

Using Iron Bio-Fortified Beans To Control Iron Deficiency Anaemia Among Children 6-59 Months In Rural Uganda

Christinah Nuwahereza (✉ christinahnuwahereza@gmail.com)

Makerere University College of Health Sciences <https://orcid.org/0000-0001-7849-5080>

Saul Kamukama

Makerere University CHS: Makerere University College of Health Sciences

Christine Nalwadda Kayemba

Makerere University CHS: Makerere University College of Health Sciences

Gerald Obai

Gulu University Faculty of Medicine

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Abstract

Objectives To establish the association between consumption of iron bio-fortified beans and iron deficiency anaemia among children aged 6-59 months in Isingiro district rural Uganda.

Design A cross sectional study was conducted in Isingiro District, Western Uganda in May 2019 among 499 participants (Child- mothers). Standardized questionnaires were used to collect data on the child health status, demographics as well as dietary history. In addition, blood samples were collected from a finger prick and tested for hemoglobin levels using hemocue 301 and data was analysed using STATA

Setting This was a community based study in rural Uganda.

Participants A total of 499 children aged 6-59 months and their mothers/main caretakers in Isingiro district rural Uganda were recruited.

Results Consumption of iron bio-fortified beans was at 39.3% while prevalence of iron deficiency anaemia was 26.3%. Consumption of iron bio-fortified beans was protective against iron deficiency anaemia (Adjusted Prevalence Ratio = 0.66, 95% CI 0.46, 0.96), dietary diversity (APR= 0.57, 95% CI 0.33, 0.86), mothers' occupation (APR= 0.62, 95% CI 0.43, 0.90), child age (APR= 0.38, 95% CI 0.18, 0.84).

Conclusions This study found that, more than a third of the participants were consuming iron bio-fortified beans and more than a quarter of the participants suffered from iron deficiency anaemia with most cases being mild anaemia. Consumption of iron bio-fortified beans was associated with mother's occupation and main source of beans. Consumption of iron bio-fortified beans was associated with prevalence of iron deficiency anaemia among children aged 6-59 months and we are not able to conclude that it was protective against anaemia because of the study design. There were other factors that were associated with iron deficiency anaemia such as, dietary diversity, child age, and mother's occupation. Therefore from this study we conclude that reducing anaemia in this study area requires a multi sectoral approach so as to improve dietary diversity and livelihoods.

Introduction

Anaemia remains a global public health problem with 43.7% (273 million) of the children aged 6-59 months having anaemia. The burden of anaemia is even higher in Uganda among children in the same age category with 53% having anaemia. Although the prevalence of anaemia in south western Uganda is 31% (1), it still constitutes a public health challenge. One of the major causes of anaemia is iron deficiency, which is responsible for about 50% of anaemia burden globally. Iron deficiency anaemia is an indicator of poor health and nutrition (2, 3). It can have irreversible effects like impaired growth and cognitive development, decreased physical activity, and poor learning ability (2, 4). The main cause of iron deficiency in children is inadequate dietary consumption of iron rich foods which result in depletion of iron body stores especially during growth and development when there are high-energy requirements (5), The iron deficiency is more pronounced in the rural and semi urban communities (6).

One of the ways of increasing iron intake is consumption of iron bio fortified foods. Key among the iron bio-fortified foods are beans, which already have high baseline iron content. Additionally, beans are consumed as whole after cooking (7) which ensures that all the iron content is taken into the body. The iron content of iron bio-fortified beans is 40% higher than that in non-bio fortified varieties. This increases iron bioavailability and absorption in beans (8, 9).

In an attempt to prevent iron deficiency anaemia in south western Uganda, the Ugandan Government introduced iron bio fortified beans in early 2016 (10). The choice of beans was because beans are consumed widely among this rural population. Equally, there is limited consumption of other foods rich in iron such as meat, fish and eggs due to financial constraints and cultural beliefs (11). However, there is limited data to show that consumption of iron bio-fortified foods helps to prevent anaemia in children aged 6-59months. Therefore, in this paper, we report consumption of bio-fortified beans to control iron deficiency anaemia among children aged 6-59months in rural western Uganda.

Methods

Study site

We conducted this cross sectional study among children aged 6 -59 months in Isingiro district, located in the Ankole sub-region, south western Uganda. The district has a population of 492,117 people in 102,967 households. Approximately, 23.2 % of the population is children aged 0-5 years. The district has a high fertility rate at an average of 6.2 children per mother (12). About 80 % of the population derive their livelihoods from subsistence farming. Key among the crops grown in the district are beans, and iron bio fortified beans were introduced in 2016 (10), as a way of addressing the high prevalence of anaemia which stands at 39.8% (13). The district experiences equatorial type of climate coupled with long dry seasons, which sometimes causes food insecurity among households.

Sample size and sampling procedure

We calculated our sample size using Kish Leslie (1964) formula for cross-sectional studies since our expected outcome is a categorical variable (anaemic and non-anaemic) reported as a proportion (14). We used anaemia prevalence of 31% from a previous study (15) and a 5% margin of error and adjusted for non-response at 5% (16) and design effect of 1.5 (17), giving us the final sample size of 519 participants.

We selected one rural and one urban sub counties using simple random generated numbers with ENA SMART (emergency nutrition assessment) software. Selection of a rural and an urban area ensured that there was a fair representation of the study area.

Secondly, we randomly selected two parishes from each sub county. The parishes in each sub county were numbered consecutively and the random selection done using ENA SMART.

A total of 519 participants were eligible for this study. We sampled 503 participants but two households were excluded because they were headed by minors. We therefore collected data from 499 children. However, two participants were excluded from the analysis because blood samples were not drawn for haemoglobin determination because they had fever.

Variable measurements

The outcome variable was absence or presence of iron deficiency anaemia; with the latter defined as haemoglobin levels (Hb) <11g/dl.

Independent variables included social demographic characteristics of the mother or primary caretaker of the child such as highest-level of education attained which was categorised as none, primary, secondary and tertiary; main occupation which was categorised as subsistence farming, salaried jobs or business; and age (list categories). The child's data collected included age, sex (male/female) and disease history in last two weeks. Data on disease history was collected because we wanted to determine health status of the children and rule out malaria and infections that are usually characterized by high fever, diarrhoea, which could alter the child's haemoglobin status. Intake of iron bio fortified beans: which was defined as having consumed a meal containing iron-bio fortified beans in the 24 hours preceding the study. It was categorized as consumed or did not consume iron bio fortified beans. Intake of iron rich foods using dietary diversity: was defined as having consumed food from four or more foods in the 24 hours preceding the study. A child was considered to meet minimum dietary diversity if he/she consumed food from four or more food groups (19).

Data collection

Social demographic

Electronic questionnaires designed in ODK were pre-tested and used to collect socio-demographic data in a face-to-face interview. Data collected from the mother/caregiver were highest level of education attained, occupation, age, household size, marital status, and relationship with the child. The child data collected were health status, sex, and age.

Blood samples

Blood samples were collected by trained and registered medical laboratory personnel. The finger was cleaned with alcohol pads to sterilize the area before pricking using Blood lancets penlet and a drop of blood from the pricked area was drawn into a micro cuvette and fitted in the HemoCue. Haemoglobin analysis was carried out on-site with quality controlled battery operated portable HemoCue analyser 301 and results were recorded to the nearest 0.1g/dl. Haemoglobin levels were categorized according to WHO classification of anaemia among children as severe <7.0 g/dL, moderate 7.0-9.9g/dl, mild 10.0-10.9g/dl and no anaemia \geq 11g/dl (1). The results were communicated to child's mother or caretaker.

Consumption of iron bio fortified beans

Intake of iron bio fortified beans was determined by using 24-hour food frequency questionnaire and individual dietary diversity score. Respondents were asked to describe all foods (meals and snacks) that a child ate or drunk during breakfast, lunch and supper in the previous 24 hours(20). All the foods, snacks and drinks mentioned were written down. When composite dishes were mentioned, the respondent was asked to list all the ingredients. After the respondents had finished recalling, research assistants probed to find out if there were any other meals not mentioned(19). In addition, if beans had been mentioned the respondent was asked which type of beans was consumed. Iron bio fortified bean charts and bean seeds were shown to respondents to confirm the type of beans eaten.

Dietary diversity

A food dietary diversity questionnaire consisting of 60 foods from 15 different food groups was used to collect data. To determine the dietary diversity score, foods were categorised into the following seven groups: i. grains, roots and tubers ii. legumes and nuts iii. dairy products (milk, yoghurt, cheese) iv. flesh foods (meat, fish, poultry and liver/organ meats) v. eggs vi. vitamin-A rich fruits and vegetables vii. other fruits and vegetables.

A child who ate from at least four of the above 7-food groups meets a minimum dietary diversity score (19, 21). The cut-off was selected because it was shown to be associated with better quality diets for both breastfed and non-breastfed children. The food groups were carefully selected using infant and young children feeding guide to include iron rich foods from both plant and animal sources (21).

This method was good because the period was short and the participants would easily recall. It was more appropriate for measuring dietary intake and diversity in individuals at the community level. It also considered all foods eaten including mixed dishes.

Analysis

Modified Poisson regression was used to measure association between iron deficiency anaemia and consumption of iron bio-fortified beans and other independent variables. The variables with P value of ≤ 0.2 were selected for multivariate analysis to include variables that would be of statistical significance or could have an influence on the outcome of interest. Modified Poisson regression was used because prevalence of anaemia was higher than 10% (26.3%).

Multivariate analysis was conducted using modified Poisson regression model with robust error variance to estimate prevalence ratios (PR) as a measure of association between anaemia and intake of iron bio fortified beans and other independent variables. A forward stepwise model was used. The independent associations were determined at 95% confidence interval and variables with P-value less than 0.05 were considered significant.

Results

Social demographic characteristics of children and respondents

The mean age of the 499 respondents (mothers and main caretakers) was 31.62 years (SD 9.2) and median age was 30 years (IQR 25–37). Most of the respondents were mothers 453/499 (90.8%) and most of the mothers were married. More than half of the participants had completed primary level education 271/499 (54.3%). In addition 499 children with a mean age of 23.9 months (SD 15.3) and median age of 20 months (IQR 10–36months) took part in the study. More than half of the children were females (55.1 %). Majority of the children ate food from less than four food groups (75.5%), whereas a half of the children were not de-wormed (53.3%) and did not consume fruits and vegetables the previous day (52.9%) as shown in Table 1.

Consumption of iron bio fortified beans in control of anaemia in children

While 83.2% (415/499) of the children had consumed beans, only 39.3% (163) had eaten iron bio-fortified beans. Out of 163 children who consumed beans 35 (21.5 %) of them had iron deficiency anaemia. Pearson's X^2 was used to test difference between haemoglobin status among children who consumed iron bio-fortified beans and those who did not consume iron bio-fortified beans (Table 2).

Multivariate analysis

After adjusting for growing iron bio fortified beans, respondent's occupation, child's dietary diversity, child age, de-worming status, consumption of fruits and vegetables, use of micronutrient supplements, child sex and respondent's age, consumption of iron bio fortified beans. Consumption of iron bio fortified beans was found to be associated with increased haemoglobin levels (Adjusted Prevalence Ratio (APR) = 0.66, 95% CI 0.46, 0.96), dietary diversity (APR = 0.57, 95% CI 0.33, 0.86), mothers' occupation (APR = 0.62, 95% CI 0.43, 0.90), child age (APR = 0.38, 95% CI 0.18, 0.84) Table 3

Discussions

This was a cross sectional study on the use of iron bio-fortified beans to control anaemia among children aged 6-59months. The study involved 519 children and their mothers (child –mother pair). Slightly more than a quarter of the children in this study suffered from iron deficiency anaemia with a majority having mild anaemia. This study demonstrated that while over 80% of the children studied consumed beans, only a third of them fed on iron bio-fortified beans. This could possibly mean that whereas beans are widely consumed in the area, the community has not yet fully accepted the newly introduced iron bio-fortified beans. Consequently, its intended purpose of preventing iron deficiency anaemia may not be fully realised. Consumption of iron bio-fortified beans was also associated with the source of beans. Children whose household's main source of beans was market were more likely to consume iron bio-fortified beans compared to those whose main source of beans was the household farm. This could be because the participants in the rural sub county were mainly from cattle keepers who don't practice crop growing. More so, they have the purchasing ability to purchase beans from other subsistence farmers. This is in

agreement with a study carried out in Zambia on orange fleshed sweet potatoes where households with purchasing ability consumed orange fleshed sweet potatoes more frequently compared to those who had low purchasing ability (22).

The prevalence of iron deficiency anaemia in this population was moderately high according to the WHO classification of anaemia (23) with most cases being mild anaemia. This prevalence was slightly lower than that of Ankole sub region and Uganda as a whole (15). However, it is generally lower than that of Northwestern Uganda, and Namutumba (24, 25). This prevalence of iron deficiency anaemia could be due to the fact that mothers are most involved in agriculture and have less time to care for the children. (12). This is supported by our finding that children whose mothers/caregivers were involved in business or a salaried job were less likely to be anaemic.

The prevalence of iron deficiency anaemia was lower (33.7%) among children who consumed iron bio fortified beans compared to those who did not consume iron bio fortified beans. This is because iron bio fortified beans have higher iron content and increased bioavailability, which increases the amount of iron available for haemoglobin production in the blood. Our findings are in agreement with those from a study conducted in India, where children aged 5–12 years who consumed iron bio-fortified pearl millet had higher haemoglobin levels as compared to those who did not consume bio fortified pearl millet (26). Although the consumption of beans showed an association with anaemia prevalence we are not able to conclude that they were protective against anaemia because of our study design.

This study also showed that iron deficiency anaemia was associated with dietary diversity and the child's age. The prevalence of anaemia was lower among children who consumed food from four or more food groups compared to those who consumed food from less than four food groups. This is because consumption of food from diverse food groups including fruits and vegetables supplement the iron obtained from the iron bio-fortified beans (27, 28). These results are consistent with those of other studies carried out in Ethiopia (29), where children who consumed less than four food groups were likely to be anaemic.

The prevalence of iron deficiency anaemia was lower among children who were aged 37–59 months compared to those who were aged 6–36 months. This could be due to high body iron requirements during early months of child development (30) and the poor complementary feeding practices among mothers where children do not receive minimum acceptable diet (15). Similarly, in Guinea Bissau, children aged 6–35 months were likely to get anaemia as compared to those aged 36–59 months (31).

Children whose mothers' main occupation was salaried job, commercial farming, or business were less likely to be anaemic as compared to those children whose mother's main occupation was subsistence farming. This may be due to the fact that mothers who have salaried jobs, business, or in commercial farming have the financial ability to buy foods of animal sources to supplement their children's diet. A study done in Uganda showed that mothers who practice subsistence farming sell their food to get other household needs (32, 33).

Children whose mothers' main occupation was salaried job, commercial farming, or business were less likely to consume iron bio-fortified beans compared to those whose mother's main occupation was subsistence farming. This could be due to the fact that mothers who have salaried jobs or business are able to buy other sources of proteins and iron apart from beans.

It was hard to study causal relationship because of the study design since it was a cross sectional study, we were not able to establish how long an anaemic child needed to consume these beans to correct the condition. These results may be generalizable to all children aged 6-59months in Isingiro district because our study employed random sampling procedures, the sample size of 519 was large enough and the response rate of 96% was good enough.

Conclusions

This study found that, more than a third of the participants were consuming iron bio-fortified beans and more than a quarter of the participants suffered from iron deficiency anaemia with most cases being mild anaemia. Consumption of iron bio-fortified beans was associated with mother's occupation and main source of beans. Consumption of iron bio-fortified beans was associated with prevalence of iron deficiency anaemia among children aged 6-59months and we are not able to conclude that it was protective against anaemia because of the study design. There were other factors that were associated with iron deficiency anaemia such as, dietary diversity, child age, and mother's occupation. Therefore from this study we conclude that reducing anaemia in this study area requires a multi sectoral approach so as to improve dietary diversity and livelihoods.

Areas for further research: Further research may focus on preferred strategies to promote and scale up consumption of iron bio-fortified beans in the study setting and similar context.

Declarations

Authors' contributions

Christinah Nuwahereza: Developed the research idea, formulated research questions, design, data analysis and writing of the manuscript.

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Tables

Table 1: Showing social demographic characteristics of the children

Variable (n=499)	Frequency (n)	Percentage (%)
Age (month)		
6-11	140	28.1
12-23	124	24.9
24-35	97	19.4
36-59	138	27.7
Sex		
Female	275	55.1
Male	224	44.9
Deworming status		
Not dewormed	266	53.3
Dewormed	233	46.7
Disease history in the previous two weeks		
No disease	450	90.2
Diseased	49	9.8
Dietary Diversity score		
Less than 4 food groups	377	75.5
Four or more food groups	122	24.5
Consumption of proteins		
Did not consume	38	7.6
Consumed	461	92.4

Consumption of fruits and vegetables		
Did not consume	264	52.9
Consumed	235	47.1
Source of beans consumed		
Home grown	298	71.8
Market	117	28.2
Birth weight		
Low	95	19.0
Normal	404	89.0

Table 2: Consumption of beans and iron deficiency anaemia

Variables	Anaemic (%)	No anaemia (%)	Chi2	95% CI P-values	
Consumption of bio fortified beans					
No consumption	69 (27.4)	183 (72.6)			
Consumption of bio fortified beans	35 (21.5)	128 (78.5)	PR = 0.175	0.54, 1.11	0.181

Table 3: Factors associated with anaemia at multivariable analysis

Variable	Anaemic (n)	%	Crude PR	95% CI	Adjusted PR	95% CI	P-values
Child's age							
6- 11	45	32.1	1.0				
12 -23	35	28.2	0.87	0.60 ,1.27	0.91	0.61 ,1.35	0.662
24-35	30	30.9	0.96	0.65,1.41	0.85	0.18 , 0.73	0.087
36-59	21	15.2	0.47	0.29, 0.75	0.38	0.18 ,0.84	*0.004
Child's sex							
Female	69	25.1	1.0				
Male	62	27.7	1.10	0.82 ,1.48	1.16	0.84 - 1.61	0.344
Mother / caretaker occupation							
Subsistence farming	95	30.8	1.0				
Salaried jobs / business	36	18.9	0.61	0.32 ,1.47	0.62	0.43 - 0.90	*0.011
Mother/ primary caretaker's Age							
16-25	46	30.7	1.0				
26-35	47	22.6	0.73	0.52, 1.04	0.80	0.54 , 1.19	0.263
36-50	33	28.7	0.93	0.64 ,1.36	1.17	0.77 , 1.77	0.440
51-70	5	19.2	0.62	0.27 ,1.43	0.74	0.29 , 1.86	0.572
Consumption of iron bio-fortified beans							
Consumed Non bio- fortified	69	27.4	1.0				

beans

Consumed Bio- fortified	35	21.5	1.27	0.89,1.82	0.66	0.46 ,0.96	*0.032
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Dietary diversity

Less than four food groups	11	330.0	1.0				
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More than four food groups	18	14.7	0.53	0.31,0.77	0.57	0.33 ,	*0.009
						0.86	

p-values with statistical significance

Supplementary Files

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