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Influence of Complementary Food Composition on Prevalence of Anemia among Children Aged 6-24 Months in West Cameroon

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ABSTRACT

Iron is an essential micronutrient for human health and inadequate intake may result in iron deficiency (ID) or iron deficiency anaemia (IDA). In western region of Cameroon, 39 % of children under 59 months suffering from IDA. To reduce the high prevalence of IDA, the evaluation of nutritional potential of complementary food is very necessary to improve the nutritional status of the young children. The objective of this study is to determine the influence of complementary food composition on prevalence of anemia among young children living in West Cameroon. A food interview survey was carried out among 50 families (25 families with children having Hb ≥ 11 g/dL and 25 families having children with Hb ≤ 11 g/d/L). Ten complementary foods frequently consumed by children were recruited near the families. The amount of food nutrient intake per day was also determined. The data were analyzed using ANOVA (p ≤ 0.05) and the principal component analysis (PCA). The PCA shows that corn meal with vegetables was a dish with high level in iron, fats, dietary fiber and calcium. The complementary food based on corn meal with okra and those based on Irish potatoes with beans and fishes were higher in protein, ash, magnesium, potassium, phosphorus and zinc. The other dishes based on irish potatoes, rice, peanuts and corn meal porridge had high levels of carbohydrates. There was no significant difference between the daily iron, protein, calcium, and potassium intakes between anemic and non anemic children. However, food intake of anemic children was low compared with non-anemic children. The daily iron intake of the children ranged between 23.73 % and 42.27 % of their iron requirement daily. Their daily iron was generally poor. Though, most of their foods were of plant source whose nutrients are poorly bioavailable. Therefore, application of improved food processing and storage techniques, good dietary diversification and fortification with intensified nutrition education would reduce iron deficiency anemia in the area.

Keywords: Iron, complementary food, nutrient intake, young children, anemia.

INTRODUCTION

Micronutrients deficiencies impose substancial health, economic, and social burdens worldwide. The World Health Organization (WHO) has estimated that, globally, 24.8 % of the global population is affected with anemia. The highest prevalence of 47.4% is in preschool-age children and the lowest prevalence of 12.7% is in men (Durrani, 2018). The demographic, and Health Surveys in Cameroon (EDSC-MICS, 2011) reported that 60 % of children aged 6 to 59 months were anemic. Data available on the local prevalence of iron deficiency anemia in West Cameroon showed that approximately 39 % of children under 24 months are anemic and 51 % of them suffering from iron deficiency (Kana *et al.,* 2015). Iron deficiency is believed to be the most important cause of anemia among children and is attributable to poor nutritional iron intake and low iron bioavailability (Casgrain *et al.,* 2012).

Iron deficiency (ID) is associated with adverse psychomotor, cognitive and emotional development. Low intelligent quotient scores have been observed in iron deficient children, even before the development of anemia (Egbi *et al.,* 2014). Adoption of recommended breastfeeding and complementary feeding practices and access to the appropriate quality and quantity of foods are essential components of optimal nutrition for infants and young children. Complementary feeding period is the time when malnutrition and iron deficiency start in many infants contributing significantly to the high prevalence of malnutrition and iron deficiency anemia in these children (Siu *et al.,* 2015). Many factors contribute to the vulnerability of children during the complementary feeding period. The complementary foods are often of low nutritional quality and given in insufficient amounts. When given too early or too frequently, they displace breast milk.

The high cost of fortified nutritious proprietary complementary foods is always beyond the reach of most Cameroonian families hence many depend on inadequately processed traditional foods consisting mainly of unsupplemented cereal porridges made from maize, sorghum and millet (Kana *et al.,* 2012). Complementary food composition data for Cameroon are limited, both in terms of the number of foods and the nutrients listed. Studies determining associations between diet and iron deficiency anemia in Cameroon are scarce. In part because of a lack of data available on the dietary habits of Cameroonians young children and also because of the deficit of data on nutritional composition of commonly consumed foods. Biochemical analysis is costly in terms of resources, time and expenses, and was therefore not feasible. Since, it is virtually impossible to biochemically analyze every composite dish listed, calculation of nutritional composition using weighed recipes was the method of choice, as has been done in many other studies (Sharma *et al.,* 2007).

Previously, in Cameroon the authors analyzed complementary foods and reported that levels were too low to meet the daily needs of children (Kouebou *et al.,* 2013). These data allowed us to compile a database specific of our study population. So, the food table composed, will be used to evaluate the children's food intake and compare it to the Dietary Reference Intake. This research is therefore aimed at studying the influence of complementary food composition on prevalence of anemia among children aged 6 to 24 months in West Cameroon.

MATERIALS AND METHODS

A previously survey on iron deficiency epidemiology of one hundred and seventy seven children living in West Region of Cameroon have been done (Kana *et al.,* 2015). This allow us to list and identify the differents families necessary for the continuation of the study. Since then, a food interview survey was carried out among 50 families. We have selected 25 families with children having Hb ≥ 11 g/dL and 25 families having children with Hb ≤ 11 g/d/L. The dietary survey was conducted among the differents families through the

questionnaire designed for this purpose, the methods of 24 hours recall, three days weighed food records and dietary history were used to determine dietary habits, the type of food and the usual frequency of consumption of food during a week. We have selected ten most frequently complementary foods (table 1). These dishes were cooked according to the recipes described by the mothers with the assistance of some to respect the culinary modes. The macronutrient and micronutrient composition of these dishes had been evaluated in the previous study by Kana *et al.,* (2008); Kouebou *et al.,* (2008); Kouebou *et al.,* (2013), indicated in table 2 and table 3. The statistical analysis of data was done by one way Analysis of Variance (ANOVA) using 5% level of significance. The principal component analyses (PCA) was used to classify the food according the main nutrients. The comparison o daily intakes of anemic and non anemic children are made by Mann-Whitney U-test. All these analyses were done using XLSTAT version 3.0 software.

Table 1: Dishes composition and description

Foods	Codes	Main ingredients	Form of consumption
Banana	BD	Banana	Pieces
Maize porridge	BO	Maize	Porridge
Maize paste with leaves vegetable	CmLS	Maize, leaves vegetables (*vernoria sp.*), tomato, garlic, dry fishes, salt	Pieces in sauce
Maize paste with okra groundnut sauce	CmSAG	Maize, okra, groundnut, tomato, garlic, dry fishes, green herbs, salt	Paste
Maize paste with okra sauce	CmSG	Maize, okra, tomato, garlic, dry fishes, green herbs, salt	Paste
Pounded irish potato with black bean	PPTH	Irish potato, black beans, red palm oil, onions, salt	Soft pieces
Irish potato paste with fresh fish	PPTP	Irish potato, fresh fish, oil, tomato carrot, salt	Pieces with sauce
Irish potato paste	PPTS	Irish potato, green herbs, tomato, red palm oil, garlic, carrot, salt	Soft pieces
Rice with groundnut sauce	RSA	Rice, peanut, tomato, herbs, fish, salt	Grain with sauce
Jallof rice	RS	Rice, tomato, gralic, green herbs, oil, carrot, fish, salt	Grain

RESULTS AND DISCUSSION

In this study, female sex was the most represented with 27 girls against 23 boys. Sixty six percent (66%) of children live in families with at least five persons. In addition, nearly 58% of mothers of investigated children had primary level of education against only 42% for secondary school level and beyond (table 4). The dietary survey revealed that the food commonly consumed by the children was community or family meals. And the complementary food were tubers (irish potatoes), cereals (maize, and rice), legumes (beans and peanuts), very little fruits and animal foods (Table 5). It was observed that children diet was very monotonous. According to Woldie *et al.* (2015) cereal based monotonous diets (undiversifed diet) are known to cause micronutrient defciency including anemia. This similarity in the eating behavior of children from one social setting to another could be explained by the fact that food diversification methods remain poorly or poorly understood; moms believe that an energy meal is a balanced meal (Mananga *et al,* 2014). In the observed dietary practices, the majority of foods consumed were those grown within families. The lack of financial means did not allow mothers to easily obtain missing food

items from their market food ration (meat, eggs, dairy products, fruits). In addition, for those with a small family breeding (chickens, goats, pigs), these animals were intended for marketing and not for own consumption in families. Most authors have shown that iron with better bioavailability is found in foods of animal origin (Young *et al.,* 2018). According to Engle-Stone *et al.,* (2012) and household size has a very big influence on young children nutritional state. There is therefore competition on the household's financial resources which could affect the nutritional status of children living in poorest families were also most malnourished.

Table 2: Macronutrients composition of some foods eaten by young children in West Region, Cameroon.

Samples code	Foods	Water (g/100g fresh weight)	Macronutrients content in g/100g DM				
			Carbohydrates	Proteins	Lipids	Crude fibre	Ash
BD	Banana[4]	74.00	21.80	1.10	0.30	2.10	1.44
BO	Maize porridge[1]	84.50	85.41	7.20	4.92	1.66	0.13
CmLS	Maize paste with leaves vegetable[2]	68.30	21.23	19.62	34.73	21.65	2.77
CmSAG	Maize paste with okra groundnut sauce[2]	78.62	25.08	28.01	29.87	13.08	3.96
CmSG	Maize paste with okra sauce[2]	75.25	54.75	11.80	16.23	12.56	6.10
PPTH	Pounded irish potatoe with black bean[2]	75.25	54.75	11.80	16.23	12.56	4.69
PPTP	Irish potatoe paste with fresh fish[1]	75.79	35.47	28.45	24.12	6.89	5.07
PPTS	Irish potatoe paste[3]	73.83	52.77	12.64	21.87	8.83	5.89
RSA	Rice with groundnut sauce[2]	78.82	47.32	16.86	7.00	12.92	5.91
RS	Jallof rice[2]	74.09	61.42	7.82	10.64	15.05	5.05

DM: Dry Matter [1]Kana *et al.* (2004); [2]Kana *et al.* (2008a); [3]Kouebou *et al.* (2008); [4]Kouebou *et al.* (2013).

Table 3: Micronutrients composition of some foods eaten by young children in West Region, Cameroon.

Samples code	Foods	Minerals content in mg/100g DM					
		Fe	Zn	Ca	Mg	K	P
BD	Banana[4]	6.34	1.07	8.34	21.80	294.98	28.65
BO	Maize porridge[1]	5.18	0.74	216.78	132.55	397.50	212.00
CmLS	Maize paste with leaves vegetable[2]	37.78	1.35	525.17	82.00	727.63	151.67
CmSAG	Maize paste with okra groundnut sauce[2]	27.97	3.17	444.67	79.17	374.75	357.00
CmSG	Maize paste with okra sauce[2]	4.91	1.86	825.33	125.00	547.00	616.33
PPTH	Pounded irish potatoe with black bean[2]	3.54	1.16	81.67	73.66	1013.67	266.67
PPTP	Irish potatoe paste with fresh fish[1]	70.00	1300.33	849.33	-	-	-
PPTS	Irish potatoe paste[3]	5.70	1.98	64.91	54.66	1178.92	302.31
RSA	Rice with groundnut sauce[2]	2.75	1.61	376.77	22.33	31.00	392.00
RS	Jallof rice[2]	1.42	1.11	32.00	85.00	197.33	126.00

DM: Dry matter; -: undetermined [1]Kana *et al.* (2004); [2]Kana *et al.* (2008b); [3]Kouebou *et al.* (2008); [4]Kouebou *et al.* (2013).

Table 4: Characteristics of the study population

Parameters	Effective	Frequency (%)
Sex		
Male	23	46
female	27	54
Age (months)		
6-12	23	46
12-24	27	54
Size of the household		
≤ 5 persons	17	34
> 5 persons	33	66
Mothers instruction level		
Primary	29	58
Secondary and beyond	21	42

Table 5 : Frequency of food consumption by children

Food	Frequency of consumption (%)
Fat foods	
Red palm	100
Refined palm oil	15
Carbohydrates foods	
Cereals	54
Tubers	40
Leafy vegetables	38
Leguminous	41
Proteins foods	
Milk products	17
Meat	17
Fish	24
Eggs	4
Vitamins and mineral foods	
Fruits	7

The variables used to classify foods based on their nutrient contents were performed to a Principal Component Analysis (Figure1). That helped to visualize the three major classes according to their nutrient formation. These variables are organized in two principal components which express 67.80 % of total variability. The axis F1 explains 49.47 % of information and the second axis F2 explains 18.33 % of information.

The analysis of the correlations between the different variables and the principal axis shows

that the variables such as carbohydrates (15.78 %), proteins (14.40%), lipids (13.04%) and zinc (11.19%) all contribute significantly to the formation of the F1 axis, while variables such as phosphorus (17.42%), fibers (16.49%), calcium (16.16%) and iron (14.12%) participate in the formation of the F2 axis. When the complementary food and nutrients are also represented in the axis system F1 x F2 (Figure 2), axis F1 corresponds to the variables. It appears clearly that corn meal with vegetables (CmLs) was a dish with high level in iron, fats, dietary fiber and calcium. The complementary food based on corn meal with okra (CmSG, CmSAG) and those based on irish potatoes (PPTH, PPTP) were higher in protein, ash, magnesium, potassium, phosphorus and zinc. The other dishes based on irish potatoes, rice, peanuts, corn meal porridge and fruits (BD, BO, RS, RSA, PPTS) had high levels of water and carbohydrates. However, some authors had shown that high intakes of non-heme iron were responsible for the inhibition of zinc by competition in the absorption route or that a high zinc / iron ratio could inhibit iron absorption (Beck *et al.,* 2013).
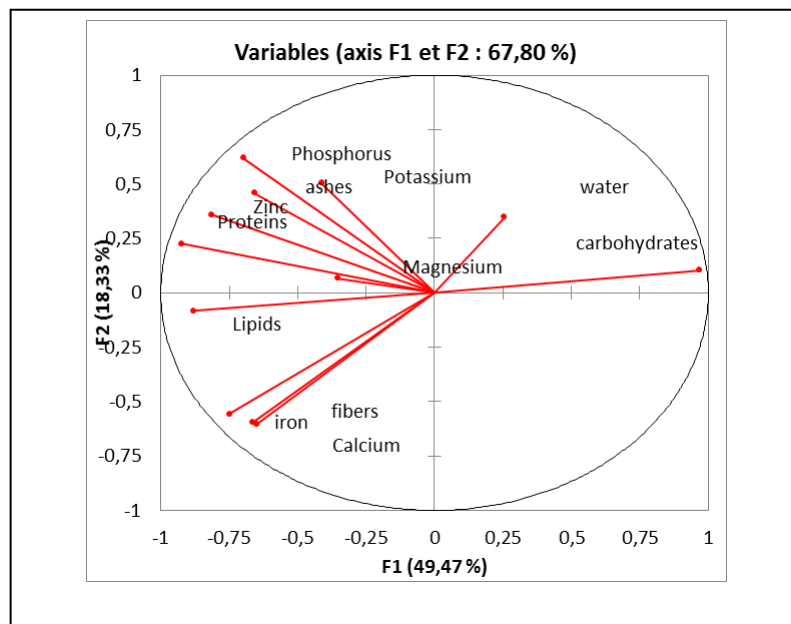

Figure 1: Correlation circle of the variables of complementary foods in the principal component analysis axis.
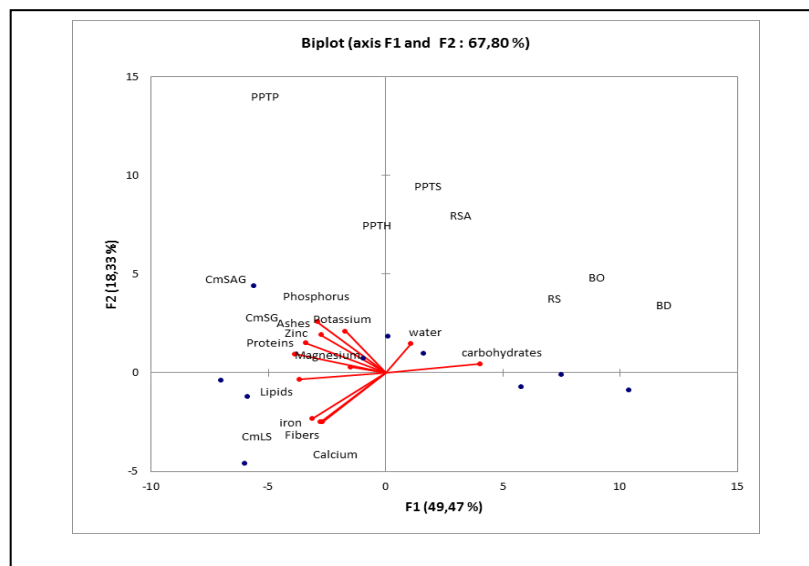

Figure 2: Distribution of complementary foods and nutrients on the axis system (F1xF2).

Estimated daily energy and nutrient intakes of children showed that food consumption of children increased according to age (table 6). Also, from 6 months, energy intake, iron, zinc and calcium were lower compared to the needs of children according to the both recommendations of FAO and WHO. These daily intakes of protein, energy, and minerals were similar to those observed by Pasricha *et al.* (2010) in study in Indian children were the last 24-hour recall of non breastfed children aged 12-23 months revealed iron and energy intakes of 1.4 mg/24h and 415 kcal/24h respectively.

Table 6: Estimated daily energy and nutrient intakes of children compared with FAO/WHO (2001) daily needs

Age	Nutrients	Protein	Energy	Fe	Zn	Ca	Mg	K	P
	Average Daily intake	8.24*	427.48*	2.61*	1.88*	129.26*	82.50*	845.76*	255.17*
[6 -12[	FAO/WHO Daily needs	11	950	11	5	270	75	650	275
	% of coverage	74.91	44.99	23.73	37.60	47.87	110	99.35	92.79
	Average Daily intake	10.97*	578.61*	4.65*	2.09*	206.32*	104.66*	509.84*	242.52*
[12-24]	FAO/WHO Daily needs	14	1150	11	5	700	130	1000	450
	% of coverage	78.36	50.31	42.27	41.80	29.47	80.51	50.98	53.89

*= Significance difference between daily intakes and daily needs. $P < 0.05$ Student T- Test.

Daily intakes of children according to status are found on table 7. The anemic and non anemic children have similarity between the dietary habits. However, the intakes of energy, protein, zinc, iron, phosphorus and potassium of non anemic children were higher compared to the nutrient intake of anemic children. These dietary habits could explain the presence of iron deficiency in the anemic children of this locality resulting in the installation of iron deficiency anemia (Kana *et al.,* 2015). In addition, our results suggested that a decrease in energy and zinc intakes would lead the onset of anemia in these children. Indeed, it was observed among mothers that during food transition, children were often looked after by their caregivers, old brothers or grand mother who themselves were not totally autonomous. While, foster mother went to various rural activities. Therefore, children could not fed in quality quantity and in a timely manner until the comeback of their mother. In addition to its impact on adult productivity through less schooling, iron deficiency anemia also affects learning capacity or cognitive development directly, with consequent impact on schooling productivity and labor productivity. It is also evidenced that dietary diversity is proxy indicator for micronutrient adequacy of diet. This finding is consistent with study reports in Brazil (Leal *et al.,* 2011) and Ghana (Egbi *et al.,* 2014).

Table 7: Daily intakes of children according to status (anemic and non anemic)

Parameters	Anemic subjects n = 25	Non anemic subjects n = 25
Protein (g)	12.85 ± 0.33	15.29 ± 0.69
Energy (Kcal)	400.89 ± 8.78	441.88 ± 14.28
Zn (mg)	0.79 ± 0.16	1.86 ± 0.21*
Fe (mg)	2.69 ± 0.55	3.76 ± 0.13
Ca (mg)	225.30 ± 19.82	199.95 ± 60.88
Mg (mg)	132.09 ± 19.01*	98.78 ± 23.47
P (mg)	232.46 ± 15.79	298.21 ± 56.07*
K (mg)	428.54 ± 109.87	439.78 ± 112

*= Significance difference between anemic and non anemic children $P < 0.05$ Comparison made by the Mann-Whitney U- Test.

The analysis of the relation between parameters in children revealed that the decrease in dietary energy intake, Fe, Zn and Ca in children would promote the occurrence of anemia in children (table 8). They are found that mother instruction level and number of children are significantly correlate (P = 0.03) to the prevalence of anemia among children. This fnding is similar to study conducted in Ethiopia, where Woldie *et al.,* (2015) reported that children of mothers with no formal education were 2.6 times more likely to be anemic than children of mother with secondary and above education level (AOR = 2.6 (95% CI: 1.26–5.27)).

Educated mothers are more conscious of their children's health and introducing scientifcally proved feeding practices, which help to improve their children iron status (MOPH, 2012). It is also confrmed that, maternal education is strong predictor for nutritional outcomes of children (Djeukeu *et al.,* 2013).

Table 8 : Significant correlation between parameters in children

Parameters	Coefficient of corrélation (r)	P
Mothers instruction level /anemia	0.06	0.03*
Number of children /anemia	0.23	0.002**
Energy intake/ anemia	-0.24	0.02*
Iron intake /anemia	0.45	0.01*
Zinc intake /anemia	-0.23	0.02*
Calcium intake /anemia	-0.87	0.05*

* p < 0,05; **p < 0,01; Spearman's correlation test.

Conclusion and recommendations

Study findings demonstrate that anemia among children is due to many problems such a inappropriate eating habits of children, food insecurity, poor sanitary conditions. Iron, zinc, calcium, energy, number of children and mothers instruction level were significantly associated with anemia. The solution therefore remains the intensification of nutrition education, dietary diversification and fortification, optimal processing, post harvest improvement in storage and handling techniques to prevent iron defciency anemia targeting children aged under two years of age.

Acknowledgement

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