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Compositional Analysis of Complementary Foods Given by Mothers to Children Aged 6-23 Months in Giginyu Nassarawa Local Government Area, Kano State, Nigeria

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ABSTRACT: Under nutrition among young children is high and poor complementary foods have been implicated. The objective of this study was to investigate compositional analysis of complementary foods given by mothers to children aged 6-23 months in Giginyu Nassarawa Local Government Area, Kano State, Nigeria using appropriate standard methods and compare with a commercial complementary food (control). Energy density was designated low if < 0.8 kcal and contribution of meals to daily requirements (RDA) of protein, calcium and zinc for young children determined. The moisture, protein, ash, energy density, calcium, zinc, and phytate contents of the complementary meals (100g wet basis) ranged from 64.32-83.7%, 0.74-6.29%, 0.04-1.41%, 0.37-1.17 kcal/ml, 0.82-27.00 mg/100g, 0.022-0.277mg/100g and 0.05-1.68%, respectively. The soybean based meal, 'SB' was significantly higher ($p<0.01$) than other meals including the control, in protein, ash, energy, calcium, zinc and phytate contents. All other meals met above 50% of the RDA for protein except CMS1 (33%), SMMG (42.1%), PS (19.7%) and MSMP (32.8%). Except SB and CMS2 that contributed above 20-37% of RDA for calcium and zinc, the rest of the complementary meals were very low in calcium and zinc content.The moisture contents of common complementary meals offered to older infants in Giginyu LGA, Kano State are quite high which affected the energy density of the meals. Except for pap/sugar and custard based meals, the meals had appreciable levels of protein contents. However, there was low calcium and zinc (micronutrients) contents of most of the meals with about 400 mls daily consumption.

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Complementary food are foods other than breast milk or infant formula (liquid, semi-solid and solids) introduced to an infant from six months to provide required nutrients (WHO/UNICEF, 2021). During the time they are consumed, complementary foods make up a large proportion of the infant's diet and contribute a significant amount of the nutrients that are necessary for growth and development. The foods, therefore, must contain sufficient amounts of the essential nutrients to complement breast-milk. Infants who do not receive quality complementary foods may become undernourished. In Nigeria, under-nutrition remains a major public health problem among under five children. According to the 2018 National Demographic and Health Survey, 22% of children are underweight, 14% are wasted and 37% are stunted (NPC/ICF, 2019). Nigeria Demographic Health Survey reports show that under nutrition rate is highest during complementary feeding stage and linked to poor quality complementary foods (Stewart *et al*., 2013). According to the survey reports, the northern part of the country is most affected. Complementary meals of infants and young children in low-income countries often contain inadequate levels of the problem micronutrients (calcium, iron and zinc) and the absorption of these micronutrients is often

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inhibited by the high levels of phytate in the traditional diets (Gibbs, 2010). The most common type of complementary food used among mothers is cereal pap commonly referred to as 'Ogi' among the Yorubas, and 'Akamu' among the Igbos (Ijarotimi *et al.*, 2022). Other types of complementary foods used in Nigeria are custard, golden morn, tea, sweet potatoes, semovita and vegetable soup, beans porridge, noodles (Anaemene and Sogunle, 2020). The cereals are fermented for a period of one to three days in cold water, ground and sieved by adding water to separate the husks. They may be supplemented with vegetables, fruits, fruit juices, and meat products. These foods are often too watery (low energy and nutrient density), bulky, lack variety and of high phytate content (Krebs *et al.*, 2007; Gibson *et al.*, 2010). The presence of anti-nutrients in these plant based complementary foods reduces bioavailability of proteins and minerals unless properly processed or enhancers added (Gibson *et al.*, 2010). For complementary foods to be termed adequate, it has to provide 6-15g protein per 100 g of complementary foods eaten by infants (6-23 months), supply sufficient energy-200 kcal for 6-8 month infants, 300 kcal for 9-11 month infants and 550 kcal for infants in the 12-23 month bracket (PAHO/WHO 2003). During infancy and early childhood (birth to 2 years), adequate amount of vital nutrients has paramount importance for full development of children's potential.

This issue of under-nutrition due to poor complementary food has attracted so much attention and thus extensive research has been carried out on improving and developing quality complementary food. However, there is limited information on the actual composition of complementary food as given to children by their mothers. The chemical composition of foods include carbohydrates, fats, proteins, fibre, ash, moisture, vitamins, mineral elements and anti-nutritional factors among others. Knowledge of the chemical composition of foods is essential in ascertaining the adequacy of foods. There is need to study the energy and nutrient contents of the traditional foods given to children by their mothers to know those that are inadequate and make recommendations. It is easier to modify these foods already known to these mothers than replacing with new ones. Therefore, the objective of this study was to investigate compositional analysis of complementary foods given by mothers to children aged 6- 23 months in Giginyu Nassarawa Local Government Area, Kano State, Nigeria

MATERIALS AND METHODS

Sample collection: About ten common complementary foods were collected from mothers and analysed for proximate, calcium, iron, zinc and phytate.

Determination of moisture content: Moisture content was determined by oven-dry method as the loss in weight due to evaporation from sample at a temperature of 105°C. The weight loss in each case represented the amount of moisture present in the sample:

$$\%\ Moisture\ content = \frac{W_1 - W_2}{W_1 - W}\ x\ \frac{100}{1} \quad (1)$$

Determination of crude protein: The crude protein content was determined following the micro Kjeldahl method (AOAC, 2005). Percentage of nitrogen (N) was calculated using the following equation:

$$\%\ Nitrogen = \frac{(S - B)\ x\ N\ x\ 0.014\ x\ D}{W_1 - \mathrm{V}}\ x\frac{100}{1} \quad (2)$$

Where D = Dilution factor, T = titre value = (S-B), W = weight of sample, 0.014 = constant value and Crude protein was obtained by multiplying the corresponding total nitrogen content by a conventional factor of 6.25.

Determination of crude fat: Crude fat was determined by the Soxhlet extraction technique (AOAC, 2016). Fat content of the dried samples was extracted into organic solvent (petroleum ether) at 60 to 80°C and allowed to reflux for six hours. Percentage of fat content was calculated using the following formula:

$$\%\ Crude\ fat\ content = \frac{Weight\ of\ fat\ in\ sample}{weight\ of\ dry\ sample} x \frac{100}{1} \quad (3)$$

Determination of ash: Ash content was determined by combusting the samples in a muffle furnace at 600°C for 8 hours according to the method of AOAC (2016).

$$\%\ Ash\ \ content = \frac{weight\ of\ ash}{weight\ of\ sample} x\ \frac{100}{1} \quad (4)$$

Determination of crude fiber: The bulk of roughage in food is referred to as the fiber. Milled sample was dried, defatted with ethanol acetone mixture and then the experiment was carried out using the standard method as described in AOAC (2016):

$$\%\ Crude\ fibre\ content = \frac{weight\ of\ residue\ weight\ of\ ash}{weight\ of\ sample} x\ \frac{100}{1} \quad (5)$$

Determination of carbohydrate: The carbohydrate content was estimated by the difference method. It was calculated by subtracting the sum of percentage of moisture, fat, protein and ash contents from 100 %.

$$\%\ carbohydrate\ content = 100\ - (moisture\% + fat\% + \text{protein}\% \ + \ \text{ash}\%) \quad (6)$$

Determination of total energy: The total energy value of the food formulation was calculated according to the method of Mahgoub, (1999) using the formula as shown in the following equation:

$$Total\ energy\ \left(\frac{kcal}{100}g\right) = [(\%\ \text{available carbohydrates x 4}) + (\%\ \text{protein x 4}) + (\%\ \text{fat x 9}) \quad (7)$$

Determination of minerals: The mineral contents were determined after the ash content determination. The ash residue of each formulation was digested with perchloric acid and nitric acid (1:4) solution. The samples were left to cool and contents were filtered through Whatman filter paper 42. Each sample solution was made up to a final volume of 25 ml with distilled water. The aliquot was used separately to determine the mineral contents of zinc and calcium by using an Atomic Absorption Spectrometer (Spectra AA 220, USA Varian) (AOAC, 2016).

Phytate: Every sample was soaked for three hours in a 250 ml conical flask containing 2 g and 100 ml of 2% hydrochloric acid. 50 millilitres of the filtrate and 107 millilitres of distilled water were added to a conical flask after the mixture was passed through two layers of hard filter paper. Each solution also received the addition of 10 ml of an ammonium thiocyanate (NH4SCM) solution at a concentration of 0.3%. The resultant solution was titrated using an iron (III) chloride standard solution (Joslyn, 1970).

RESULTS AND DISCUSSION

The proximate composition of complementary foods is shown in Table 1. It reveals that the moisture content of the complementary foods varied from 64.32% to 83.70%. However, it shows that milk and sugar mix (MS) had the highest moisture level while soya bean based food (SB) had the least moisture level.

Table 1. Proximate composition of complementary food as eaten (g/100g wet basis)

Sample name	Moisture	CP	Fat	Fiber	Ash	NFE
CMS1	80.23±2.4	1.24±0.14	0.002±0.00	0.00±0.00	0.21±0.14	18.30±0.21
CMS2	72.30±1.7	4.21±0.30	0.011±0.01	0.005±0.03	0.55±0.01	22.92.±1.40
MS	83.70±0.7	1.99±0.01	0.005±0.00	0.00±0.00	0.37±0.50	13.47±0.17
SB	64.32±0.9	6.29±0.41	0.093±0.04	0.003±0.04	1.41±0.13	27.94±3.31
PS	80.26±1.4	0.74±0.02	0.004±0.01	0.00±0.00	0.14±0.11	18.85±1.80
SMMG	77.50±1.5	1.58±0.01	0.009±0.00	0.001±0.00	0.20±0.00	21.40±1.48
KGS	76.15±1.6	2.97±1.30	0.007±0.09	0.0005±0.01	0.05±0.00	20.82±0.26
WGSM	72.60±1.8	3.14±0.11	0.011±0.01	0.001±0.00	0.37±0.01	24.24±1.73
SMSPS	74.37±0.1	3.89±1.54	0.003±0.00	0.001±0.001	0.15±0.00	21.72±1.30
MSMP	78.83±0.0	1.23±0.00	0.022±0.31	0.0012±0.01	0.04±0.00	19.82±3.04

Values are means ± SD of duplicate samples.CMS1-Custard, Milk, Sugar;CMS2-Cerelac, Milk, Sugar; MS-Milk, Sugar; SB- Soya Beans curd (awara); PS-Pap, Sugar; SMMG-Sorghum, Milk, Millet, Sugar; KGS- Kunun Gyada, Sugar;WGSM- Wheat, Groundnut, Sugar, Milk;SMSPS- Soya beans, Milk, Sugar, Pap, Sorghum; MSMP-Maize, Sugar, Milk, Palm oil.

Table 2 Energy, phytate and mineral content of complementary food as eaten (g/100g wet basis)

Samples name	Energy (Kcal)	Energy density(kcal/g)	Phytate (10^3)(%)	Calcium (mg/100g)	Zinc (mg/100g)
CMS1	63.72 ±0.41	0.63	1.00±0.07	9.70 ±0.04	0.022 ±0.09
CMS2	90.90±1..41	0.90	1.09±0.01	16.00 ±0.00	0.179 ±0.10
MS	51.18 ± 1.11	0.51	0.55±0.49	0.82 ±0.01	0.063 ±0.12
SB	116.69 ±1.20	1.17	1.68 ±0.30	27.00 ±0.18	0.277 ±0.16
PS	63.75 ±0.91	0.64	0.71±0.01	7.70 ±0.000	0.035 ±1.20
SMMG	73.40 ±1.50	0.73	0.60±0.14	8.80 ±0.015	0.037±1.02
KGS	78.93 ±1.41	0.79	0.66±0.09	6.90 ±0.010	0.049 ±0.00
WGSM	90.28 ±0.71	0.90	0.79±0.01	5.40 ±0.360	0.057 ±0.00
SMSPS	84.97 ±1.02	0.85	1.12±0.16	12.60 ±0.000	0.059 ±0.00
MSMP	69.30 ±1.41	0.69	0.50 ±0.28	8.3 ±0.091	0.061 ±0.10

Values are means ± SD of duplicate samples.CMS1-Custard, Milk, Sugar;CMS2-Cerelac, Milk, Sugar; MS-Milk, Sugar; SB- Soya Beans (Wara); PS-Pap, Sugar; SMMG-Sorghum, Milk, Millet, Sugar; KGS- Kunun Gyada, Sugar; WGSM- Wheat, Groundnut, Sugar, Milk; SMSPS- Soya beans, Milk, Sugar, Pap, Sorghum; MSMP-Maize, Sugar, Milk, Palm oil.

The result also shows that SB had the highest protein value (6.29%), fat content (0.09%), fibre content (0.003%) and ash content (1.41%) compared to the other samples while pap and sugar (PS) had the lowest protein value of (0.74%). Soyabean meal (SB) (WARA) contained the highest carbohydrate content (27.94%), followed by sorghum, milk, millet and groundnut (SMMG) (24.3%). It was observed that SB had the highest energy value (116.6kcal) while MS had the least energy value of 51.17 kcal (Table 2). Based on the data, soya bean meal (SB) had the highest phytate value (1.68%) while MSMP had the least phytate value (0.52%). The mineral analysis showed that SB had the highest calcium content (27 mg/100g) while CSM2 had the least calcium content (0.82 mg/100g). The result also indicates that SB had the highest zinc value of 0.277 mg/100g while CMS1 had the least value (0.022 mg/100g).

The soybean based meal, 'SB' (wara) was significantly higher than the control in protein, ash, energy, calcium, zinc and phytat. The control was comparable to CMS2, SMSPS, WGSM and KGS in protein content. The carbohydrate contents of CMS1 (18.3%), PS (18.5%) and MSMP (19.5%) are comparable to that of control (16.1%) while the rest are significantly different.

Table 3. Proximate and mineral content of complementary foods compared with Control (g/100g wet basis) as eaten. values in the same column with different superscripts indicate significant difference ($p< 0.05$).CMS1-Custard, Milk, Sugar;CMS2-Cerelac, Milk, Sugar; MS-Milk, Sugar; SB- Soya Beans (Wara); PS-Pap, Sugar; SMMG-Sorghum, Milk, Millet, Sugar; KGS- Kunun Gyada, *Sugar;*

Sample name	Moisture (%)	CP (%)	Fat (%)	Fiber (%)	Ash (%)	NFE (%)	Energy (Kcal/100g)	Phytate (%)	Calcium (mg/100g)	Zinc (mg/100g)
CMS1	80.23^{ab}	1.24^{e}	0.002^{c}	0.000^{c}	0.21^{cd}	18.30^{de}	63.72^{f}	1.00^{c}	9.70^{d}	0.022^{d}
CMS2	72.30^{f}	4.21^{b}	0.011^{c}	0.005^{b}	0.55^{bc}	22.92^{bc}	90.90^{b}	1.09^{c}	16.00^{b}	0.179^{b}
MS	83.70^{a}	1.99^{cde}	0.005^{c}	0.000^{c}	0.37^{cd}	13.47^{f}	51.18^{g}	0.45^{e}	0.82^{f}	0.063^{c}
SB	64.32^{g}	6.29^{a}	0.093^{b}	0.003^{bc}	1.40^{a}	27.94^{a}	116.69^{a}	1.68^{a}	27.00^{a}	0.277^{a}
PS	80.26^{ab}	0.74^{e}	0.004^{c}	0.000^{c}	0.14^{d}	18.86^{cde}	63.75^{f}	0.71^{d}	7.70^{d}	0.035^{d}
SMMG	77.50^{bcd}	1.58^{de}	0.009^{c}	0.000^{c}	0.002^{d}	21.40^{bcd}	73.40^{de}	0.60^{de}	8.80^{d}	0.037^{d}
KGS	76.15^{cd}	2.97^{bcd}	0.007^{c}	0.000^{c}	0.05^{d}	20.82^{bcd}	78.93^{d}	0.66^{de}	6.90^{d}	0.049^{cd}
WGSM	72.60^{ef}	3.14^{bc}	0.011^{c}	0.003^{bc}	0.002^{d}	24.25^{ab}	90.28^{b}	0.79^{cd}	5.40^{e}	0.057^{c}
SMSPS	74.37^{def}	3.89^{b}	0.003^{c}	0.000^{c}	0.015^{d}	21.72^{bcd}	84.97^{c}	1.12^{b}	12.60^{c}	0.059^{c}
MSMP	78.83^{bc}	1.23^{e}	0.022^{c}	0.000^{c}	0.04^{d}	19.83^{cde}	69.30^{e}	0.52^{e}	8.30^{d}	0.061^{c}
CRL	76.0^{cde}	3.89^{b}	2.30^{a}	1.100^{a}	0.75^{b}	16.10^{ef}	99.00^{b}	0.65^{de}	15.00^{b}	0.170^{b}

WGSM- Wheat, Groundnut, Sugar, Milk; SMSPS- Soya beans, Milk, Sugar, Pap, Sorghum; MSMP-Maize, Sugar, Milk, Palm; oil, CRL-Cerelac

Table 4. Nutrient Contents and Recommended Dietary Allowances

	CMS1	CMS2	MS	SB	PS	SMMG	KGS	WGSM	SMSPS	MSMP
PROTEIN	4.96	16.84	7.96	26.33	2.94	6.32	11.88	12.56	15.56	4.92
RDA	15	15	15	15	15	15	15	15	15	15
%RDA	33	112.3	53	175.5	19.7	42.1	79	83.7	103.7	32.8
CALCIUM	38.8	64.0	32.8	108.0	30.8	35.2	27.6	21.6	50.4	33.2
RDA	500	500	500	500	500	500	500	500	500	500
%RDA	7.76	12.8	4.7	21.6	6.2	7.04	5.52	4.32	10.1	6.64
ZINC	0.09	0.716	0.256	1.11	0.140	0.148	0.196	0.228	0.236	0.244
RDA	3	3	3	3	3	3	3	3	3	3
%RDA	2.9	23.8	8.5	37.0	4.7	4.9	6.5	7.6	7.9	8.1

CMS1-Custard, Milk, Sugar;CMS2-Cerelac, Milk, Sugar; MS-Milk, Sugar; SB- Soya Beans (Wara); PS-Pap, Sugar; SMMG-Sorghum, Milk, Millet, Sugar; KGS- Kunun Gyada, Sugar; WGSM- Wheat, Groundnut, Sugar, Milk; SMSPS- Soya beans, Milk, Sugar, Pap, Sorghum; MSMP-Maize, Sugar, Milk, Palm oil.

Source: Recommended Dietary Allowance and adequate intakes from the National Academics. Daily Values from FDA Food Labelling Revision of Nutrition and Supplement Fact labels 2016.

All other meals met above 50% of the RDA for protein intake except CMS1 (33%), SMMG (42.1%) , PS (19.7%) and MSMP (32.8%). The commercial and soybean based actually contributed more than 100% of the RDA for protein. Except SB and CMS2 that contributed above 20-37% of calcium and zinc, the rest of the complementary meals were very low in zinc contents.

The study brings to limelight the various complementary meals offered to children in this area. Gruels from sorghum, millet, maize and wheat with added milk, sugar, and soybeans/groundnut were common while very few added palm oil. However, it is a serious concern that pap and sugar only is still in use as complementary food. From the analysis, pap/sugar (PS) and milk/sugar meal were the lowest in nutritional value and had the highest moisture content too. The soybased meals particularly 'Wara' (SB), a local cheese made from soybean curd were the best in terms of low moisture content, appreciable protein, fat, calcium and zinc content. Low moisture content was also observed in soybased meals by Akinsola *et al.* (2017) and Zakari *et al*. (2018). High moisture content in food has been shown to encourage microbial growth. Bolarinwa *et al.* (2015) reported that the lower the moisture content of a product to be stored, the better the shelf stability of the food product. The high protein of soybased meals also agrees with a study by Okoye *et al.* (2021), who reported that the sample with 30% soybean and 20% Irish potato flours had the highest level of protein (15.15%). The higher quality of the soya based meals is also attributed to the fact that soyabean seeds are high in proteins and other minerals. Another finding by Akinsola *et al.* (2017) that crude protein was highest (17.08%) in the sample containing maize, millet and soybeans also supports the finding of the analysis. However, the report of Mahamed *et al.* (2023), who found that the protein content was highest in samples containing the ratio of 70 g of sorghum to 30 g of peanut flour (17.38 %) contradicts the finding in this study.

Commercial based cereal and custard with added milk and sugar were also common but the commercial cereal based meal was of better nutritional composition because of fortification with minerals. Inclusion of eggs, flesh foods, fruits and vegetables was not observed. This implies zero vegetable and fruit consumption (ZVF) among this 6-23 months aged children and a serious situation. WHO indicates that poor vegetable and fruit consumption is a risk factor for developing non-communicable diseases (NCDs) (WHO/UNICEF, 2021). One serving of vegetable per meal of the young child is recommended. Poor diet diversity may result in micronutrient deficiencies which contributes to poor physical and cognitive development among children. Mekonen *et al.* (2024) in their review, reported that only 14% and 29% of 6-23 month old children in Sub-Saharan Africa consumed eggs or other fruits and vegetable daily. Only two meals, soybean-milk-sugar-sorghum (SMSPS) and wheat-groundnut-sugar-milk (WGSM) had upto three diverse food groups, but had higher phytate content compared to others particularly Wara (SB). This poses another concern about the bioavailability of diversified meals with legumes. Special emphasis should be placed on the micronutrient composition, nutrient bioavailability and utilization of local diets in the form these diets are actually consumed by the people. Plant based sources have been noted to have high anti-nutritional factors, thus the bioavailability of protein and other minerals may be negatively affected. Proper processing methods such as fermentation and germination can reduce phytate to improve bioavailability of these nutrients.

The soybased meals, commercial based cereal with milk and sugar and wheat meal with groundnut met above recommended energy density of 0.8kcal/ml of complementary meal while others did not, including the meal with added palm oil. The work of Tufa *et al*. (2016) also showed that the energy value of food samples was highest (442.46 and 430.57kcal/100g) in diets with soybean seeds. The low energy density of most of the meals could be attributed to probable low quantity of palm oil added in addition to the high moisture content of the meals. Consuming these low energy dense meals could result in wasting among these children. Two studies undertaken in Kano States among 6-23 months children in 2019 reported high rates of wasting (49.5% and 38.9%) (Ibrahim *et al.*, 2019a, b)

About two feeds of 200 mls each of the meals a day, met above 50% of recommended daily allowance for protein except pap/sugar and custard based meals. Inclusion of nuts and milk in the meals improved the protein content of these meals. However, contribution of the meals to the daily calcium and zinc was low except for SB (Wara) and commercial based meals which contributed about 20%. According to the literature, zinc is one of the most essential minerals for infants which is essential for brain development. Result from this study, indicates that SB had the highest zinc value of 0.277 mg/100g while CMS1 had the least value (0.022 mg/100g) on wet basis. Tufa *et al*. (2016) also observed a similar result in his study, Diets 3 (70 % unfermented sorghum, 30 % soybean) and 7 (70 % unfermented maize, 30 % soybean) had the highest zinc values (3.67 and 3.44 mg/100 g, respectively), while diet 6 (100% fermented maize) had the lowest zinc value (1.21 mg/100 g). However, in contrast with the finding of this study, Mahmed *et al.* (2023), reported lower zinc values in soybased flour compared to peanut based flour. Comprehensive Nutrient Gap Assessments (CONGA) analyses done in seven countries in Southeast Asia showed that iron, zinc, calcium and Vitamin D were the major micro-nutrient gaps among children aged 6–23 months (White *et al.*, 2023)

Anigo *et al*. (2009) carried out a similar study on commonly used complementary food in North-Western States (Kaduna, Kebbi and Niger States) of Nigeria and reported higher moisture values ranging from 80-93% and subsequent lower nutrient values on wet basis compared to the findings of this study. Apparently, it was not mentioned if the cereal gruels had other ingredients, although ‘Fura nono’ is a dairy based meal. The better nutritional values of complementary meals found in this study compared to the ones studied by Anigo and co-workers might be attributed to the long period of study during which a lot of infant and young child feeding targeted programmes have been implemented. The level of awareness on young child feeding practices has tremendously improved over the years but the present study highlights that there are still gaps that need to be filled, particularly in the area of diet diversity, quantities of food groups, energy density and processing of staples.

The major strength of this study is that meals used were collected at the point of feeding which represents exactly what were given to the children. This dealt with the problem of recall bias or over/under reporting associated with dietary recall and other methods. However, one limitation is that information on the recipe or quantities of ingredients used in the preparation of these meals was not obtained. Secondly, only one local government was covered. Therefore, the findings may not represent the situation in the State or country.

Conclusion: The moisture contents of common complementary meals offered to older infants in Giginyu LGA of Kano State were quite high which affected the energy density of the meals. However, the level of awareness on fortification of cereal-based complementary meals with oily seeds, dairy and even palm oil is notable. Except for pap/sugar and custard based meals, the meals had appreciable levels of protein contents. Of particular concern is the low calcium and zinc (micronutrients) contents of most of the meals with about 400 ml daily consumption.

REFERENCES

Anaemene, DI; Sogunle, WO (2020). Complementary feeding practices of older infants attending child welfare centre in a South Western town, Nigeria. *FUDMA J. Sci.* 4(1): 607 –616.

Akinsola, AO; Idowu, MA; Shittu, TA; Ade-Omowaye, BIO; Oke, EK; Laniran, AM (2017). Effect of processing methods on the chemical composition and storage stability of maize-millet-soybean complementary food. *Annals. Food Sci. Technol.* 18: 2.

Anigo, KM; Ameh, DA; Ibrahim, S; Danbauchi, SS (2009). Nutrient composition of commonly used complementary foods in North western Nigeria. *Afri. J. of Biotechnol.* 8(17): 4211-4216.

AOAC. (2016). Official methods of analysis of AOAC International; Horwitz W, eds. Gaithersburg, MD, Washington, DC, USA: AOAC International.

Bolarinwa, IF; Olaniyan, SA; Adebayo, LO; Ademola, AA (2015). Malted sorghum – soybean composite flour: preparation, chemical and physicochemical properties. *J. Food Process. Technol.* 6:467.

Gibson, RS; Bailey, KB; Gibbs, M; Ferguson, EL (2010). A review of phytate, iron, zinc and calcium concentration in plant based complementary foods used in low-income countries and implications for bioavailability. *Food Nutr. Bulletin*. 31: S134-S146.

Ibrahim, UA; Gboluwaga, AT; Iliyasu, Z (2019a). Mother's feeding practices and nutritional status of infants in a rural community in Kano State, North-West, Nigeria. *J. of Med. tropics*. 21(2): 93-99.

Ibrahim, UA; Gboluwaga, AT; Iliyasu, Z; Jahun, MG (2019b). Feeding practices of motherss and nutritional status of infants in an urban community in Kano State, North-West, Nigeria. *Ind. J Health Sci Biomed*, 12: 215-22.

Ijarotimi, OS; Fatiregun, MR; Oluwajuyitan, TD (2022). Nutritional, antioxidant and organoleptic properties of therapeutic-complementary-food formulated from locally available food materials for severe acute malnutrition management. *Bull Natl Res Cent.* 46: 39.

Joslyn, A.M. (1970). Methods in Food Analysis. Physical, Chemical and Instrumental Methods of Analysis. 2nd Ed. San Francisco, New York: Academic Press, 1–3.

Krebs, N.F., Hambidge, K.M., (2007). Complementary feeding: clinically relevant factors affecting timing and composition. *Am J Clin Nutr* 85: 639S-645.

Mahamed, DA; Shamsedin, MH; Hodo, MJ (2023). Development of complementary food from sorghum blended with peanut. Research square.

Mekonen, E.G., Zegeye, A.F. and Workney, B.S. (2024). Complementary feeding practices and associated factors among mothers of children aged 6-23 monthsin Sub-saharan African countries: a multilevel analysis of the recent demographic and health survey.BMC Public Health, 24:115.

National Population Commission (NPC) (Nigeria) and ICF. (2019). Nigeria Demographic Health Survey, 2018 Key indicators report. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF.

Okoye, JI; Egbujie, AE; Ene, GI (2021). Evaluation of complementary foods produced from sorghum, soybean and irish potato composite flours. *Sci. World J.* 16(3).

PAHO/WHO (2003). Guiding principles for complementary feeding of the breastfed child. Washington: Pan African Health Organisation-World Health Organisation. (https//www.who.int/nutrition/publications/guidin g principles compfeeding breastfed.pdf,). Accessed 28 Jan 2024).

Stewart, C.P., Lannotti, L., Dewey, K.G., Michaelsen, K.F., Onyango, A.W., (2013). Program in International and Community Nutrition, Department of Nutition, University of California. *Matern Child Nutr*. Sep;9 Suppl 2:27-45. Doi: 10.11 11/mcn. 12088.

Tufa, MA; Urga, K; Weledesemayat, GT; Mitiku, BG (2016). Development and Nutritional Assessment of Complementary Foods from Fermented Cereals and Soybean. *J Food Sci Nutr.* 2 (14).

United States Department of Agriculture, (2009). Complementary feeding in U.S, editor. Infant nutrition and feeding. Washington, DC: United States Department of Agriculture (USAD) p.101-28.

White, JM; Drummond, E; Bijalwan, V; Singhkumarwong, A; Betigeri, A; Blankenship, J (2023). Micronutrient gaps during the complementary feeding period in seven countries in Southeast Asia: A Comprehensive Nutrient Gap Assessment. *Matern Child Nutr.* 19(S2):e13577. DOI: 10.1111/mcn.13577.https://doi.org/10.1111/mcn.13577

World Health Organisation and United Nations Children's Fund (2021). Indicators for assessing infant and young child feeding practice: Definitions and measurements methods. Joiint report of WHO and UNICEF.

Zakari, UM; Hassan, A; Fatima, K (2018). Chemical composition, functional and organoleptic properties of complementary foods formulated from millet, soybean and African locust bean fruit pulp flour blends. *Afr. J. of Food Sci.* 12(6): 126-130.