nyaikuro). Working on six different processed Finger millet (whole flour, semi-refined flour, bran riche fraction, boiled, pressure cooked and germinated), (41) reported significant effect of location on tannin composition. More recently, (26) reported significant effect of genotype on anti-nutrient composition of finger millet. (36) determined the contribution of location of growth to the variation in the concentration of antinutrient in Tamba grains as 20 to 50%. (39) noticed high percentage of difference for concentration of antinutrients in finger millet grains due to location and year of growth or environmental effects.

Conclusion and Application

1. This study revealed that Tamba grain (*Eleusine coracana*) is rich in nutrients required by human and animals and that location has generally significant influence on composition.
2. Tamba grains can be used as food for both humans and animal provided the anti-nutritional factors have been controlled.

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