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Evaluation of Proximate and Micronutrient Compositions of Some Selected Locally Consumed Biscuits Within Enugu State, Nigeria

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Abstract. This work evaluated the mineral, proximate and vitamin compositions of some locally consumed biscuits within Enugu State, Nigeria. The nutritional compositions of the biscuit samples were assessed using conventional techniques. The results of the proximate analysis showed that the moisture contents of the different biscuit samples ranged from 1.82±0.03 to 4.58±0.10% and ash content ranged from 0.55±0.04% to 2.24±0.01%. The crude lipid content ranged from 11.56±0.05% to 26.63±0.04% while the crude fibre content varied from 0.03±0.01% to 3.50±0.40%. The crude protein content in the biscuit samples varied from 2.49±0.00% to 5.04±0.05%. The total reducing sugar contents in the biscuit samples varied from 24.89±0.28 mg/100 g to 39.80±0.42 mg/100 g, while the calorific value varied from 1740.49±0.64 KJ to 2259.05±1.63kj/100 g. Vitamin C contents of the different biscuit samples varied from 1.02±0.19 mg/100 g to 12.95±0.17 mg/100 g. The vitamin B1 contents of the different biscuit samples ranged from 1.30±0.14 µg/100 g to 51.90±0.14 µg/100 g, while the vitamin B2 contents varied from 1.30±0.14 µg/100 g to 51.90±0.14 µg/100 g. Vitamin B12 content varied from 0.34±0.07 µg/100 g to 41.12±0.28 µg/100 g. The vitamin A content varied from 4.49±0.11 mg/100 g to 15.05±0.11 mg/100 g while the vitamin E content varied from 4.57±0.11 µg/100 g to 35.83±0.11 µg/100 g. The sodium concentration ranged from 43.36±0.0092 ppm to 82.59 ±0.0039 ppm, while calcium concentration varied from 1.08±0.0005 ppm to 10.93±0.0005 ppm, while the phosphorus concentration varied from 0.01±0.0001 ppm to 0.05±0.0006 ppm. The findings of this study showed that the different biscuit samples consumed in Enugu State contain important nutrients in a considerable amount.

Keywords: biscuits, vitamin, mineral, calorific value, proximate

Introduction

Wheat, millet, sorghum, oat and maize are examples of cereal foods that contribute to about 73% of plants produce globally (Rawat *et al*., 2023). They are used in the making of morning cereals, noodle pasta, biscuits, bread and wine (Okonkwo and Agharandu, 2017). Cereals are rich in macro and micronutrients (Baniwal *et al*., 2021), as well as phytochemicals (Bhat *et al*., 2023). They can also help prevent ailments including cardiovascular disease and diabetes (Liu and Cai, 2024).

Biscuits are a ready-to-eat, inexpensive and handy food item that is consumed by people of all ages in many nations (Latif and Pik Wan, 2023; Obasi *et al*., 2012). It's flat, crisp, sweetened or unsweetened depending on personal choice. Biscuits can be prepared with hard dough, hard sweet dough, short or soft dough or a combination of the three. It is made by blending ingredients like wheat flour, fat sweetener and water into a dough. Unlike bread, the dough is not allowed to ferment before being baked in the oven. (He *et al*., 2023). Biscuits are a type of confectionery that has been dried to a very low combination content.

A biscuit is a small, thin, crisp cake prepared using unleavened dough. Biscuits are obtained from a flour and water mixture that may also contain fat, sugar and other ingredients. The dough is left for a while before being placed between rollers to form a sheet (Ogunlakin *et al*., 2012).

The consumption of ready-made or convenience meals such as bread, cookies and cake is on the rise in Nigeria. Advances in wealth and urbanization, combined with the massive growth in population in recent years, have led to a surge in the consumption of wheat-based products, particularly biscuits and bread, in many countries of Sub-Sahara Africa, particularly Nigeria (Dada *et al*., 2023). All biscuits are nutrient-dense, providing important amounts of iron, calcium, calories, fibre and B vitamins to our diet and daily food needs. When cereals are combined with legumes such as Bambara nut and peanut, composite flour has the added

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benefit of increasing the nutritional value of biscuits and other baked products (Dada *et al*., 2023). Plain wheat flour is commonly used nowadays, while other ingredients including peanuts, pulverized rice and maize flour are occasionally added to modify the texture (Ogunlakin *et al*., 2012).

Presently, several foods are processed into snacks and form the major diets for several people. There are varieties of biscuits in the market with different vitamin, proximate and mineral compositions. However, sometimes, the vitamins, proximate and mineral compositions of these biscuit samples are not properly stated. Thus, due to the increasing nutritional awareness among consumers, there is a need to evaluate the vitamin, proximate and mineral compositions of various biscuit samples consumed in Enugu State, Nigeria to ensure that they contain the necessary nutrients required by the body system.

Materials and Methods

Selection of biscuit samples. The biscuits were bought from the grocery shop, in Nsukka metropolis, Enugu state, Nigeria 6 months minimum before their date of expiration. Different biscuit samples (10) were used and designated samples A-J respectively.

Reagents/chemicals. The chemicals used in this study were acetic anhydride, ammonium sulphate, bromine water, chloroform, concentrated ammonium hydroxide, hydrochloric acid, diethyl ether, ethanol, ethyl acetate, Fehling solutions (A and B), ferric chloride, lead sub-acetate and n-butanol.

Instruments/equipment. The equipment used included beakers, centrifuge, conical flasks, filter papers, glass funnel, spectrophotometer, test tubes, water bath (Gallenkamp, England), weighing balance and micro-mill Retsch, mesh 0.50.

Preparation of biscuit samples. The materials were mashed in a Retsch analytic micro-mill with a mesh of 0.50, then put in nylon bags and vacuum sealed until investigation.

Vitamin A content determination. The technique by Pearson (1976) was employed to evaluate the vitamin A content of the biscuit samples.

Determination of vitamin B. ***Vitamin B$_1$ content determination.*** The technique of Pearson (1976) was utilized to evaluate the vitamin B1 content of the biscuit samples.

Vitamin B$_2$ content determination. A technique described by Aberasturi *et al*. (2002) was utilized in the evaluation of vitamin B$_2$.

Vitamin B$_3$ content determination. The vitamin B$_3$ content of the biscuit samples was estimated using the AOAC (2003) technique.

Vitamin B$_6$ content determination. The vitamin B$_6$ content of the biscuit samples was estimated using the AOAC (2003) technique.

Vitamin B$_9$ content determination. The technique stated by AOAC (2003) was employed.

Vitamin B$_{12}$ content determination. The technique stated by Bruno (2007) was utilized for the evaluation of vitamin B$_{12}$.

Vitamin C content determination. The AOAC (1990) procedure was utilized.

Vitamin E content determination. The procedure of Pearson (1976) was employed to evaluate the vitamin E content of the biscuit samples.

Mineral content determination. ***Calcium and iron content determination.*** The calcium and iron content was evaluated employing the technique outlined by Pearson (1976).

Zinc content determination. The procedure of Sommer (1989) was utilized to evaluate the zinc content of the biscuit samples.

Phosphorus content determination. Phosphorus was quantified using a technique given by Pulliana and Wallin (1996).

Determination of potassium. A method by Zhenbo *et al.* (2016) was used in the determination of potassium.

Proximate analysis of the biscuit samples. The proximate components of the biscuit samples were evaluated using the AOAC (1990) technique.

Statistical analysis. The statistical analysis was performed utilizing the Statistical Package of Service and Solutions (SPSS) version 2016. The data were analyzed using a one-way analysis of variance (ANOVA).

Results and Discussion

Proximate compositions of some selected biscuit samples. The pronimat composition of some selected biscuit sample as shown in Table 1.

Total reducing sugar contents of some selected biscuit samples. The analysis of reducing sugar contents in the biscuit samples as seen in Fig. 1 below showed that the total reducing sugar contents in the biscuit samples varied from 24.89 mg/100 g to 39.80 mg/100 g. Sample D showed a significant increase (P<0.05) when compared to samples A, B, E, F, G, H, I and J. When comparing sample D to sample C, however, no significant change (P>0.05) was found. Also, a significant decrease (P<0.05) was observed in sample E compared to samples A, B, H, I and J. However, no significant difference (P>0.05) was observed in sample E when compared with samples F and G.

Calorific value of some selected biscuit samples. The calorific value of the biscuit samples ranged from 1740.49 KJ/100 to 2259.05 KJ/100 g as seen in Fig. 2 below. The caloric value of sample H increased when compared to samples A, B, C, D, I and J. No significant difference between samples A when compared with samples C, H and I.

Vitamins B complex and C compositions of some selected biscuit samples. The vitamin content evaluation of the different biscuit samples indicated the presence of vitamins A, B1, B2, B3, B6, B12, C and E. Vitamin C contents of the different biscuit samples varied from 1.02±0.19 mg/100 g to 12.95±0.17 mg/100 g. In comparison to sample A, sample B showed a significant increase (p<0.05). However, vitamin C was not detected in samples C, D, E, F, G, H, I and J Table 2.

Vitamins A and E compositions of some selected biscuit samples. The biscuit varieties included varying amounts of vitamin A from 4.49±0.11 mg/100 g to 15.05±0.11 mg/100 g. Sample D showed a significant increase (p<0.05) when compared to samples A, B, C, E, F, G, H, I and J. Sample A showed a significant decrease (p<0.05) when compared to samples B, C, E,

Table 1. Proximate compositions of some selected biscuit samples

Samples	Moisture (%)	Ash (%)	Crude lipids (%)	Crude fibre (%)	Crude protein (%)	CHO (%)
A	3.67±0.07^{abc}	0.59±0.01^{a}	13.06±0.05^{a}	3.35±0.18^{c}	5.04±0.05^{c}	74.29
B	4.28±0.47^{cd}	1.53±0.01^{bc}	24.41±0.13^{acd}	0.04±0.01^{a}	2.49±0.00^{a}	67.25
C	3.42±0.11^{b}	1.87±0.20^{cd}	11.56±0.05^{a}	0.03±0.01^{a}	4.37±0.00^{bc}	78.75
D	3.10±0.01^{b}	2.24±0.01^{d}	17.73±0.57^{ab}	0.22±0.01^{ab}	3.44±0.47^{ab}	73.27
E	4.50±0.10^{d}	0.89±0.08^{a}	26.63±0.04^{cd}	3.50±0.40^{c}	3.45±0.45^{ab}	61.03
F	2.25±0.05^{a}	0.97±0.10^{ab}	30.65±0.04^{d}	0.05±0.01^{a}	3.13±0.00^{ab}	62.95
G	4.22±0.01^{cd}	0.55±0.04^{a}	22..11±0.21^{abc}	0.05±0.01^{a}	4.38±0.00^{bc}	68.69
H	2.38±0.02^{a}	1.63±0.00^{cd}	12.20±0.16^{a}	0.03±0.01^{a}	3.12±0.89^{ab}	80.64
I	1.82±0.02^{a}	1.60±0.08^{cd}	11.73±0.16^{a}	0.81±0.07^{b}	2.49±0.00^{a}	81.55
J	4.58±0.10^{d}	0.89±0.09^{a}	22.63±5.70b^{c}	3.50±0.40^{c}	3.77±0.00^{abc}	64.63

Values are presented as mean±SD. Values in the same column with different superscripts differ significantly at p<0.05.

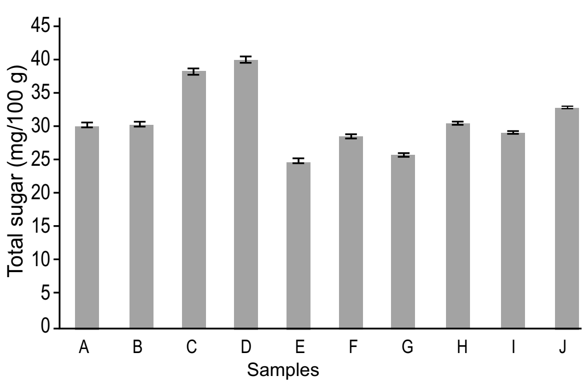

Fig. 1. Total reducing sugar contents of some selected biscuit samples.

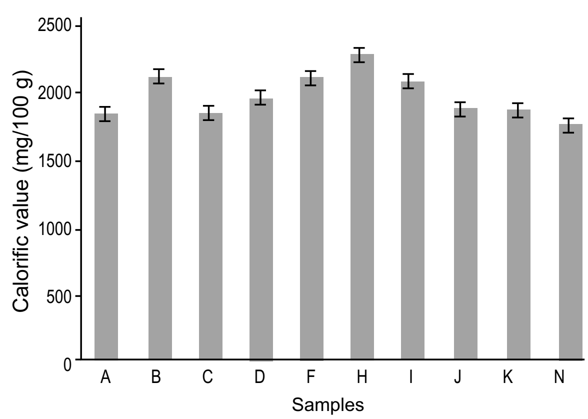

Fig. 2. Calorific value of some selected biscuit samples.

Table 2. Vitamins B complex and C compositions of some selected biscuit samples

Samples	Vitamin C (mg/100 g)	Vitamin B1 (µg/100 g)	Vitamin B2 (µg/100 g)	Vitamin B3 (µg/100 g)	Vitamin B6 (µg/100 g)	Vitamin B12 (µg/100 g)
A	12.95±0.17^{b}	5.10±0.14^{de}	20.65±0.21^{e}	42.45±0.14^{g}	13.00±0.14^{b}	0.84±0.21^{b}
B	1.02±0.19^{a}	5.50±0.12^{e}	5.60±0.14^{c}	26.15±0.21^{d}	37.50±0.14^{d}	ND
C	ND	4.80±0.1^{cd}	45.80±0.18^{g}	32.20±0.14^{e}	38.10±0.28^{e}	ND
D	ND	3.88±0.21^{b}	6.65±0.07^{c}	8.00±0.14^{a}	37.25±0.21^{d}	ND
E	ND	4.30±0.14b^{c}	1.30±0.14^{a}	33.40±0.12^{f}	ND	ND
F	ND	ND	51.90±0.14^{h}	51.90±0.14^{h}	37.05±0.07^{d}	0.98±0.28^{b}
G	ND	5.30±0.14^{e}	15.80±0.14^{d}	15.80±0.14^{b}	ND	0.34±0.07^{a}
H	ND	3.55±0.07^{a}	20.25±0.21^{e}	23.60±0.14^{c}	1.80±0.14^{a}	3.44±0.28^{c}
I	ND	3.70±0.00^{a}	32.00±0.14^{f}	76.75±0.21^{i}	13.60±0.14^{c}	ND
J	ND	4.30±0.14b^{c}	1.30±0,11^{a}	107.30±0.28^{j}	ND	4.12±0.28^{d}

Values are presented as mean±SD. Values in the same column with different superscripts differ significantly at p<0.05.

F, G, H, I and J. Sample F, on the other hand, showed no significant change (P>0.05) when compared to sample G. Sample C also showed no significant change (P>0.05) when compared to samples E and J.

Vitamin E levels in the biscuits ranged from 4.57±0.11 g/100 g to 35.83±0.11 g/100 g. Sample A showed a significant increase (P<0.05) when compared to samples B, C, D, E, F, G, H, I and J. Sample J showed a significant decrease (P<0.05) when compared to samples B, C, D, E, F, G, H and I. Sample E, on the other hand, showed no significant change (P>0.05) when compared to sample F. In addition, there was no significant difference (P>0.05) between sample C and sample I as mentioned in Table 3.

Table 3. Vitamins A and E compositions of some selected biscuit samples

Samples	Vitamin A (mg/100 g)	Vitamin E (µg/100 g)
A	4.49±0.02^{a}	35.83±0.11^{h}
B	5.90±0.02^{b}	13.27±0.17^{f}
C	C7.21±0.01^{c}	9.61±0.11^{e}
D	15.05±0.11^{g}	7.92±0.16^{c}
E	11.59±0.00^{f}	26.38±0.11^{g}
F	7.64±0.11^{c}	7.64±0.11b^{c}
G	7.20±0.17^{c}	7.21±0.16^{b}
H	8.53±0.02^{d}	8.23±0.17^{d}
I	10.64±0.01^{e}	9.17±0.17^{e}
J	11.59±0.00^{f}	4.57±0.11^{a}

Values are presented as mean±SD. Values in the same column with different superscripts differ significantly at p<0.05.

Mineral compositions of some selected biscuit samples. The iron concentration of the different biscuit samples as seen in Table 4 ranged from 0.31±0.0019 ppm to 0.70±0.0000 ppm, with sample J having the highest concentration (0.70±0.0000 ppm)and sample H having the lowest concentration (0.31±0.0019 ppm).

The zinc concentration of the different biscuit samples ranged from 0.44±0.0003 ppm to 0.87±0.0001 ppm, with sample C having the highest concentration (0.87±0.0001 ppm) and sample B having the lowest concentration (0.44±0.0003 ppm).

The potassium concentration of the different biscuit samples ranged from 0.02±0.0003 ppm to 0.74±0.0019 ppm, with sample F having the highest concentration (0.74±0.0019 ppm) and sample A having the least concentration (0.02±0.0003 ppm).

The sodium concentration of the different biscuit samples ranged from 43.36±0.0092 ppm to 82.59 ±0.0039 ppm, with sample F having the highest concentration (82.59 ±0.0039 ppm) and sample H having the least concentration (43.36±0.0092 ppm).

The calcium concentration of the different biscuit samples ranged from 1.08±0.0005 ppm to 10.93±0.0005 ppm, with sample D having the highest concentration of (10.93±0.0005 ppm) and sample E having the lowest concentration (1.08±0.0005 ppm).

The phosphorus concentration of the different biscuit samples ranged from 0.01±0.0001 ppm to 0.05±0.0006 ppm with samples D and E having the highest concentrations and samples A and I having the least. Phosphorus was not detected in sample H.

Biscuits are a typical ready-to-eat baked snack among people all around the world. This present study evaluated the proximate, mineral and vitamin compositions of some selected locally consumed biscuits in Nsukka, Enugu State, Nigeria as shown in Table 1. The results of the proximate analysis are different from the results of Agu and Okoli (2014) that reported moisture of biscuits (1.82±0.02%), ash (1.60±0.08%), crude lipid (11.73±0.16%), crude fibre (0.81±0.07%) and crude protein (2.49±0.00%). Also, the results of proximate analysis differed from that reported by Amadi (2019), who reported the following proximate compositions: moisture (3.10±0.01%), ash (2.24±0.01%) and crude protein (3.44±0.47%). The result of the crude lipid is similar to the result of Youssef (2016) who reported 11.73% crude lipid content. The variations in the proximate compositions of various biscuits could be attributed to inherent (genetic), environmental (climate, temperature and soil type), processing (cooking and preservation method) and analytical factors (Menezes, 2003).

The total reducing sugar contents in the biscuit samples ranged from 24.89 mg/100 g to 39.80 mg/100 g, while the calorific value of the biscuit samples ranged from 1740.49 kJ to 2259.05 kJ/100 g. Normally, dietary energy is expressed in kilojoules. Dietary energy is used by the body for metabolic processes, physiological functioning, muscle activity, heat production, growth, material transit around the body enzyme and hormone synthesis (Okwunodulu, 2019).

Vitamin C contents of the different varieties of biscuits varied from 1.02±0.19 mg/100 g to 12.95±0.17 mg/100 g, while vitamin A content in the biscuit samples ranged from 4.49±0.11 mg/100 g to 15.05±0.11 mg/100 g. Also, vitamin E content in the biscuit samples ranged from 4.57±0.11 µg/100 g to 35.83±0.11µg/100 g. The results of vitamin E and A are different from the results of Youssef (2016) who reported vitamin E content of 4.00 mg/100 g and vitamin A of 1354 mg/ 100 g. Also, Youssef (2016) did not detect the presence of vitamin C in the biscuit samples. In addition, the result of the vitamin B complex is similar to the results of Makanjuola and Adebowale (2020) who reported low concentrations of vitamin B2 (8.02±0.00 mg/100 g to 27.49±0.70 mg/100 g) and vitamin B6 (1.00±0.00 mg/100 g to 6.20±0.00 mg/100 g). Vitamin A is an essential vitamin that can be present in complementary foods.

Vitamin A is required for epithelial cell differentiation and proliferation in the eyes, salivary glands and genitourinary tract.

Vitamin B2 promotes the breakdown of proteins, fats and carbohydrates, as well as sustaining the body's energy source. Pantothenic acid (Vitamin B5) is required for glucose and protein metabolism, as well as the growth and function of body cells (Poddar *et al*., 2011). Vitamin D is essential for supporting healthy bone metabolism.

Many other physiological functions, including muscular function, cardiovascular homeostasis, neuron function and immunological response, have been linked to vitamin D in recent studies.

Vitamin D's main purpose is to boost plasma calcium and phosphate levels, which promotes the mineralization of osteoid in the bone. Vitamin E is best known for its antioxidant properties and can only be obtained from diet. During fat oxidation, vitamin E suppresses the formation of reactive oxygen species.

The iron concentration of the different biscuit samples ranged from 0.31±0.0002 ppm to 0.70±0.00 ppm, with

Table 4. Mineral compositions of some selected biscuit samples

Samples	Iron (ppm)	zinc (ppm)	potassium (ppm)	sodium (ppm)	calcium (ppm)	phospho rus (ppm)
A	0.63±0.0002^{cd}	0.68±0.0010^{c}	0.02±0.0003^{a}	57.71±0.0017^{c}	5.31±0.0003^{c}	0.01±0.0003^{a}
B	0.68±0.0052^{d}	0.44±0.0003^{a}	0.03±0.0004^{a}	66.71±0.0009^{d}	3.72±0.0003^{bc}	0.03±0.0005^{ab}
C	0.48±0.0032^{b}	0.87±0.0001^{d}	0.04±0.0007^{a}	57.23±0016^{c}	4.12±0.0007^{c}	0.04±0.0010^{ab}
D	0.56±0.0014^{c}	0.60±0.0001^{bc}	0.08±0.0018^{a}	48.42±0.0002^{ab}	10.95±0.0005^{d}	0.05±0.0004^{b}
E	0.68±0.014^{d}	0.68±0.0005^{c}	0.74±0.0019^{e}	71.99±0.0008^{e}	1.08±0.0005^{a}	0.05±0.0006^{b}
F	0.62±0.0006^{c}	0.46±0.0002^{a}	0.64±0.0010^{d}	82.59±0.0039^{f}	4.23±0.0007^{c}	0.01±0.0002^{a}
G	0.48±0.0013^{b}	0.66±0.0001^{c}	0.37±0.0221^{c}	51.68±0.0022^{b}	2.07±0.0001^{ab}	0.01±0.0001^{a}
H	0.31±0.0019^{a}	0.49±0.0004^{a}	0.19±0.0225^{b}	43.36±0.0092^{a}	2.89±0.00003^{b}	ND
I	0.35±0.0045^{a}	0.71±0.0004^{c}	0.74±0.0198^{e}	59.92±0.0034^{c}	10.97±0.0002^{d}	0.01±0.0005^{a}
J	0.70±0.0000^{d}	0.56±0.001^{a}	0.64±0.0084^{d}	47.57±0.0017^{ab}	4.31±0.0003^{c}	0.03±0.0003^{a}

Values are presented as mean±SD. Values in the same column with different superscripts differ significantly at $p<0.05$.

sample N having the highest concentration (0.70±0.00 ppm) and sample J having the lowest concentration. The iron concentration observed in the biscuits samples is lower than the amount in fortified wheat flour (10-60 ppm) (Hurrel and Egli, 2010). The mineral contents, potassium, calcium and phosphorus of all the biscuit samples are lower which is not in line with those obtained by Amadi (2019), potassium (594±0.03 ppm), calcium (83.50±0.09 ppm) and phosphorus (1307.30±0.08 ppm). The utilization of K and Na is required to maintain ionic equilibrium. This link between K and Na in diet aids in the prevention of hypertension (Saupi *et al*., 2015; Brandt *et al*., 2011). Mn is necessary for enzymatic activities as well as the production of haemoglobin (Radha *et al*., 2021). Mg is required for energy metabolism, bone production, and enzyme activity (Radha *et al*., 2021). Zn works as a stimulant, causing beta cells in the pancreas to release insulin and keeping blood glucose levels normal. Fe is essential for tissue repair and growth, as well as the creation of haemoglobin, the delivery of oxygen and the enhancement of the body's immunity (Radha *et al*., 2021).

Conclusion

Considering the result shown above, the various biscuits samples selected contain appreciable amounts of nutrients such as vitamins A, B1, B2, B3, B6, C and E. Again, they contain other important micronutrients such as iron, zinc, potassium, sodium, magnesium, calcium and phosphorus. Also, the proximate composition indicated an appreciable amount of carbohydrates, lipids and proteins. However, biscuits must be fortified with vitamins and minerals and enriched with other protein sources such as oilseeds and legumes.

Conflict of Interest. The authors declare that they have no conflict of interest.

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