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CHEMICAL ANALYSIS AND NUTRIENT ADEQUACY OF MAIZE GRUEL *(PAP)* SUPPLEMENTED WITH OTHER FOOD SOURCES IN NGOR-OKPALA LGA, IMO STATE, NIGERIA

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Abstract
This study was carried out to determine the chemical composition and nutrient adequacy of maize gruel *(pap)* supplemented with common food sources by mothers in Ngor-Okpala Local Government Area. Thirty-two (32) rural women each of whom had a child between 6 and 24 months participated in a focus group discussion. Common food sources used to complement pap were identified and analysed. Proximate, vitamin and mineral contents were determined using standard methods. Values were also compared with 65g estimates of the diets to determine its adequacy for infants. Data from the focus group were recorded in note books and audio tapes and later transcribed. Differences in the nutrient content of pap and pap mixes were determined using ANOVA. The common food sources added to pap from the focus group discussion were infant formula (PMILK), ground crayfish (PCRA), ground soybean (PSOY) and groundnut paste (PGRA). The protein content ranged from 2.17-28.70g, fat (0.80-25.05g), carbohydrate (46.11-95.98g), and energy (409.16-490-17kcal). Based on 65g estimates of the analysed pap and pap mixes, PSOY and PGRA met the fat requirements, while PCRA, PSOY and PGRA met protein requirement. The energy and mineral content of pap and pap mixes were found to be inadequate. Fortification of the local pap and pap mixes is therefore recommended.

Keywords: Maize gruel, pap, soybean, groundnut, crayfish

1. Introduction

The first year of life is crucial in laying the foundation of good health and improving the quality of life of children. The World Health organisation (WHO) recommends that infants be exclusively breastfed for the first 6 months of life (WHO 2001). However, after 6 months, breast milk alone will no longer be sufficient both in terms of quantity and quality to meet the nutritional requirements of the child especially for energy and micronutrients notably zinc, iron and vitamin A (UNICEF 2009). It thus becomes necessary to supplement breast milk with other foods as the child grows older. These foods start as liquid foods and progress to solid foods. This is the process of complementary feeding and it starts from 6 months.

In most cultures in Nigeria, the first line complementary food is cereal gruel made from maize, millet or guinea corn (Ibe 2008). It is called by different names "*pap, akamu, ogi,* or *koko"* (King and Ashworth 1987). These cereals are eaten in large quantities in developing countries and are prepared as gruel and used in feeding infants (Ikujenlola 2008). Due to their high viscosity on cooling, a large amount of water is used during preparation to obtain the right consistency. The high viscosity characteristic of cereal grain is obviously responsible for young children's inability to fulfil their energy and nutrient requirement (Kikafunda *et al*. 2006). Since young children have small gastric capacities, they are unable to meet their energy requirements. This thus contributes to high rate of malnutrition especially in areas where cereals form the major complementary diets.

Cereals have lower nutritional value than animal based ones. Plain porridges made from cereals and tuber flour, though commonly used is not sufficiently rich in energy, proteins and essential vitamins such as vitamin A and C. In order to improve the nutrient content of cereal based complementary diets, different types of economical protein rich plant mixtures can be used. These include plant proteins like soybean and groundnut (Ibe 2008) (Nwamarah and Amadi 2009). The low income group seldom feed meat, eggs or fish to their infants as a result of socioeconomic factors, taboos and ignorance (Ijarotimi 2008). Also, commercial ready-to-eat complementary foods are available in the market, but they are relatively expensive and out of the reach of rural and low income group (Ijarotimi, 2008; Nnam 2008). This has made utilisation of cereals a very important source of complementary food among low income nursing mothers (Ijarotimi and Bakare 2008). Coupled with these problems is the problem of processing which leads to leaching or depletion of protein from the resultant gruel.

This study will therefore evaluate the nutrient composition of maize gruel (pap) and pap mixes as well as ascertain their adequacy for infant feeding in order to be better able to manage the diets of infants.

2. Materials and methods

2.1 Study area

The study was carried out in Ngor-Okpala Local Government Area (LGA) of Imo state. Ngor-Okpala LGA is made up of 10 political wards and communities. Each ward has at least five villages. The area is inhabited by farmers, civil servants, craftsmen and traders. In each ward, there is a Primary Health care centre which carters for the health needs of the communities. The health centres in the communities were used for the focus group discussions (FGDs).

2.2 Study population

The study population comprised of all mothers attending the health care centre for immunisation of their infants.

2.3 Study design

Since the LGA is made up of ten wards, using these wards as clusters, four were randomly selected using simple random sampling technique. Each of these four wards has a primary health facility. With the assistance of nurses in the selected health facilities, eight nursing mothers were randomly selected from each ward to make a total of 32 mothers. Focus group discussions were conducted in each of the health facilities among eight (8) of the eligible mothers. Commonly used food sources for fortifying pap were identified. Chemical analysis was carried out in duplicate on the samples to determine their nutrient content.

2.4 Focus group discussions

Four focus group sessions were held in the selected health facilities of the four wards. This was conducted with the assistance of two trained research assistants (nurses) with the aim of soliciting information on breastfeeding, age of introducing complementary foods and first line complementary foods given. Food sources/ingredients used to fortify pap and reasons for use, as well as mode of preparing the complementary foods were identified. The FGD's were conducted in their local dialect *"igbo"* by the researcher and research assistants. The FGD themes were explored using the same question guide for all the four FGD sessions. The researcher and research assistants recorded in audio cassettes and in notebooks proceedings of each discussion. The tape recorded sessions were transcribed verbatim and combined with review of notes that was taken by the researcher and research assistance. Findings from the FGD were used to assess the nutrient content of pap and pap mixes used by the mothers.

2.5 Sample collection

The samples of pap and pap mixes commonly fed to infants were collected from mothers as they were feeding the child either in their homes or health facility. The samples were placed in a container with ice and transported to the laboratory for chemical analysis.

2.6 Chemical analysis

Representative samples were subjected to proximate, vitamin and mineral analysis using standard procedures (AOAC 2000). All analysis was carried out in duplicates. Carbohydrate was determined by difference. Energy value was calculated using Atwater factors.

2.7 Statistical analysis

Means and standard deviations were calculated for all the values using procedures of Steel and Torrie (1960). Means were subjected to ANOVA to determine significant differences at $P<0.05$. The adequacy of the complementary foods was determined using FAO/WHO (2002) recommended nutrient intakes (RNI) for infants.

3. Results and Discussion

3.1 Focus group discussion

Four major themes were generated.

Theme 1

Breastfeeding and age of introduction of complementary foods

Quotes

"…….I still continue to breastfeed my baby for up to 1 year even after introducing other foods".

"…….I normally give complementary foods from 3 months because only breast milk will not be enough for my baby. Although, I still continue to breastfeed for more than a year".

"…….I am afraid of giving only breast milk for up to 6 months without adding any other thing because I feel it will be too draining on me".

"…….I have to go back to income generating activities in order to help with family expenses, so I have to add

something to hold baby and stop her from crying while I am away".
"…….I am still breastfeeding. At antenatal clinics, the nurses tell us complementary foods should start from 6 months. But when baby continues crying after breastfeeding, one has no other choice but to introduce it even before 3 months".

Theme 2

First line complementary foods given to infants and reasons for choice.

Quote

"…….what we normally give here in this community is 'akamu' (pap). Our forefathers started us on "akamu", so we will start our children too on 'akamu" (pap).
"…….I give pap first because it is light and watery and can pass through the babies throat. Infact I make it thin at first then as the baby grows older, I increase the consistency and add other foods".
"…….I normally start off with pap first, gradually, I introduce other foods like mashed rice, mashed yam".
"…….I give pap first. My adding any other thing depends on the age I introduced the pap to my baby. If I introduced it as early as two months, I cannot add anything except baby milk, so that she can swallow it".
".....I use pap and ground soybean, but if there is money, at any point in time, I use cerelac.

Theme 3

Food sources added to pap and reasons for choice.

Quotes

"…….I add ground crayfish
"……. They say soybean and groundnut is good, but I normally use soybean. The soybean powder lasts longer for me than groundnut paste.
"…….sometimes, I use only pap, because my baby prefers the taste of plain pap or I can add very little sugar".
"…….I add baby milk when I can afford it. It is really expensive. Infact, if you add it, it means you are a rich man".
''.....My adding anything depends on baby's preference. If I add ground soybean or crayfish and he doesn't like it, I stop and give only pap, but I will continue trying out addition of new things in between".

Reasons for choice of food choice

Quotes

".....I believe the things I add give nourishment to my baby".
''.....Those things added will make baby have weight".

Theme 4

Preparation of the complementary foods

Quotes

"…….I process the pap myself because it is cheaper for me. All I need do is put the bag containing the raw gruel which I have processed inside water and change it everyday because I don't have a refrigerator to preserve it. For the other ingredients like soybean and crayfish, I also process them myself and add as desired".
"…….I try as much as possible to process it with the older children in the house. Whereby I cannot for some reasons, I buy already prepared gruel and other ingredients. Though, it's more expensive this way".

The FGD results revealed that the mothers interviewed generally agreed that they breastfed for up to 2 years. However, they still expressed doubts as to the adequacy of breast milk alone both in terms of quantity and quality. Similarly, Aghaji (2002) reported that nursing mothers especially those from rural areas believe that breast milk is insufficient and is of poor quality and does not make the infant gain weight adequately.

The mothers introduced complementary foods as from 3 months. Anigo *et al.* (2009) reported that complementary foods are introduced to majority of children in the northern part of the country before the third month. This goes contrary to WHO recommendation of six months for introduction of complementary foods (WHO 2002). The main reasons given were insufficient breast milk and continuous crying by the baby. Similar reasons have also been cited by Aghaji (2002).

The results further revealed that the first line complementary foods the mothers started their infants on was pap gruel. The mothers believed that use of pap is an age long practice handed down to them by their fore fathers. On a similar note, other authors (Uwaegbute 1991) (Ene-Obong 2008) noted that fermented cereal gruel pap *(Ogi/akamu)* continues to be the preferred complementary foods fed infants in Nigeria.

The various food sources added to the pap gruel include soybean (PSOY), groundnut (PGRA), crayfish (PCRA) and infant formula (PMIL). The use of infant formula was however prohibited by its high cost as

noted by some mothers. As a result of this, it was only used when available or in most cases used sparingly. Ibe (2008) similarly observed that costs determine the availability of sufficient amount of milk product for infant The different food sources added to pap corroborates the reports of ACC/SCN (2001) that addition of locally available animal products to the usual cereal gruel could improve the quality of complementary foods fed to young infants in developing countries. Crayfish (animal protein), groundnut and soybean which are cheap sources of plant protein and are valuable in the management of protein energy malnutrition (IITA 1986). The popularity of traditional pap as complementary food as highlighted in this study has been reported by other authors (Agbon *et al*. 2009; Anigo *et al*. 2009; Nwamarah and Amadi 2009). Pap is a plain porridge prepared from cereals and water and as such is not sufficiently rich in energy. It lacks protein and other essential vitamins and minerals. It is thus important to add other food sources like protein rich legumes, animal products and vegetable oils in order to increase the energy density.

The fact that the complementary foods were mainly prepared by the mothers is some how encouraging, as this will help reduce the risk of contamination from other unknown sources when processing the gruel .

The results on Table 1 revealed that the mean moisture content ranged from 74.50±0.10 for PGRA to 77.29±0.01% for PAPO. Moisture content was similar for PCRA, PSOY and PGRA. ($P>0.05$). Moisture content is an index of water activity of many foods. The high moisture content of the samples may reduce the energy and nutrient densities of the complementary foods. Other authors (Ijarotimi and Bakare 2009; Nwamarah and Amadi 2009) also observed similar moisture content in their study of nutrient content of complementary foods. FAO (2001) reported that staple foods such as maize, millet and sorghum are high in starch and as such, absorb a lot of water during cooking which makes them bulky. Infant thus need to consume large quantities to obtain enough energy and nutrients. This is difficult because infants have small stomach capacity (30-40ml) (Ene-Obong 2008; Nnam, 2008).

Protein content varied from 2.17±0.01 to 28.70±0.03g. PCRA had the highest protein content, while PAPO had the least ($P<0.05$) (Table 1). The protein content of the samples when compared to the RDA value of 13-14g/d (FAO/WHO 2002) for infants up to 1 year was adequate for PCRA, PSOY and PGRA. The higher protein content of PCRA was due to addition of an animal source (crayfish) as compared to PSOY and PGRA in which comprised of soybean and groundnut, respectively. Legumes have been noted to be valuable in the diet because they are relatively cheap and good sources of protein, B-vitamins and carbohydrates (Lathan 1987; Ihekoronye and Ngoddy 1985).

It is well documented (ACC/SCN 2001) that when cereals and legumes and/or locally available animal products are blended, the resultant protein could be high, equal or better than that of animal. Ibeanu (2009) further noted that complementation could help improve the quality of complementary foods fed to young children in developing countries. The low protein content of PMIL which contains milk as its source of protein could be as a result of addition of small quantity of infant formula due to its high cost. This corroborates result of the focus group discussion in which a participant reported that *"infant milk is used when they can afford it and it's really expensive"*. The least protein content of PAPO is as a result of use of only cereal grain (maize), which has been shown to be low in protein (Ihekoronye and Ngoddy 1985). Thus, use of only pap as complementary food for infants can be regarded as substandard. This is because it may not be able to support normal growth especially if not complemented with foods from other groups. Akinrele and Edwards (1971) noted that the protein content of pap was too low even to support growth of rats. Ketiku and Ayoku (1984) similarly observed that corn gruel provides some energy, but not other nutrients needed for growth of babies. Anigo *et al*. (2009) reported that complementary foods used in the Northern part of Nigeria was mainly cereal based and had low protein values.

Fat content ranged from 0.80±0.01g in PAPO to 25.05±0.01g in PGRA. PGRA had the highest value followed by PSOY (18.79±0.02), while PAPO had the least ($P<0.05$) (Table 1). The higher fat content of PGRA and PSOY is not surprising since legumes such as groundnut and soybean have been noted to be high in oil content (Ihekoronye and Ngoddy 1985). This is in line with FAO/WHO (1998) recommendation that vegetable oils be included in foods meant for infants and children in order to increase the energy density as well as serve as a transport vehicle for fat soluble vitamins. The fat content of PGRA, PSOY and PCRA was however observed to be higher than the 10g recommended by FAO/WHO (1985).

There was significant difference ($P<0.05$) in the crude fibre content of all the samples with PAPO having the least value (0.50±0.01) (Table 1). The least fibre content of PAPO could be attributed to the refining process during the preparation of the maize gruel which resulted in a lower dietary fibre content coupled with lack of complementation of the pap. The crude fibre content of all the diets was lower than the recommended 5g/100g (FAO/WHO 1985).

Ash content was in the range of 0.75g±0.00 in PAPO and 4.82±0.01g in PSOY (Table 1). The higher ash content of PGRA, PCRA and PSOY is as a result of incorporation of groundnut paste, ground crayfish and soy bean,

respectively into the pap mixture. Ash content of a food is a determinant of the mineral content of that particular The higher the ash content, the more the mineral content of the food. The relatively low ash in pap only (PAPO) suggests that it is a poor source of mineral. However, when it is mixed with other foods, the ash content will increase due to the synergistic effects of other foods.

The sample PAPO (95.78±0.02g) had a significantly higher (P<0.05) carbohydrate content as compared to other samples, while PGRA had the least value (46.11±0.00) (Table 1). The higher carbohydrate level in PAPO could be explained by its sole composition of cereal which contains high carbohydrate level than when complemented with other food sources.

The energy value of the samples varied from 409.16kcal in PAPO to 490.17kcal in PGRA (Table 1). The higher energy value of the other food samples as compared to pap only is as a result of their higher protein and fat contents. The FAO/WHO (1985) has recommended that foods fed to infants should be energy dense. According to recommendations, this is necessary because low energy dense foods tend to limit total energy intake and the utilisation of other nutrients. Solomon (2005) observed that high-energy foods are necessary for children to cover their energy needs considering the small size of their stomach.

In Table 2, estimated amounts of 65g of pap and pap mixes were calculated and compared with FAO recommended nutrient intake (RNI). The amounts of protein provided by 65g of PCRA (18.66), PSOY (13.40) and PGRA (13.04) exceeded the FAO value (13-14g) for infants up to I year of age. Their protein content was also higher than the proprietary formula cerelac. This shows that the local foods have great potentials as complementary foods. Soybean, groundnut and crayfish according to Nnam (2002) are food commodities that have been recommended for infant feeding due to their positive contribution to protein nutrition levels.

The fat content of PGRA (16.28) and PSOY (12.21g) met the recommendation (10-25g) and were also higher than the proprietary cerelac, while the other pap mixes fell short of the recommendation (Table 2). A similar trend was observed for fibre content. The lower fibre content of cerelac compared to PCRA, PSOY and PGRA could be as a result of series of refining that took place during its processing. Ash content was higher for the other pap mixes than for cerelac except for PAPO based on 65g estimates. Carbohydrate value of PMIL was close to that of cerelac. Others (PCRA, PSOY, PGRA) had lower values, while PAPO had the highest content. Energy value of cerelac was similar to that of the other pap mixes (P>0.05). However, the energy values of the complementary foods were lower than recommended for infants under one year. Studies have reported that complementary foods fed infants by mothers in developing countries, Nigeria inclusive are deficient in macronutrients (protein, fat and carbohydrate) leading to protein energy malnutrition, as well as micronutrients (vitamins and minerals) leading to "hidden hunger" (Millward and Jackson 2004). This suggests that infants may have to consume more quantities of the pap and pap mixes to meet their energy requirements. This is usually impossible considering their small stomach capacities.

The vitamin and mineral content of the complementary foods fed infants as shown in Table 3 revealed that zinc content was significantly higher (P<0.05) in PCRA (4.9±0.00), while PAPO had the least value (1.5±0.00). The higher zinc content of PCRA and PMIL is as a result of their content of animal food source.

Calcium was significantly higher (P<0.05) in PCRA (18.98±0.01) than the rest of the samples Table 3. The higher calcium in PCRA and PSOY is due to inclusion of crayfish which is a good source of calcium and blend of the legume soybean, respectively. PMIL (milk) which should have been a very good source of calcium unexpectedly had low calcium content. The reason is not far-fetched. It is possible that the mothers added very little quantity of infant formula to the pap. This was probably due to high cost of infant formula as was rightly pointed out in the focus group discussion by one of the mothers "*I add milk when I can afford it. It is really expensive. Infact if you add it, it means you are a rich man*".

Magnesium was highest in PCRA (35.69±0.01mg) with PAPO having the least (3.75±0.00). Potassium was significantly higher (P<0.05) in PCRA (40.80±0.00mg), while PGRA (31.82^{b}±0.01) and PSOY (30.65±0.01mg) had similar values (P>0.05). Sodium content of the complementary foods was similar for PMILK (2.10±0.00mg), PCRA (2.40±0,01mg) and PSOY (2.60±0.01mg) and PGRA (2.75±0.00mg) (P>0.05) (Table 3).

The vitamin C content of PCRA (11.43±0.01mg), PSOY (11.68±0.01mg) and PGRA (10.98±0.01) were similar (P>0.05), but differed significantly from PMIL (8.48±0.00mg) and PAPO (2.90±0.00mg) (P<0.05) (Table 3). The higher mean value of PGRA and PSOY could be attributed to the fact that vitamin C is found in higher amounts in plant than animal food sources.

Vitamin A was highest in PCRA (4.83±0.01mg), closely followed by PMIL (3.93±0.01mg). PSOY (2.90±0.01mg) and PGRA (2.86±0.00) had similar values (p>0.05), while PAPO had the least (0.20±0.00mg) (Table

3). The higher vitamin A content of PCRA and PMIL as compared to other samples was due to the incorporation of crayfish and milk, which are good sources of vitamin A.

The result on Table 4 shows the estimated amounts of vitamins and minerals. Calculation of vitamins and mineral amounts in 65g of the complementary foods compared with RNI shows that PCRA (3.19mg) met the RNI for zinc for infants less than 1 year. This was as a result of addition of crayfish which is a good source of zinc. Other minerals did not meet the recommendations based on 65g of samples. The proprietary cerelac also had higher values for all the minerals than the pap and pap mixes. Expectedly, the vitamin and mineral content of cerelac was higher and this could be due to the fortification process normally carried out on such product (Nwamarah and Amadi 2009).The low mineral content of the pap and pap mixes could also be attributed to the presence of anti-nutrients and poor bioavailability of minerals in plant foods. It could also be due to losses that occurred during processing. These according to Temple *et al*. (1996) all play a role in micronutrient deficiency in infants. Complementary foods have low bioavailability and as such, high levels of animal sources are required in order to meet the nutrient requirement for infants. For this reason, fortification of these foods with micronutrients becomes necessary so that it can adequately complement breast milk.

4. Conclusion and Recommendation

Findings from this study has shown that the energy content of pap and pap mixes based on the amounts consumed as provided by 65g of the diet was inadequate compared to standards. This shows that the complementary foods cannot meet the energy needs of infants and children. Similarly, the diets did not also meet the recommended misneral requirements for infants and young children.

It is therefore recommended that fortification of the pap and pap mixes with appropriate minerals be encouraged since it will serve as a food based approach for combating micronutrient deficiency among infants in the study area and other parts of the country that use the local pap and pap mixes as complementary foods.

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Table 1: Proximate composition of complementary foods fed infants (g/100g)

	Moisture (%)	Protein (g)	Crude fat (g)	Crude fibre (g)	Ash (g)	Carbohydrate (g)	Energy (Kcal)
PAPO	77.29^{a}±0.01	2.17^{d}±0.01	0.80^{e}±0.01	0.50^{e}±0.01	0.75^{d}±0.00	95.98^{a}±0.02	409.16
PMIL	76.17^{b}±0.00	10.67^{c}±0.00	7.84^{d}±0.00	1.51^{d}±0.01	3.27^{c}±0.01	76.71^{b}±0.01	420.08
PCRA	74.63^{c}±0.20	28.70^{a}±0.02	10.63^{c}±0.02	3.54^{b}±0.01	4.61^{a}±0.00	52.52^{c}±0.02	420.55
PSOY	75.36^{c}±0.10	20.62^{b}±0.01	18.79^{b}±0.02	3.95^{a}±0.01	4.82^{a}±0.02	53.04^{c}±0.02	463.75
PGRA	74.50^{c}±0.10	20.07^{b}±0.01	25.05^{a}±0.01	3.10^{c}±0.00	4.45^{b}±0.00	46.11^{d}±0.00	490.17
Cerelac*	-	15.0	9.00	2.95	2.60	67.95	413.00
RNI for infants under I year	-	13-14	10-25	-	<3	64	650

RNI=Recommended nutrient intake, PAPO=Pap only, PMIL= Pap+milk, PCRA= Pap+ground crayfish, PSOY=Pap+ground soybean, PGRA= Pap+groundnut paste.
*Values as indicated by manufacturer

Table 2: Estimated amounts provided by 65g of the complementary foods compared to FAO (2002) standards.

	Protein (g)	Fat (g)	Fibre (g)	Ash (g)	Carbohydrate(g)	Energy (kcal)
PAPO	1.14	0.52	0.33	0.49	62.25	258.18
PMIL	6.94	5.10	0.98	2.13	49.86	273.10
PCRA	18.66	6.91	2.30	3.00	34.13	273.35
PSOY	13.40	12.21	2.02	2.89	34.48	301.41
PGRA	13.04	16.28	2.57	3.13	29.97	318.61
Cerelac	9.75	5.85	1.92	1.69	44.17	268.45

PAPO=Pap only, PMIL= Pap+milk, PCRA= Pap+ground crayfish, PSOY=Pap+ground soybean, PGRA= Pap+groundnut paste

Table 3: Vitamin and mineral composition of complementary foods fed infants (mg/100)

	Zn (mg)	Ca (mg)	Mg (g)	K (g)	Na (g)	Vitamin C (mg)	Vitamin A (mg)
PAPO	1.5^{d}±0.00	4.6^{e}±0.00	3.75^{d}±0.00	7.66^{d}±0.01	1.11^{b}±0.00	2.90^{c}±0.10	0.20^{d}±0.00
PMIL	3.6^{b}±0.01	13.99^{c}±0.01	9.65^{c}±0.01	17.76^{c}±0.00	2.10^{a}±0.00	8.48^{b}±0.00	3.93^{b}±0.01
PCRA	4.9^{a}±0.00	18.98^{a}±0.01	35.69^{a}±0.01	40.80^{a}±0.00	2.40^{a}±0.00	11.43^{a}±0.01	4.83^{a}±0.01
PSOY	2.8^{c}±0.01	17.71^{b}±0.01	22.99^{b}±0.00	30.65^{b}±0.01	2.60^{a}±0.00	11.68^{a}±0.01	2.90^{c}±0.01
PGRA	2.9^{c}±0.00	9.38^{d}±0.00	22.00^{b}±0.01	31.82^{b}±0.01	2.75^{a}±0.00	10.98^{a}±0.01	2.86^{c}±0.00
Cerelac	7.00	420	NA	700	220	3.6	NA
RNI for infants under 1 year	5	400	40	500	120	-	-

PAPO=Pap only, PMIL= Pap+milk, PCRA= Pap+ground crayfish, PSOY=Pap+ground soybean, PGRA= Pap+groundnut paste.
NA= Not available

Table 4: Estimated amounts of vitamins and minerals provided by 65g of the complementary foods compared with recommended nutrient intakes (mg/100g).

	Zn (mg)	Ca (mg)	Mg (g)	K (g)	Na (g)	Vitamin C (mg)	Vitamin A (mg)
PAPO	0.98	2.99	2.43	4.98	0.72	1.20	0.13
PMIL	2.34	9.09	6.27	11.54	1.34	5.51	2.55
PCRA	3.19	12.34	23.19	26.52	1.56	7.43	3.14
PSOY	1.82	11.51	14.94	19.92	1.69	7.60	1.88
PGRA	1.89	6.09	14.30	20.68	1.79	7.14	1.86
Cerelac	4.55	273	-	455	143	2.34	-

PAPO=Pap only, PMIL= Pap+milk, PCRA= Pap+ground crayfish, PSOY=Pap+ground soybean, PGRA= Pap+groundnut paste.