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Evaluation of the Contribution of Cassava Staple to the Recommended Dietary Allowance of Selected Nutrients Among the under Five Children in Mtwara Rural District, Tanzania

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Abstract

This study aimed at evaluating the contribution of cassava recipe in meeting Recommended Dietary Allowance (RDA) of the under five children for the selected nutrients (protein, fat, iron and zinc) in Mtwara rural district. This was achieved by identifying the common cassava recipes and the consumption pattern by using a 24h dietary recall and Food Frequency Questionnaire (FFQ). Proximate composition, mineral contents and anti-nutrients (cyanide and phytate contents) were also determined. The rate of consumption of a child was computed based on food portion and consumption frequency in a day. The sufficiency of nutrient of cassava recipes was determined on the basis of the quantity of food eaten per day. Computed nutrient intake was evaluated against the RDA of respective nutrient for respective age category.

The findings indicate that the contribution of cassava to the RDAs of the respective nutrients were 19.4% for iron, 21% for zinc, 0.527% for fat and 4.26% for protein among the under five children which is extremely low. The anti-nutrient (phytate) content was far above the tolerable level of 25 mg/100g but cyanide was within the acceptable level. The computed Individual Dietary Diversity Score (IDDS) of 2.5 was similarly far below the target IDDS of 5. This implies an extremely poor dietary diversity indicative of very low consumption of food varieties including those of animal origin. It is thus important to develop strategies which encourage and make easy for dietary diversification among community members in order to complement

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cassava based recipes with readily available foods rich in macro and micronutrients. The strategy should also consider dietary practices such as control of intake of inhibitors e.g. of iron absorption and increase intake of enhancers of absorption in a given meal. These strategies can also include cassava recipe supplementation and fortification.

Introduction

Malnutrition is a serious issue not only for the reason that great numbers of inhabitants are affected, but also because it is a risk factor for numerous diseases. It is defined as a situation of nutrition in which a shortage or surplus (or imbalance) of energy, protein and other nutrients results in quantifiable undesirable effects on tissue/body form (body shape, size, composition), body function and clinical ending.[1] It is increasingly recognized as a prevalent and important health problem in many developing countries. This has serious long term consequences for the children health and adversely influences their development. The crop plays vital roles in African advancement such as famine reserve, rural foodstuff staple, cash crop and urban food staple.[2] It is extensively grown-up in every agricultural systems due to its adaptableness to various soils and agro-ecological situations. Cassava is an ever more important crop in the country and is the next most vital food crop behind maize in terms of production quantity and per capita consumption, sustaining the living of 37% farmers in rural parts. The greater part of the poorest farmers (59%) are reported to cultivate the crop for food.[3] Tanzania is the fourth producer of cassava in Africa,[4] the main producing areas being the coastal strip along the Indian Ocean (where Mtwara is), around Lake Victoria, Lake Tanganyika and along the shores of Lake Nyasa. Mtwara region is a highly cassava growing area and cassava is the dominant annual crop grown in the region. Its production is the topmost for roots and tuber crops in the region with a sum production of 72,087 tones which represent 99.7% of the total root and tuber produce.[5]

Tanzania's prevalence of malnutrition (stunting which is a chronic form of malnutrition affecting children at high rate compared to other forms of malnutrition) has decreased from 42% to 34.4%.[6] The prevalence of malnutrition however shows much variability between regions within the country. In many regions prevalence of stunting was below 40%, while in Mtwara region stunting prevalence was above 45%.[7] In 2014 however, the prevalence of chronic malnutrition in Mtwara Rural District was found to be 31.65%,[8] which still calls for attention in nutrition assessment and analysis.

Cassava meal alone cannot cater for the body nutrients requirement, however, can only be improved by in cooperating other foods to make cassava diet nutritious.[9] As soon as the population can't afford to broaden the horizons of their diets with sufficient quantities of fruits, vegetables or animal-source foods that contain great quantities of micronutrients, insufficiencies regularly arise due to monotony and nutritional inadequacy. Insufficient dietary intake and extended under nutrition can cause short and long term effects, which can diminish financial, physical, and social capital, further aggravating the cycle of under nourishment, poverty, and unhealthful household situation that the majority food-insecure families already have.[10]

The Recommended Dietary Allowance (RDA) is set in order people to understand the amount of nutrients required for normal growth. It can be defined as the levels of in-take of energy and dietary components which, on the basis are considered adequate for the maintenance of health and well-being of a healthy person in the population. Children are vulnerable to malnutrition and thus a group of interest to follow up on whether their meals meet the RDA. Poor nutrition can have a devastating impact in their growth and development. Thus evaluating the contribution of cassava staple RDA would form an appropriate base that for dietary diversity intervention and also broaden awareness among the affected population. It is thus important to evaluate how cassava based meals can adequately contribute to RDA for healthy life. The objective of this investigation was therefore to evaluate the contribution of cassava staple to the recommended dietary allowances of selected nutrients among the under five children in Mtwara rural district.

Materials and Methods

Study area, Design and Study Population

Mtwara Rural District was purposively chosen as a study location due to high cassava production[4] and malnutrition rate of 45% [7] which has declined to 31.65% [8] but is still reasonably high. The study population constituted of the under five children with their mothers/caregivers responsible for preparing their food. The sample size of the study population was computed from the formula $n = t^2 x \frac{(1-p)}{m^2}$ where n= desired sample size, t=Confidence Interval level 95% (standard value 1.96), p=estimated malnutrition prevalence which is 31.65% [8] and m=margin error at 5% (0.05) which gave a sample of 332 under five children. Out of 332 children, 329 fully participated and successfully provided useful data for the study.[11] The study employed a cross-sectional study design that involved 329 children aged 6 to 59 months. This was complemented with an experimental analysis.

Dietary Assessment

The 24h dietary recall survey was applied to collect comprehensive information given by a mother/ care-giver for every foodstuff and drinks eaten by a child for the previous 24h. The quantity of food indicated to be eaten by children in 24 h dietary recall was approximated by using family utensils such as cups and bowls. Food Frequency Questionnaire (FFQ) was used to determine frequency of consumption of different food groups in the households in order to derive more habitual intake. The rate of consumption of a child was computed based on food share and meal frequency in a day. The sufficiency of nutrient of complementary food was computed on the basis of the quantity of food eaten in a day. Computed nutrient intake was evaluated against the RDA of respective nutrient for respective age category.

In addition dietary diversity score (DDS) was calculated to determine the quality of their diet as it includes the number of foodstuff groupings eaten in a meal. The questionnaire was constructed in a three stage multiple pass interview,[12] in which the first pass involved a 24-hour dietary recall from which the description of cassava meal recipes including cooking methods was obtained, the second pass involved a food frequency questionnaire to identify the consumption frequency of different foods in a week and the third pass involved dietary diversity in which the number of food groups consumed were identified to measure dietary diversity of an individual.

Identification and Preparation of Cassava Recipes

The common cassava recipes and methods for their preparations were identified through a dietary pattern assessment method using the 24h dietary recall and food frequency questionnaire. This was important to collect complete information given by a mother or care giver for all food stuff and drinks eaten by a child in 24h and the frequency of consumption. Plain cassava recipe (which was among the four identified recipes) was used in the present study for

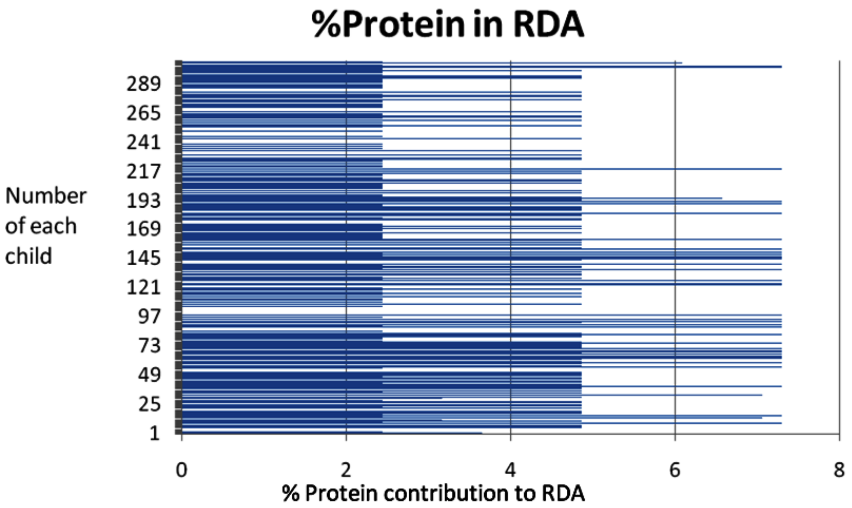

Fig. 1: Protein contribution (%) to its RDA among under five children

evaluation of the RDA of selected nutrients because was the most commonly consumed recipe (97%). Two households from among the households that constituted the study sample were selected for preparation of the identified recipes. The recipes/ samples were prepared in duplicates by each household to avoid biasness. The ingredients and other raw materials used for preparation of the various cassava based recipes described during the interview were obtained from a local market. After cooking, the recipes (meals) were left at room temperature (30 °C) to cool down for about one hour then packed in duplicates in the freezer bags which were then stored in the freezer model WestPoint (Tropical, made in France) with temperature set at -20 °C.

Laboratory Analyses

During analysis the frozen samples were defrosted, homogenized and analysed as per analytical method. The laboratory parameters analyzed were proximate composition, minerals contents and anti-nutrients (cyanide and phytates).

Analysis of Nutrients (Proximate Composition and Mineral Contents)

The proximate analysis of moisture, ash content, fat and protein content was carried out.[13] Kjeldahl method was used for the analysis of protein and Soxhlet method for the determination of fat. Crude fiber was determined[14] and total carbohydrate (in percentage) was calculated by subtracting the sum of the percentage values of moisture, crude protein, ash and crude fat from 100%.[15] Cassava recipes were analyzed for the minerals (iron, zinc, copper, potasium, calcium, magnesium and manganese) using the atomic absorption spectrophotometer model iCE3000series.[16]

Analysis of Phytate and Cyanide Contents

Phytate content of the samples was done as described by Davis[17] and total cyanide content in the samples was analyzed using the alkaline titration method using AOAC (1990) methods.[13]

Determination of Targeted Individual Dietary Diversity Score (IDDS)

The IDDS was computed based on a set of 8 food groups consumed by members, through the following procedure[18]

$$i.e.\ Sum\ IDDS = (S_1 + S_2 + S_3 + S_4 \ldots\ldots\ldots + S_{329})$$

Where S is the score for every single household which reflects the number of food groupings eaten by every household from among the eight food groups

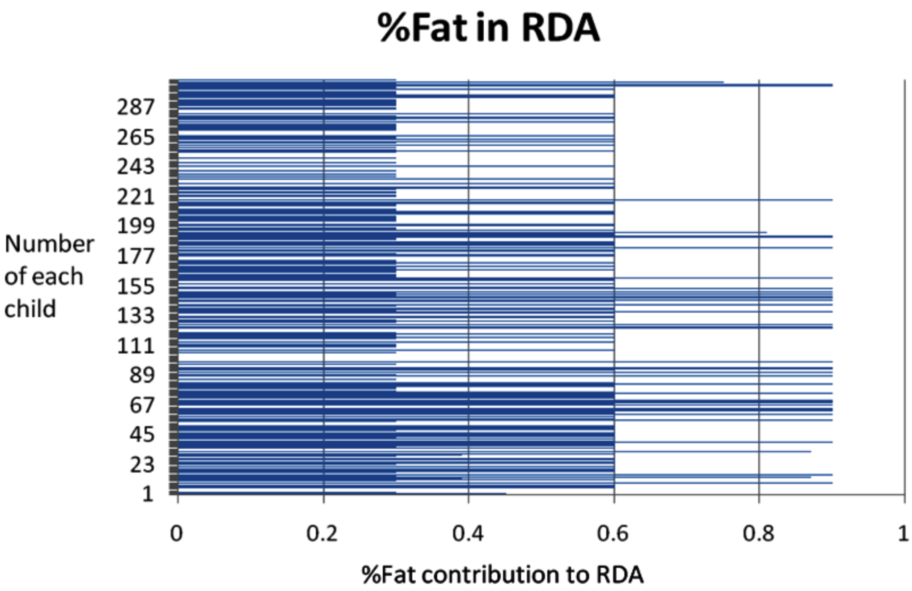

Fig. 2: % of Fat contribution into its RDA in each child among under five children

The average IDDS was computed using the below formula

$$Average\ IDDS = \frac{Sum\ (IDDS)}{Total\ Number\ of\ Households}$$

Determination of IDDS target for a particular population

It is desired that the variations in IDDS be evaluated against some important target level of diversity. Regrettably, standard data on 'ideal' or 'target' levels of diversity are generally not existing but choices are available to establish suitable target levels whereby an IDDS target for the population can be determined by taking the average diversity of the 33% of individuals with the uppermost diversity score (upper tercile of diversity) within the population.[18]

Determination of Nutrition Intake for the Study Population

Four cassava recipes were identified however, of the four recipes the most commonly used recipe (97%) was plain cassava recipe hence used for determination of nutrient intake. Amount of nutrients taken from proximates was computed as follows

Nutrient Intake % = Quantified Nutrient Contentin a sample (5) χ Average Cassava Intakeper Day(g) / Sample Weight (g)

Amount of nutrients taken from minerals was computed in weight basis as follows

Nutrient Intake (Minerals)mg = Quantified Mineral Content(mg) χ Average Cassava Intake per day(g) / 100g

Computation of RDA Percentages from Cassava Meal

The percentage of RDA's was computed from the below formula based on the amount of nutrient intake by a child from a cassava meal.

The percentage contribution of both proximate components and mineral contents to the standard RDA were calculated from the formula below

Table 1: Nutrition Composition of Plain Cassava Recipe and the Recommended Dietary Allowance (RDA), Adequate Intakes (AI) and Acceptable Macronutrient Distribution Range (AMDR) for under five children

Nutrients	Sample weight	Nutrient content in cassava meal	RDA*/ AI**/ AMDR***	Average nutrient intake per day	% intake/ day
Protein	0.3g	0.07±0.01%	24g	1.024g	4.2%
Fat	5.0g	0.18±0.13%	30g*	0.158g	0.51 -0.395%
Fibre	1g	2.63+0.55%	19-25g *	-	
Moisture	12g	73.55+0.27%	-	-	
Ash	27g	1.87+0.02%	-	-	
Carbohydrates	-	21.69+0.67%	95-130g	19.23g	20.2-14.8%
Calcium	1.5g	91.24+5.74mg/kg	400-800mg	40.11mg	10.03-5.01%
Magnesium	1.5g	243.77+7.48mg/kg	80-130mg	107.16mg	133.9-82.4%
Potassium	1.5g	0.02+0.00mg/kg	3000-3800mg	0.009mg	0.0003-2.6x10-6%
Zinc	1.5g	1.91+0.48mg/kg	4mg	0.84mg	21%
Copper	1.5g	1.66+0.42mg/kg	340-440µg	0.73mg	214.7-165.9%
Iron	1.5g	4.41+1.12mg/kg	10mg	1.94mg	19.4%
Manganese	1.5g	2.90+0.37mg/kg	1.2-1.5mg	1.275mg	106.3-85%
Cyanide	10.5g	0.32+0.00 µmol/g) (7.44ppm	safe WHO level is 10ppm	-	
Phytate	0.35g	319.78+0.48mg/100g	tolerable level is 25 mg/100g	-	

Source: *:19, **/***:20

Percentage of a nutrient in s tan dard RDA = (Amount of nutrientstaken) / RDA S tab dard Amount x 100

Statistical Analysis

IBM SPSS Statistics version 20 analytical package was used for the analysis of the data. The variability of nutrient contents among cassava based recipes (treatments) among the test treatments were analyzed by using one way analysis of variance (ANOVA) and the difference between means was determined using the Least Significant Difference (LSD) at ($p<0.05$) statistical significance.

Results and Discussion

The mostly Consumed Cassava Staple Recipes

Four cassava recipes were identified namely; plain cassava recipe, coconut cassava recipe, groundnut cassava recipe and tomato cassava recipe. It was observed that plain cassava recipe was the most commonly used (97%) among the four recipes. It was further established that plain cassava recipe was preferred due to its affordability as cassava is the only sole ingredient apart from water and salt. Therefore, it is the cheapest recipe compared to all other recipes. The amount of cassava meal consumed by children per day ranged from 150 grams -750 grams per day and the average consumption was 439 grams per day.

Nutrition Composition of Plain Cassava Recipe

As indicated earlier, plain cassava recipe was the mostly consumed recipe hence it was worth evaluating the contribution of the selected nutrients to the RDA. The quantified nutrient contents were thus used to determine the contribution of the respective nutrient to the RDA among the under five children. Table 1 present the results of the nutrient content of the plain cassava recipe, RDA for an under five child as well as the average nutrient intake per day (which was calculated for each nutrient) quantified from plain cassava recipe.

The quantified nutrient contents for the plain cassava recipe (Table 1) indicates very low contribution to the average nutrient intake per day except for magnesium, copper and manganese. This observation supports the statement that cassava meal alone cannot cater for the body nutrients requirement.[9] This further justify the need for improved dietary diversity by inclusion in their diets the under consumed food groups. Dietary diversification can be achieved by incorporating locally available foods such as green vegetables, coconuts, fish, and poultry in their meal and increase the consumption frequencies of the nutritionally enriched cassava staple meal.[9] These results well indicate poor contribution of cassava meal to average nutrient intake per day for zinc, iron, potassium, calcium, protein, carbohydrate and fat.

Anti-Nutritional Factors

The result (Table 1) also presents the levels of ant-nutrients, phytate and cyanide in plain cassava meal. The anti-nutrient (phytate) content was far above the tolerable level of 25 mg/100g but cyanide was within the acceptable level. Phytate levels above the tolerable level have a nutritional implication due their ability to interact and form none-soluble complexes with calcium, zinc, iron and copper and flavonoids (which are a group of polyphenolic compounds that include tannins) chelate metals such as iron and zinc and decrease their absorption.[21] The complexing of phytate with vital nutritional elements and the probability of interfering with protolytic digestion have been advocated as responsible for

Table 2: Percentage of contribution of a nutrient into total RDA

Nutrient	RDA values f or u5 children	Amount of nutrients taken	% contribution by cassava meal to RDA	Statistical Significance (P <0.05)
Iron	10mg	1.94mg	19.4	0.59
Zinc	4mg	0.84mg	21	
Protein	24g	1.024g	4.26	
Fat	30g*	0.158g	0.527	

RDA: 19, *Adequate Intake: 20

anti-nutritional action. Phytate is negatively charged with phosphate compound that binds minerals and inhibits absorption.[22] It is also indicated that such toxic substances can be reduced during processing of cassava, for example through cooking, fermentation and soaking. Similarly, it was indicated that cooking and fermentation destroy anti-nutritional factors.[21] This implies that the levels of anti-nutritional factors are much higher in raw cassava and suggests that phytate could also be a causative factor to high occurrence of malnutrition in that area due to high cassava consumption rate.

Contribution of Selected Nutrients from Plain Cassava Recipe to the Total Rda

The percentage contribution of selected cassava nutrients to the RDA of the respective nutrient is presented in Table 2. The adequacy of nutrient of plain cassava recipe was computed based on the quantity of foodstuff eaten in a day and the computed nutrient intake was evaluated against the RDA of respective nutrient for respective age category.

RDA for Macronutrients

The RDAs for protein and fat were selected for evaluation, due to their importance on children's optimal growth and development. Carbohydrate deficiency is so rare among children, as it is so abundant in common diets. The results show that regardless of the high consumption rate, cassava provided an average of 4.26% only to the protein RDA which is an extremely low contribution. This imply its contribution to protein RDA is negligible in view of the amount of protein the body requires (p=0.59) and the amount of protein plain cassava meal supplies per day, that is, only 4.2%.

The findings of this study which indicate little contribution of cassava to protein RDA agree with those of other researcher[23] who observed that the amount of protein among familiar cassava cultivars is classically only 1%.[24] He further indicated that, people that eat great amounts of cassava could well be at risk for insufficient dietary protein ingested. It was argued based on observational study that was conducted in Kenya and Nigeria,[23] that eating cassava as a staple food puts children 2-5 years old at risk for inadequate protein intake. The other researcher[25] found insufficient protein intake in the diets of Nigerian and Kenyan children eating cassava as a main food. The other study[26] that involved 2-5 years children which was conducted in Ede-Oballa

Table 3: Individual Dietary Diversity Score for Children

Food Groups	% of individuals consuming / not consuming a particular food group			
	Yes	(%)	No	(%)
White potatoes, white yam, white cassava, or other foods made from roots	246	74.8	83	25.2
Pumpkin, carrot, squash, or sweet potato that are orange inside + *other locally available vitamin A rich*	19	5.8	310	94.2
Other fruits, including wild fruits and 100% fruit juice made from these	71	21.6	258	78.4
Meat, poultry, fresh or dried fish or shellfish/seafood	142	43.2	187	56.8
Dried beans, dried peas, lentils, nuts, seeds or foods made from these (e.g. hummus, peanut butter)	91	27.7	238	72.3
Milk, cheese, yogurt or other milk products	68	20.7	261	79.3
Eggs from chicken, duck, guinea fowl or any other egg	2	0.6	327	99.4
Oil, fats or butter added to food or used for cooking	169	51.4	160	48.6
Sum IDDS	808			
Average IIDS	2.5			
Target IIDS for the population	5.0			

Community indicated that the contribution of starchy root was only 1.72±0.2 g out of 16g of Food and Agriculture Organization/World Health Organization protein requirement which further supports the present findings.

Figure 1 shows the percentage score of each child for cassava contribution to protein RDA which ranged from 1.45% to 7.29 % among the children population depending on their consumption frequency of cassava. The results provide the average percentage contribution of 4.26% of cassava in children's RDA as presented in Table 2.

The link between growth and intake of protein, as established by earlier researcher[10] don't verify a causal relationship, in particular since the amount of micronutrient in the diets as well as other ecological factors are likely to be confounding factors. Nonetheless, the proof from observational human studies and animal intervention studies suggests that stunting occurs if a least amount of protein to energy ratio is not achieved.[10] From the dietary diversity and consumption pattern among children in Mtwara rural district as indicated in Table 3, protein can be obtained from food sources like meat/poultry/fish and beans/legumes food groups which are however poorly consumed. Therefore provision of nutrition education and counseling is important to enhance consumption of other food groups to increase dietary availability of protein.

It was important to evaluate the RDA for dietary fat due to its importance as a superior source of necessary fatty acids (e.g. omega 3 fats) and concentrated energy. Energy balance is vital to sustaining healthy body weight and guaranteeing best possible nutrient intakes. Fats and fatty acids are metabolized and used in the body, change cell membrane function, manage gene transcription and expression, and interact with one another. Fats specifically long chain poly unsaturated fatty acids has a role on newborn mental advancement, as well as a advantageous role in safeguarding long-term health and avoidance of specific chronic diseases.[27] The findings of this study show that cassava contributed only 0.527% to the fat RDA. Figure 2 indicates the percentage contribution of plain cassava meal to the fat RDA among children which ranged from 0.18% to 0.9%. The results clearly imply low contribution of plain cassava meal to the amount of fat required by the body for optimal growth and development. Previous intervention researches from developed countries propose that diets with lower % of energy from fat tend to be hypo caloric and are thus linked with short term weight loss.[27] This could imply that children who are underweight might have experienced a hypo caloric condition and might require diets enriched with fat to re-gain healthier weight. The results on dietary diversity (Table 3) indicate that only 51.4% households consume fat/ oils food group which implies the need for more emphasis to food diversification to meet the body's

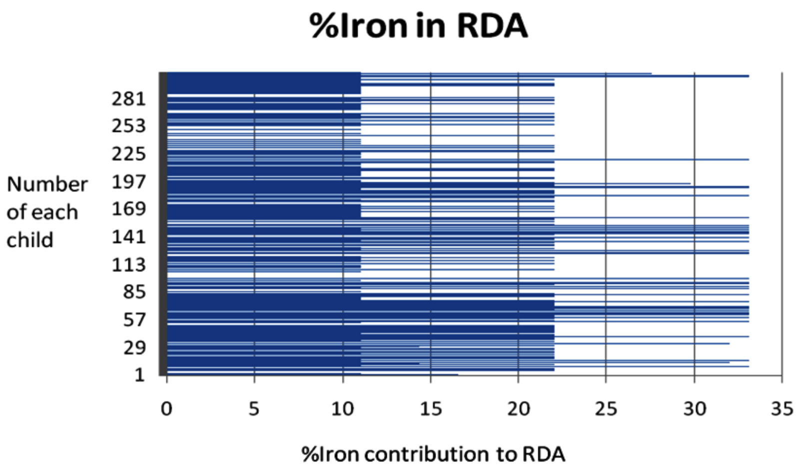

Fig. 3: Percentage contribution of plain cassava meal to Iron contribution into its RDA in each under five child.

requirements using the locally available food sources such as coconuts.

RDA for Micronutrients

Micronutrients are chemical elements including vitamins and minerals that are required in trace amounts for good health, normal growth and development of human and other organisms. Iron is an indispensable nutrient that is engaged in oxygen transport, energy metabolism, immune response, and plays a vital role in brain/cognitive development. The findings of the present study show that the average amount of iron and zinc that is consumed from plain cassava recipe is 1.94 g/day and 0.84 g/day respectively which contribute 19.4% and 21% respectively of the required RDA (Table 2). This is far below children RDA requirements for these potential minerals. This further suggests the need for food diversification and / or fortification in order to meet the RDA for both iron and zinc. Dietary diversity results (Table 3) indicate that sea foods and foods from animal sources as well as fruits and vegetables which are rich in iron and zinc are rarely consumed.

The percentage contribution of plain cassava to iron and zinc RDAs (Figures 3 and 4) for each child ranged from 6.62% to 33.08% and 7.16 to 35.81% for iron and zinc respectively. It is well documented that young children are vulnerable to the effects of iron deficiency (ID) because of rapid growth and development of their brain and other organs that occurs from birth to the age of three.[28] Low intake of iron can contribute to anemia which indicates the vulnerability of this age group to the same.

Iron scarcity (ID) is the most regular micronutrient shortage globally and young children are a particular risk group as infant becomes reliant on extra dietary iron and, due to rapid growth; iron demands per kilogram body weight are greater than during any other stage of life. The previous situation of iron deficiency rates shows 35% of under five children (6-59 months) had moderate anaemia and the anemic children were 59%,[29] and the recent study shows that 30% Tanzanian children have moderate anaemia and 58% are anemic.[6] This shows poor progress in reducing iron deficiency rate among children. Eating of foods such as meat, fruits, cereals and fortified formulas appear to protect against iron deficiency. A previous study[30] has proved the effective ways of achieving the daily needs of minerals, protein, and energy is through fortification of cassava products. This further suggests that in places where cassava is a staple food with limited food diversity food fortification could be a viable option. This is further supported by the existing literature31 which shows that minerals such as iron and zinc are obtained in low quantities in cereal and tuber based meal. The report further indicates that inclusion of legumes slightly boosts the iron contents of such meals. However, the bioavailability of this non-haem iron source is very low. Therefore it is impossible to meet

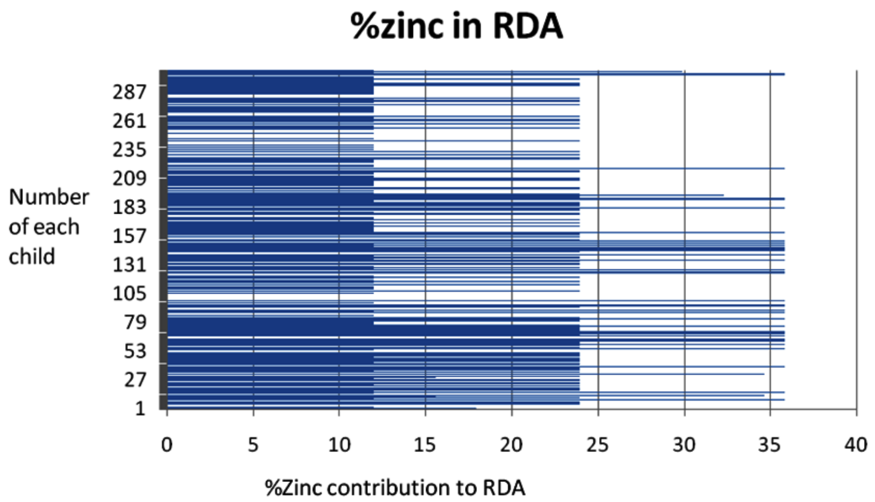

Fig. 4: Percentage contribution of plain cassava meal to Zinc RDA in each under five child

the recommended levels of iron in the staple based diet through a food based approach unless such foods like meat or fish is also included.

On the other hand, zinc scarcity has been indicated globally to cause substantial morbidity and mortality in developing countries because of little intake of animal protein and great intake of phytates.[21] The results of this study also show that the phyate contents in plain cassava recipe (PCR) is 319.78mg/100g which is far above the tolerable level of 25 mg/100g. This could thus have a nutritional implication as phytates could interact and form insoluble complexes with iron and zinc thus reducing their absorption.[21]

There is some indication that malnourished children put on weight more rapidly as they are offered zinc supplementation.[32] According to approximation by the International Zinc Nutrition Consultative Group (IZiNCG), 37.5% of the country's inhabitants is at risk of insufficient zinc intake,33 which spaces Tanzania in the 'high' risk group for zinc shortage. The documentation also indicate that zinc deficiency is a public health concern in which case high phytate levels could be one of the main contributing factors.[34] Inadequate zinc intake is recognized to impair the immune system and children with trivial nutritional status are at major risk of developing zinc exhaustion. Hence appropriate nutritional interventions in addressing micronutrient deficiencies are required to address the problem.

Individual Dietary Diversity for the under Five Children

Dietary diversity gives a clear picture of how many food groups are consumed in a particular area, and which ones are mostly consumed. Table 3 presents the Individual Dietary Diversity Score (IDDS) for Children under this study.

The average IDDS of 2.5 which was found in the present study (Table 3) further indicate poor dietary diversity among population members. It can be observed from the results (Table 3) that consumption of foods of animal origin (which are rich in iron and vitamin A) is very low.

Furthermore, the results indicate that the average IDDS that was obtained in the current study is far below the average target IDDS for the study population that stands at 5. This was computed based on 10 children who had the highest IDDS of 5, using the computational formula of determining the IDDS target for the target population. This was achieved by considering the average diversity of 33% of individuals with the highest individual IDDS. In this case 33% of 10 children give 3.3 children which approximates to 3 children. Therefore, the targeted population IDDS is 5 as indicated below:

$$IDDS = \frac{(5+5+5)}{3} = 5$$

The 5 IDDS score shows a meaningful target level of diversity for children in Mtwara rural district which has to be attained. This means has to be over and above the average IDDS of 2.5 that has been established in this study. Thus a 2.5 IDDS score obtained from this study implies the need for further improvements of the average food groups consumed by the children. The problem of dietary diversity seems to affect many regions in the country based on the findings of the previous study[35] which showed an average of less than 5 IDDS for many regions. This implies the need for countrywide nutrition interventions to combat the problem of malnutrition.

The poor dietary diversification observed in the present study suggest the need for developing strategies to encourage and make possible dietary diversification in order to achieve complementarity and prevent malnutrition.

Conclusions

The results of the present study indicated poor contribution of plain cassava recipe to the RDA for protein, fat, zinc and iron. The IDDS (of 2.5) was similarly far below the targeted population IDDS of 5 implying poor dietary diversity among population members. The anti nutritional factors in particular phytate was far above the tolerable level which is likely to chelate such minerals like zinc and iron and reduce their bio-availability. This could in turn expose the population to malnutrition especially young children. It is thus important to develop strategies which encourage and make easy for dietary diversification among community members in order to complement cassava based recipes with readily available foods rich in macro and micronutrients. This would enrich the diets with a diverse of nutrients and meet the nutritional requirements of children. The strategy could also consider dietary practices such as control of intake of inhibitors e.g. of iron absorption and increase intake of enhancers of absorption in a given meal.

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