Proximate Composition and Mineral Content in Different Types of Traditional *TOGWA* Used in Tanzania as a Weaning Food

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Abstract

Six types of traditional togwa (a traditional fermented gruel prepared from a mixture of malted and unmalted cereal grains), six simulated togwa and their ingredients were analysed for proximate composition, energy and mineral contents. The cereals used were maize (Zea mays), finger millet (Eleusine coracana) and sorghum (Sorghum bicolor). Malt was prepared from sorghum and finger millet. The concentration of protein in traditional and simulated togwa was higher compared to their main ingredients. The ranges were 9.1-12.5, 9.9-12.9 and 8.7-12.0% respectively. Crude fibre was also higher in traditional and simulated togwa than in the main ingredients, while carbohydrate percent of DM and energy contents were lower than in the ingredients. Ash contents in traditional togwa was 1.44–2.21% and for simulated togwa 1.32-2.2%. Results for mineral contents indicated that phosphorus, magnesium and potassium were the major mineral constituents in both the traditional togwa and laboratory simulated samples. In the traditional and simulated togwa samples, phosphorus content ranged, respectively between 196–334 and 191–332 (mg/100g), magnesium between 59.5 – 123.7 and 59.4 – 123 (mg/100g) and potassium between 167–315, and 167 – 313 (mg/100g). Calcium range was 3.95 – 12.32 (mg/100g) in traditional togwa and 3.40 – 11.92 (mg/100g) in simulated togwa compared to 5.57 – 14.59 (mg/100g) in the main ingredients. Iron, zinc and copper contents were slightly higher in traditional and in simulated togwa compared to their levels in the main ingredients. Iron ranged between 18.5–23.8 and 18.5–24.8 (mg/100g) in traditional and simulated samples respectively, and zinc ranged between 1.39 – 1.82(mg/100g) in traditional togwa and 1.41 – 1.81(mg/100g) in simulated samples. The contant of coppel in traditional and simulated togwa were 0.33 – 0.69 and 0.32- 0.70 (mg/100g), respectively. Apparently, the choice of cereal and malt and the processes of germination and fermentation for togwa production affects the proportions of nutrients found in the product. This results in different types of togwa with variation in proximate composition, energy density and mineral content.

Key words: *Togwa*, proximate composition, energy and mineral content

Introduction

Togwa is a traditional fermented gruel prepared from a mixture of flours of malted and unmalted cereal grains by utilising native amylase from the malt as a saccharifying enzyme. *Togwa* can be made from maize (*Zea mays*), sorghum (*Sorghum bicolor*) or finger millet (*Eleusine coracana*) flour or their mixtures. *Togwa* has been reported to reduce the transmission of infectious bacteria, which cause diarrhoea among young children (Lorri 1993; Darling *et al*, 1995; Kingamkono 1997). This is an important attribute of *togwa*, because diarrhoea and malnutrition appear to reinforce one another in a sense that a child with nutritional inadequacy is at a high risk of contracting infectious diseases due to reduced immunity (Lorri 1993; Mensah *et al.* 1995) thereby affecting the health of the children. *Togwa* being a fermented cereal product can be a

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good source of proteins, vitamins and minerals for weaning age children in low-income populations in Tanzania. Traditional techniques and ingredients used for *togwa* preparation vary from one place to another depending on availability of raw materials and consumption and social habits, which has resulted in *togwa* of different types and quality. So far the nutrient quality of the different types of *togwa* is not known, because few scientific studies have been carried out on their nutrient composition. This study was therefore aimed at assessing and documenting the proximate composition and mineral content of traditionally prepared *togwa* found in urban and rural areas of Dar-es-Salaam, Iringa, Morogoro and Zanzibar in Tanzania, where *togwa* has been used as a weaning food for many years. Simulated *togwa* samples were prepared under controlled laboratory conditions for product quality improvement and for comparison with the traditional *togwa*.

Materials and Methods

Selection and collection of traditional *togwa* samples

Based on their formulation, six types of *togwa* were selected and collected, two each from Dar-es-Salaam, Iringa and Morogoro (Table 1). The selection of the six types of *togwa* was based on the results of the survey carried out in the mentioned regions (Ndabikunze *et al.* unpublished), which showed that the types selected for each region were those used for weaning age children by the majority of the people interviewed. For each type of *togwa*, five sample lots, ca. 3 litres each, were collected at random from five different families who were using *togwa* as a weaning food, labelled and transported in a cooling box (model Iglo Kool mate36) to the Department of Food Science and Technology, Sokoine University of Agriculture, and frozen at $-4^{\circ}C$ for future nutrient analysis. The main ingredients used in the preparation of *togwa* from each family were also collected for analysis to assess the changes in nutrient composition of the resulting *togwa*.

Table 1: Types of *togwa* selected for analysis

Togwa Type	Ingredients mixtures and rations
DM + MF	Dehulled maize flour (DM): Malted finger millet (MF) [3:1,(w/w)].
WM +MF	Whole maze flour (WM): Malted finger millet (MF) [3:1,(w/w)].
DM + MF	Dehulled maize flour: Malted sorghum(var.*tegemeo*) (MS) [3:1, (w/w)].
WS+MS	Whole sorghum (var. T*egemeo*)flour (UD): Malted local sorghum (MU) [4:1,(w/w)].
UD + MU	Local sorghum (var.udo)flour (UD): Malted local sorghum (MU) [4:1, (w/w)].
WS+MF	Whole sorghum flour (WS): Malted finger millet (MF) [3:1,(w/w)].

Preparation of simulated *togwa* samples

Cereals for simulation studies included maize (*staha* variety), sorghum (var. *tegemeo* and *udo*, a local variety) and finger millet. Maize and finger millet were bought from Iringa market and sorghum (var. *tegemeo*) was bought from Ilonga Research Institute in Morogoro, while sorghum(var. *Udo*) was bought from Dar-es-Salaam local market. Maize was dehulled using a laboratory dehuller (Rajan Metal Machinery Ltd. Model RMML/50, 1995. Dar-es-Salaam, Tanzania). Malted flour was from sorghum and finger millet. Germination procedures for the grains were similar to the traditional ones but were closely monitored under laboratory conditions. Grains were soaked in distilled water and kept in a dark place for 12h. After draining all the water, the grains were washed with distilled water, spread out in a 1cm thick layer between wet cheesecloth and left to germinate at room temperature for 72 h.

The grains were sprinkled with distilled water every 12 h. Sprouted seeds were put on clean aluminium plates, covered with wire-mesh and sun dried to moisture content of 10%. Dry sprouted grains along side whole and dehulled maize and sorghum were milled separately using a laboratory micro-milling machine (Model 102 Magic mill, U.K.) to obtain fine flour. The different types of *togwa* were then prepared in the sequence shown in Figure 1. Three simulations were prepared for each type of *togwa*.

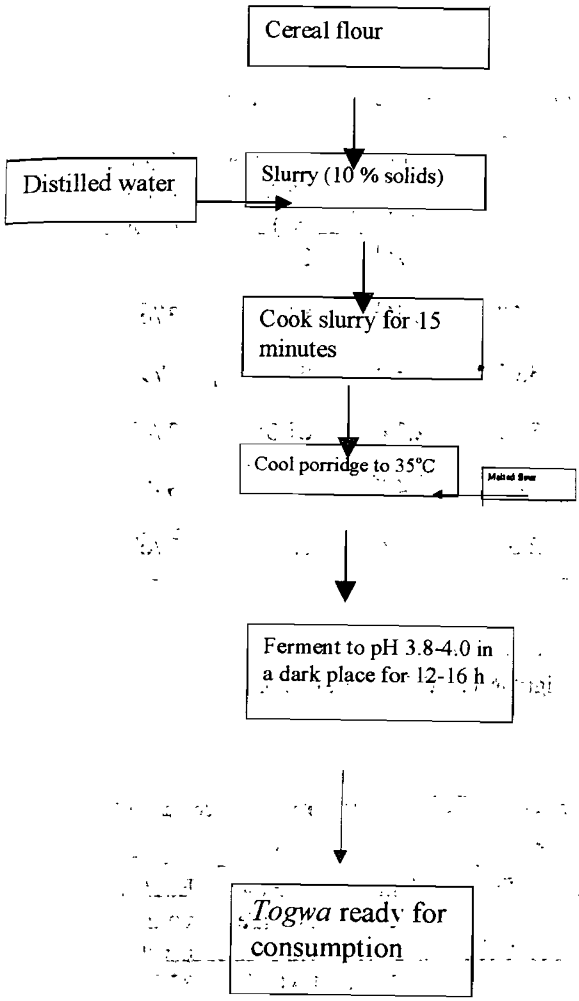

Figure 1: Flow diagram for preparation of simulated *togwa*

Proximate composition

The proximate composition of the main ingredients of traditional *togwa* and of simulated *togwa* samples was analysed according to the AOAC (1990) methods. Moisture content was determined by hot air-oven method at 75 - 80°C for 48 hours (for *togwa*) and at 105°C for 24 hours for the main ingredients. Dried samples were analysed for crude protein by the micro-Kjeldhal method using a conversion factor of 6.25 (AOAC 1984). Fat content was determined by ether extraction using the Soxtec System (Tecator Soxtec System HT 1043, Tecator AB, Hoganas, Sweden). Crude fibre was analysed by dilute acid hydrolysis (Osborne and Voogt 1978), while ash content was determined using the dry ashing method at 550°C (AOAC 1990). Carbohydrate was calculated as the percentage difference (Livesey 1995). Energy values were calculated by multiplying % fat, % protein and % carbohydrate by factors of 9, 4, and 3.75, respectively (Paul and Southgate 1988; AOAC 1990). For each lot analysis was carried out in triplicates.

Mineral content

The ash obtained from the ash content determination was used for analysis of minerals according to the AOAC (1990) procedures. The ash was dissolved in 20 ml of 1N HCl, and heated for 5 minutes at 80 - 90 °C. The mixture was then transferred quantitatively to a 100ml volumetric flask and made up to volume with 1N HCl.

Calcium, magnesium, iron, zinc and copper were determined using a UNICAM Atomic Absorption Spectrophotometer (Model 919, Cambridge. U.K); while, sodium and potassium was determined by a Flame Photometer (Corning Model 410, Cambridge, U.K.).

A single beam cathode lamp was used for each element. Phosphorus was estimated calorimetrically using the UV/VIS spectrophotometer (UNICAM Model UV5625 052303 D2 v3.00, Milton technical Centre, Cambridge, U.K.). The results were expressed on dry matter basis.

Statistical analysis

All samples were analysed in triplicate and the data were subjected to a one-way analysis of variance using the MSTAT-C programme (Freed *et al.* 1990). Differences among means were compared by Duncan's multiple range test with a probability (p= 0.05) (Duncan 1955).

Results and Discussion

Proximate composition, carbohydrate and energy content.

The proximate composition and carbohydrate and energy contents of the main ingredients, traditional *togwa* and simulated *togwa* are shown in Tables 2, 3 and 4, respectively. Proximate composition is a quick way of screening the nutritional quality of foods and food substances and therefore its was used to scan the nutrient contents of different types of *togwa*.

Table 2a: Nutrient composition of different formulations used in the preparation of traditional *togwa*[1]

Ingredients	Dry matter (%)	Crude protein (%)	Crude fibre (%)	Fat (%)	Ash (%)	Carbohydrate (%)	Energy value (kcal/100g)
DM + MF	88.8[b]	8.73[d]	1.56[d]	1.92[f]	1.29[f]	86.5[a]	377[b]
WM + MF	89.5[b]	8.91[d]	3.22[a]	3.73[a]	2.19[b]	81.9[d]	376[b]
DM + MS	80.8[d]	9.87[c]	3.21[a]	3.62[b]	1.35[e]	81.9[d]	379[a]
WS + MS	84.5[c]	10.11[c]	3.16[a]	3.19[c]	2.22[a]	81.3[e]	374[c]
UD + MU	90.1[a]	10.81[a]	2.68[b]	2.06[e]	1.48[d]	82.9[b]	373[c]
WS + MF	85.3[c]	11.62[a]	2.26[c]	2.37[d]	1.46[d]	82.3[c]	376[b]

[1]Each value is an average of triplicate determinations expressed on dry matter basis.
Means not sharing a common superscript in a column are significantly different at $P<0.05$.

Table 2b: Nutrient composition of different formulations used in the preparation of simulated *togwa*[1]

Ingredients	Dry matter (%)	Crude protein (%)	Crude fibre (%)	Fat (%)	Ash (%)	Carbohydrate (%)	Energy value (kcal/100g)
DM + MF	89.9[a]	9.28[d]	1.60[d]	1.85[d]	1.32[cd]	86.0[a]	376[bc]
WM + MF	89.3[a]	8.92[d]	3.15[a]	3.68[a]	2.05[a]	82.1[c]	377[b]
DM + MS	82.6[b]	10.62[c]	3.18[a]	3.63[a]	1.28[d]	81.0[d]	380[a]
WS + MS	85.5[ab]	10.9[bc]	3.11[a]	3.01[b]	1.96[b]	81.0[d]	374[cd]
UD + MU	90.1[a]	11.0[b]	2.98[b]	2.16[c]	1.35[c]	82.6[b]	372[d]
WS + MF	86.1[ab]	12.01[a]	2.21[c]	2.25[c]	1.31[cd]	81.9[c]	376[bc]

[1]Each value is an average of triplicate determinations expressed on dry matter basis.
Means not sharing a common superscript in a column are significantly different at $P<0.05$.

Table 3: Nutrient composition of different types of traditional *togwa*[1]

Togwa type	Dry matter (%)	Crude protein (%)	Crude fibre (%)	Fat (%)	Ash (%)	Carbohydrate (%)	Energy value (kca/100g)
DM +MF	10.8^{b}	9.1^{d}	2:33^{e}	1.58^{f}	1.45^{d}	85.4^{a}	371^{d}
WM + MF	11.0^{b}	9.5^{d}	3.58^{b}	3.54^{a}	2.21^{a}	81.2^{c}	374b
DM +MS	10.1^{c}	10.9^{b}	3.65^{a}	3.17^{b}	1.44^{d}	80.8^{d}	375^{a}
WS + MS	10.0^{c}	11.0^{b}	3.49^{c}	3.01^{c}	1.52^{c}	80.9^{c}	374^{b}
UD + MU	11.9^{a}	10.5^{c}	3.16^{d}	2.26^{d}	1.54^{c}	82.6^{b}	372^{c}
WS + MF	10.0^{c}	12.5^{a}	3.68^{ab}	2.10^{e}	1.65^{b}	80.1^{e}	369^{e}

[1]Each value is an average of triplicate determinations for each lot expressed on dry matter basis.

Means not sharing a common superscript in a column are significantly different at $P<0.05$.

Table 4: Nutrient composition of different types of simulated *togwa*[1]

Togwa type	Dry matter (%)	Crude protein (%)	Crude fibre (%)	Fat (%)	Ash (%)	Carbohydrate (%)	Energy value (kca/100g)
DM +MF	10.1^{d}	9.92^{e}	2.56^{f}	1.19^{e}	1.37^{e}	85.0^{a}	369^{d}
WM + MF	10.9^{b}	9.86^{e}	3.67^{b}	3.21^{a}	2.20^{a}	81.0^{c}	372^{b}
DM + MS	10.5^{c}	11.66^{b}	3.26^{e}	3.03^{b}	1.32^{f}	80.7^{d}	377^{a}
WS + MS	10.2^{c}	11.91^{b}	3.62^{c}	2.06^{c}	1.46^{d}	80.9^{c}	370^{c}
UD + MD	11.2^{a}	11.05^{d}	3.37^{d}	2.04^{c}	1.47^{c}	82.0^{b}	370^{c}
WS + MF	9.9^{d}	12.92^{a}	3.75^{a}	1.97^{d}	1.56^{b}	79.8^{e}	369^{d}

[1]Each value is an average of triplicate determinations for each lot expressed on dry matter basis.
Means not sharing a common superscript in a column are significantly different at $P<0.05$.

The percentage protein in DM of all types of *togwa* except for *togwa* type (UD + MU) was higher compared to their main ingredients. The protein percentage in traditional *togwa* type (WS + MF) (12.5 %) was significantly ($P < 0.05$) higher than in other traditional *togwa*. There was no significant difference ($P > 0.05$) in protein percentage (10.92 and 11.0 %) (Table 3), between traditional *togwa* type (DM + MS) and (WS + MS). The lowest protein percentages, (9.1 and 9.5%), were observed in traditional *togwa* type (DM + MF) and (WM + MF), respectively. The increase of protein percentage was higher in simulated samples than in traditionally fermented *togwa* (Table 4). This difference could be a reflection of better process control during the preparation of simulated *togwa* than in home prepared traditional *togwa*. Krishnakumari and Thayumanavan (1995) and Abdalla *et al.* (1998) also observed higher protein percentage after fermentation of cereal based weaning foods, and they attributed this increase to better utilization of substrate by fermenting microorganisms. Krishnakumari and Thayumanavan (1995) also suggested that such increase was due to improved contribution by malted flour. However, we suggest that the apparent slight increase in protein is due to the loss from carbohydrate and fat components, some being metabolised into volatile compounds during fermentation. Basically, the amount of protein as analysed by the micro-Kjeldahl method can hardly change. However, if some components disappear, the relationships of amounts of components may change. Similar increases in protein content of germinated and fermented cereal based foods have also been reported by other researchers (Adewusi *et al.*, 1992; Mtebe *et al.* 1993; Steinkraus 1996; Sanni *et al.* 1999). Among the six types of *togwa* no single type could meet the protein requirement of infants (6-12 months). The average recommended protein intake is 14g per day (Latham 1997). This is because of low dry matter of *togwa* fed to the infants and low frequency of feeding.

The fat percentage in DM ranged between 1.58% for traditional *togwa* type (DM + MF) to 3.54% for type (WM +MF). The higher fat content in type (WM +MF) may be due to the high fat content in the germ of whole maize flour, containing more than 80% of the grain fat.

Lower fat levels in small grains were probably due to lipolytic activity of fermenting microorganisms, which could oxidise the lipids to obtain energy for their metabolic activities. Decrease in fat content for fermented sorghum and finger millet was also reported by Opoku *et al.*, (1981), Ikemfuna and Atii (1994) and Sanni *et al.*, (1999). The low level of fat is, however, desirable as it enhances the storage stability and keeping quality of *togwa*.

The percentage fibre in DM was higher in all the traditional and the simulated *togwa* compared to their base ingredients (Tables 2, 3 and 4). For traditional *togwa* it ranged from 2.33% for type (DM +MF) to 3.68% for type (WS + MF), and was most often highest in simulated samples. These results are in agreement with those of Malleshi and Klopfenstein (1998) working with sorghum and finger millet. During germination and fermentation - and -amylase contributes to the solubilization of carbohydrates, and proteolytic enzymes to partial protein digestion. The apparent increase in fibre content of *togwa* may have been due to further metabolism into volatile compounds, which may then reduce the dry matter. The increase in fibre content has both positive and negative effects; the negative effects being that high diet fibre content has been reported for reducing the bioavailability of micronutrients (Torre *et al.*, 1991; William 1995) in cereal based weaning foods. The positive effect is that children fed on *togwa* will have reduced problems of constipation; the fibre absorbs water and provides roughage for the bowels, assisting intestinal transit (Anderson *et al.*, 1990). This may be a reason why *togwa* is fed to infants as young as four months old.

The ash percentage in DM among different main ingredients ranged from 1.29% for type (DM + MF) to 2.22% for type (WS + MS). Type (WM + MF) *togwa* had a significantly (P 0.05) higher ash than other traditional *togwa*. This was probably due to the large proportion of whole maize flour in the mixture. Although malting and fermentation have been reported to decrease ash content of sorghum or finger millet (Malleshi and Klopfenstein, 1998), variation in ash for traditional *togwa* may also be due to the type of water used in its preparation. Water samples used for preparation of *togwa* from the four regions were collected and analysed for minerals. Sodium and potassium were the dominant minerals in water but in insignificant amounts. Other minerals included calcium, iron, zinc and copper. Also contaminating dust and other dirt may have contributed to an increase in ash in traditional *togwa*. For example ash content was low for simulated *togwa*, which were prepared using well-cleaned grains and distilled water instead of tap water (Table 4).

The carbohydrate percentages and energy contents of traditional and simulated *togwa* were mainly lower than those of the main ingredients (Tables 2, 3 and 4). Carbohydrate contnts variea, ranging from 80.1% for type (WS + MF) to 85.4% for traditional *togwa* type (DM + MF) and 79.8 – 85.0% for simulated *togwa* of the same types. Energy content was significantly ($P < 0.05$) higher in type (DM +MS) for both traditional and simulated *togwa* (375 and 377 kcal/100g, respectively) compared to the other types of *togwa*. This was a reflection of their high fat and protein contents (Tables 3 and 4). Fat produces double the amount of energy per gram compared to carbohydrates (Paul and Southgate, 1985). The energy content in both the traditional and simulated *togwa* (Tables 3 and 4) were within the range suggested by Walker (1990) for infant weaning foods. This author suggested energy content of 370 kcal/100g as being desirable. The dry matter of *togwa* ranged from 9.95 to 11.91 %. This means that the energy density of *togwa* will adjust to 55.3 – 75.3 kcal/100ml. The decrease in carbohydrate and energy from the base ingredients to *togwa* agrees with findings of Abdalla *et al.* (1998). Carbohydrates are the principal substrates for fermenting lactic acid bacteria; hence to supplement this requirement there is significant degradation of starch by - and- -amylase produced mainly by the malted flour (Krishnakumari and Thayumanavan, 1995) and in some cases by fermenting micro-organisms. This decrease has also been reported in other fermented cereal products such as *ogi*, *uji* and *mahewu* (Steinkraus, 1996).

Mineral content

The mineral contents of the six types of the main ingredients used to prepare traditional and simulated *togwa* are shown in Tables 5a and 5b, respectively, and for traditional and simulated *togwa* in Tables 6 and 7, respectively. Phosphorus, magnesium and potassium were the major mineral constituents in the main ingredients, traditional and simulated *togwa.* Calcium in the main ingredients for traditional *togwa* ranged from 5.6 mg/100g for type (UD + MU) to 14.6 mg/100g for type (WS + MF). This was significantly (P 0.05) highest in type (WS + MF) and lowest in type (UD + MU). A similar trend was observed among diferent types of traditional and simulated *togwa* (Tables 6 and 7). These values are higher than those reported by Klaus and Karel (1991), Ikemfuna and Atii (1994) and Abdallah *et al.*, (1998), for single grain flour, which shows that porridge fermented with a mixture of unmalted and malted flour produces a better product such as *togwa* with increased nutrient density. *Togwa* type (WS + MF) for both traditional and simulated *togwa*, had significantly (P0.05) higher calcium than the other types of *togwa*, and was lowest in *togwa* type (WS+MS).

Table 5a: Mineral content in different ingredients used for preparation of traditional *togwa*

Ingredients	Ca	P	Mg	K	Na	Fe	Zn	Cu
				(mg/100gDM)[1]				
DM +MF	10.3^{b}	200^{f}	67.1^{f}	163^{f}	13.3^{c}	15.3^{c}	1.3^{d}	0.3^{c}
WM +MF	8.6^{c}	225^{e}	93.5^{e}	228^{d}	8.9^{e}	21.3^{a}	1.6^{b}	0.2^{d}
DM +MS	5.6^{e}	302^{b}	107.1^{c}	203^{e}	9.5^{d}	20.7^{b}	1.7^{a}	0.4^{b}
WS +MS	6.3^{d}	362^{a}	104.6^{d}	306^{b}	12.8^{c}	18.5^{c}	1.6^{b}	0.4^{b}
UD + MU	5.6^{e}	293^{c}	125.3^{a}	318^{a}	14.3^{b}	17.7^{d}	1.6^{b}	0.4^{b}
WS + MF	14.6^{a}	261^{d}	118.8^{b}	258^{c}	16.0^{a}	21.3^{a}	1.5^{c}	0.7^{a}

[1] Each value is an average of triplicate determinations expressed on dry matter basis.
Means not sharing a common superscript in a column are significantly different at $P<0.05$.

Table 5b: Mineral content in different ingredients used for preparation of simulated *togwa*

Ingredients	Ca	P	Mg	K	Na	Fe	Zn	Cu
				(mg/100gDM)[1]				
DM+MF	13.3[b]	191[f]	59.4[f]	168[f]	19.1[b]	24.2[a]	1.7[a]	0.67[a]
WM+MF	12.4[b]	219[e]	78.5[e]	231[c]	18.5[b]	24.4[a]	1.5[b]	0.40[d]
DM+MS	9.8[c]	261[c]	100.1[c]	213[e]	11.1[e]	22.1[b]	1.5[b]	0.43[c]
WS+MS	7.4[d]	332[a]	125.3[a]	312[a]	14.6[d]	18.9[c]	1.4[c]	0.43[c]
UD+MU	9.7[c]	283[b]	118.0[b]	282[b]	15.4[c]	18.9[c]	1.5[b]	0.31[e]
WS+MF	14.0[a]	242[d]	98[d]	220[d]	20.1[a]	21.7[b]	1.5[b]	0.65[b]

[1] Each value is an average of triplicate determinations expressed on dry matter basis.
Means not sharing a common superscript in a column are significanlty different at P<0.05.

Phosphorus in the main ingredients for traditional *togwa* ranged from 200 mg/100g (DM +MF) to 362 mg/100g (WS + MS) and from 191 to 332 mg/100g in the main ingredients for simulated *togwa*. In traditional *togwa* and simulated samples, type (WS + MS) had significantly (P 0.05) the highest phosphorus (334 and 332 mg/100g), respectively.

Results in Tables 6 and 7 show that *togwa* made from ingredients containing sorghum tended to have higher phosphorus values than those made from maize. Generally calcium and phosphorus content in traditional *togwa* was low compared to those in the main ingredients. The decrease in calcium and phosphorus has also been reported in fermented cereal weaning foods (Sanni *et al.*, 1999). This slight decrease in the calcium and phosphorus contents in traditional *togwa* may have resulted from the fact that ingredients for traditional *togwa* were not standardized to be sure that the same amounts were used during *togwa* preparation. This decrease in calcium content for traditional *togwa* is a disadvantage because if *togwa* is used as a weaning food, it needs enough

Table 6: Mineral contents in different types of traditional *togwa*

Togwa type	Ca	P	Mg	K	Na	Fe	Zn	Cu
				(Mg/100g DM)[1]				
DM+MF	7.0[b]	196[f]	59.5[f]	167[f]	18.7[b]	23.8[a]	1.82[a]	0.69[a]
WM+MF	4.2[d]	219[e]	80.9[e]	233c	10.6[f]	22.5[b]	1.54[b]	0.46[c]
DM+MS	4.6[C]	264[C]	101.2[C]	213[e]	11.9[e]	21.0[e]	1.55[b]	0.46[c]
WS+MS	3.9[e]	334[a]	123.7[a]	315[a]	14.6[d]	18.8[d]	1.39[c]	0.46[c]
UD+MU	4.0[e]	285[b]	117.2[b]	281[b]	15.4[c]	18.5[d]	1.59[b]	0.33[d]
WS+MF	12.3[a]	243[d]	98.6[d]	220[d]	20.5[a]	22.0[b]	1.54[b]	0.67[b]

[1]Each value is an average of triplicate determinations for each lot expressed on dry matter basis.
Means not sharing a common supercript in a column are significantly different at P<0.05.

calcium to sustain the growing child. The recommended calcium intake per day is 400-500 mg for 12-36 months child. Both traditional and simulated *togwa* did not meet this requirement. Iron content of traditional and simulated *togwa* ranged from 18.5 mg/100g for type (UD +MU) to 23.8

mg/100g for type (DM + MF) and from 18.5 to 24.7 mg/100g, respectively (Tables 6 and 7)

Table 7: Mineral contents in different types of simulated *togwa*

Togwa[1] type	Ca	P	Mg	K	Na	Fe	Zn	Cu
				(Mg/100g DM)[1]				
DM+MF	13.3^{b}	191^{f}	59.4^{f}	167^{f}	19.12^{b}	24.7^{a}	1.81^{a}	0.70^{a}
WM+MF	12.2^{c}	218^{e}	79.9^{e}	232c	10.65^{f}	23.5^{b}	1.53^{b}	0.45^{c}
DM+MS	9.38^{d}	262^{c}	100^{c}	213^{e}	11.45^{c}	22.0^{c}	1.52^{b}	0.46^{c}
WS+MS	7.3^{f}	332^{a}	123^{a}	313^{a}	14.85^{d}	19.0^{e}	1.41^{c}	0.46^{c}
UD+MU	9.0^{e}	284^{b}	116^{b}	281^{b}	15.62^{c}	18.5^{f}	1.54^{b}	0.32^{d}
WS+MF	14.8^{a}	243^{d}	97.7^{d}	221^{d}	20.95^{a}	22.0^{d}	1.54^{b}	0.67^{b}

[1]Each value is an average of triplicate determinationas for each lot expressed on dry matter basis.
Means not sharing a common supercript in a column are significantly different at $P<0.05$.

All types of traditional *togwa* had an increased iron content compared to their main ingredients while with simulated *togwa* the increase was not significant indicating that, most of the iron found in the ingredients for simulated *togwa* was retained at the end of fermentation. Magnesium ranged from 67.1 to 125.3 mg/100g for the different types of the main ingredients for traditional *togwa* and from 59.4 to 125.3 mg/100g in the ingredients used for simulated *togwa*. *Togwa* prepared from a mixture of type (WS + MS) had a significantly (P 0.05) higher amount of magnesium than other types both for the traditional *togwa* and simulated *togwa* (Tables 6 and 7). Generally, there were significant (P0.05) differences in magnesium contents among different types of *togwa*.

There was an apparent slight increase in potassium content of (DM + MF), (WM + MF), (DM + MS) and (WS + MS) types for traditional *togwa* (Table 6). For simulated *togwa* samples, potassium ranged from 167 to 313 mg/100g. The main ingredients of type (WS + MF) exhibited significantly (P 0.05) higher value of sodium than the other types. This trend was also observed in the different types of traditional and simulated *togwa*. Sodium contents ranged from 10.6 mg/100g for type (WM + MF) to 20.5 mg/100g for type (WS + MF) for traditional *togwa* samples and from 10.6 mg/100g type (WM + MF) to 20.9 mg/100g type (WS + MF) for simulated *togwa*. *Togwa* type (WS + MF) had significantly (P0.05) higher sodium content than other types. Zinc content ranged from 1.39 to 1.82 mg/100g among traditional *togwa* samples and from 1.41 to 1.81 mg/100g for simulated samples. All types of traditional *togwa* had a slight increase in zinc content compared to the main ingredients. This increase may have been contributed from the water used to prepare traditional *togwa*. Copper was also higher in traditional *togwa* compared to the main ingredients ranging from 0.33 mg/100g for type (UD +MU) to 0.69 mg/100g for *togwa* type (DM +MF) (Table 6). For simulated *togwa* samples, copper ranged from 0.32 mg/100g for type (UD + MU) to 0.7 mg/100g for type (DM +MF) (Table 7).

Conclusions

The different types of *togwa* studied were characterised by variations in proximate composition, energy values and in mineral contents. However, these variations were observed not to be associated with geographical differences but rather the main ingredients used to prepare traditional *togwa*.. The processes of germination and fermentation affected the proportions of nutrients found in the *togwa*. Although there was an apparent increase in protein and some minerals, the food value of *togwa* as a weaning food cannot completely be predicted on the basis of this study. The quantity of *togwa* that can be consumed, quality of its protein in terms of amino acid composition and the bioavailabity of micronutrients and content of important vitamins such as B and C, could reflect on the actual nutritive potential of *togwa* as a weaning food.

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