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Consumption Pattern of Fruits and Vegetables among Solar Market Garden Women's Groups from Kalalé District of Northern Benin, West Africa

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Abstract

Background: Anemia and iron (ID) and vitamin A (VAD) deficiency continue to be significant public health issues in northern Benin, despite the installation of solar market gardens (SMGs), suggesting an urgent need of implementing nutrition programs to benefit the full impact of SMG. However, for an effective nutrition promotion, it is important to identify the fruits and vegetables (F&V) consumed to determine their suitability for promotion.

Objective: To assess the consumption pattern of F&V in Kalalé district of Northern Benin to identify the potential F&V that could be promoted in the district for improving anemia and micronutrients status.

Methods: Cross-sectional surveys were conducted among 250 mothers/caregivers aged 19 years and above. All questionnaires assessed socio-demographic characteristics and types of staples foods consumed as well as the types of F&V consumed and their frequency of consumption. Descriptive analyses were tabulated using STATA version 14.

Results: Several F&V are eaten in the district, but their frequency of daily consumption is low. However, mangoes are abundant during the two fruiting seasons and could be easily accessed by the participating women. Likewise, Moringa oleifera leaves are available all year round and could be incorporated into selected recipes.

Conclusions and Implications: Mangoes and Moringa oleifera leaves are potential sources of β-carotene to be promoted on a sustainable basis among SMG women's groups of Kalalé district of Northern Benin. However, nutrition educational messages should include behavior change campaigns that will make the women see the need for consuming F&V on a daily basis.

Keywords: Green Leafy Vegetables; Fruits; Fortification; Vitamin A Deficiency; Benin

Introduction

Anemia and iron (ID) and vitamin A (VAD) deficiency are challenging public health issues among young children in many low- and middle-income countries (LMICs) where they have adverse implications for their academic performance, physical, and social development [1,2]. Benin is no exception since 58% of children 6-59 months old children have anemia while greater than a third of young children have ID, with a greater prevalence in rural areas [3,4]. VAD is present in two-thirds of children 12-71 months old [5]. In response to this situation, in 2014, Solar Market Gardens (SMG) using solar-powered drip irrigation for horticultural crops was installed in conjunction with local women's agricultural groups to improve food security and child nutrition status in the Kalalé district, one of the rural districts in Benin. Although improvements in children's iron status and growth occurred one-year after the intervention, 63% of children were still anemic, 21% were ID, and 24% continued to have VAD [6]. Therefore, there is an urgent need of incorporating nutrition and health programs with agricultural interventions to benefit from the full impact of SMG systems in Benin.

Interventions to address anemia and other micronutrient deficiencies included nutrition education programs, fortification and supplementation, and cultivation of exotic vegetables, which could not be sustained because they are expensive [7]. A viable approach that could prove to be effective to addressing these problems could be identification and promotion of indigenous micronutrient-rich foods that are adapted to the environment and are easy and cheap to produce. Currently, many reports have indicated that indigenous green leafy vegetables, which are rich sources of provitamin A carotenoids, vitamin C, folic acid, and dietary minerals such as iron, calcium, zinc, and manganese, have the potential for meeting many micronutrient requirements of

developing countries [8,9]. For example, Saint Saveur and Broin [10] indicated that 100g of fresh Moringa oleifera (M. oleifera) leaves could cover 100% of the daily needs of vitamin A, which ranges from 400µg retinol equivalent for young children to 1,000µg retinol equivalents for breastfeeding women. Recently, Egbi *et al.* [11] found that consumption of green leafy vegetables powder increased mean hemoglobin and retinol concentrations of schoolchildren 4-9 years old. Specifically, lack of dietary diversity is a particularly severe problem in Benin where diets are based predominantly on starchy staples with little or no animal products and few fresh fruits and vegetables [3,12,13]. Thus, with abundance of seasonal fruits and green leafy vegetables cultivated all year round [14], consumption of these foods could be a cheap and sustainable means of resolving these public health concerns.

However, for effective nutrition promotion, it is necessary to identify the fruits and vegetables (F&V) consumed in the locality, evaluate the micronutrients content of those F&V to determine their suitability for promotion before designing a promotion package for the community. This study therefore surveyed the consumption of F&V in Kalalé district of Northern Benin to identify the potential F&V that could be promoted in the district for improving anemia and micronutrients status. While this study is aimed at producing formative knowledge on suitable foods for future fortification, the larger work will offer an opportunity for capacity building through two avenues. At the individual level, it will build up local knowledge on the benefits of food diversity and fortification through educational and practical sessions. At the community level, this work will be conducted in tandem with women's groups (WG), which can use the knowledge gained to package and sell the fortified foods commercially. This can therefore serve as an income generating activity for the WGs and contribute towards economic security for the women, their families, and the community in general. Finally, at its core, this study will focus on locally available, accessible, affordable, and acceptable foods for fortification, which will increase the likelihood of sustained use during and post- intervention.

Materials and Methods

Location

The study was conducted during the rainy season in July 2019 in the Kalalé district of Northern Benin. The Kalalé district is home to more than 180 000 people, 95% of whom rely on subsistence farming as their primary means of survival. For most, farming is limited to the rainy season due to a lack of water for irrigation [15].

Study Design

This cross-sectional survey is a sub-study of a sample of a longitudinal cohort study conducted by the University of Stanford, UC San Diego, and the University of Arizona, which focuses on evaluating the impact of commercial-scale solar-powered drip irrigation systems (solar market gardens, or SMG) on food security, maternal and infant nutrition status, and women's empowerment [16]. According to the main study conducted between 2014 and 2015, there were 312 enrolled mothers/caregivers in SMG women's groups. In order to qualify for our study, mothers/caregivers must be aged 19 years and above, be a member of SMG women's groups in one of the eight villages where SMG were installed, and have at least one child between the ages of 4-12 years old. From the list of SMG women's groups, 250 mothers/caregivers met our inclusion criteria and were interviewed to assess F&V consumption patterns. The main reason for non-response was the failure to find individuals at home despite repeated visits (n=22) and refusal to participate (n=8) while four women with incomplete record were excluded (n=5). In addition, 27 did not meet our inclusion criteria (child age and WG). Ethical clearance was obtained from the institutional review boards charged with the protection of human research subjects of the University of Arizona. All women were informed verbally about the aims and procedures of the study and informed consent was obtained before enrolment.

Data collection

A pre-tested, structured questionnaire divided in four sub-sections was used to collect information. The first section covered various socio-demographic characteristics of mothers/caregivers such as age, marital status, religion, education, occupation, ethnicity, and number of children. The second part of the questionnaire had a detailed section for obtaining information on the types of staples foods they consumed in the district from a list of staples provided: starchy foods, cereals, pulses and nuts. In the third and fourth sections, questions posed included the types of F&V cultivated in the garden and in their own farm, consumed as well as their frequency of consumption. Participants were also asked to mention if children 4-12 years old and adults consumed the same types of F&V. Finally, the survey questionnaire originally in English was translated in French and delivered by four data collectors in the local languages when necessary.

Data Analysis

Data were recorded on paper by the enumerators, managed using Redcap electronic data capture tools hosted at the University of Arizona [17,18], and then analyzed with Stata version 14. Quality control occurred in the field and data entry was checked for misspellings, ID miscoding, and other coding errors to the extent possible, if needed by rechecking the original hand-written files. To summarize data, categorical variables were expressed as frequencies and percentages while continuous variables as arithmetic means and standard deviations (SD).

Results

Sociodemographic Characteristics

Of 250 mothers/caregivers surveyed (Table 1), the majority had no formal education (91.2%), and most were aged 30–44 years (72%),

married (98.8), and Muslim (98.8%). Their main occupation was housewife and the mean number of children was 5.8 (SD=2.6). The highest ethnic group was Gando (40.9%) followed by Boo (36.9%) and other ethnic groups (Peulh, Boko, and Bariba).

Variables	n (%)
Age	
≤29 years	29(11.60)
30-44 years	**180(72.00)**
45 and above	41(16.40)
Marital status	
Single	3(1.20)
Married	**247(98.80)**
Religion	
Christianity	3(1.20)
Muslim	**247(98.80)**
Education	
No education	**228(91.20)**
Primary school	10(4.00)
Secondary school	7(2.80)
Koranic school	5(2.00)
Occupation	
Housewife	**247(98.80)**
Trader	3(1.20)
Ethnicity	
Gando	**102(40.96)**
Boo	**92(36.95)**
Peulh	24(9.64)
Boko	7(2.81)
Bariba	24(9.64)
Number of children –mean (SD)	**5.76 (2.63)**

Table 1: Socio-demographics of mothers/caregivers of children 4-12 years

Staples foods

The basic diet of the participating mothers/caregivers comprised carbohydrate staples: corn, yam, gari, sorghum, cassava and rice. Sweet potato, mil/millet and wheat were also consumed occasionally. Cowpea, peanuts, and soy were also important sources of protein, in addition to meat, in the district. Children ate the same food as the adults. On the average, people ate two main meals a day (Table 2).

Variables	n (%)
Starchy foods	
Cassava	**236(94.40)**
Taro	1(0.40)
Plantain	2(0.80)
Yam	**249(99.60)**
Yam cossette	**249(99.60)**
Gari	**238(95.20)**
Sweet potato	164(65.60)
Cereals	
Corn	**250 (100)**
Mil/Millet	137 (54.80)
Sorghum	**247 (98.80)**
Wheat	85(34.00)
Local rice	250(100)
Imported rice	250 (100)
Pulses and nuts	
Cowpea	250 (100)
Peanuts	250 (100)
Palm nuts	36(14.40)
Cola nuts	17(6.80)
Shea nuts	32(12.8)
Soy	167(66.8)
Same foods consumed by adults and children 4-12 years	
Yes	250 (100)
Staples foods usually consumed by children 4-12 years	
Starchy foods	250 (100)
Cereals	239(95.60)
Pulses and nuts	238(95.20)

Table 2: Staples intake

Fruits Consumption and Production

As show in Table 3, fruits consumed by women's groups include mango, watermelon, cashew apple, banana, shea fruits, guava, and orange/Tangerine. With the exception of mangoes, watermelon and cashew apple, which were consumed by more than 50% of the respondents, all other fruits are consumed by less than 10% of the respondents, with 72% of respondents consuming fruits on daily basis. About 18.4% of the respondents indicated that they consumed fruits once a week. Eight percent (8%) of the respondents said they consumed fruits three times per week. Four respondents indicated that they consumed the fruits seasonally. Survey on fruit cultivation showed that the respondents grow mostly papaya (99.6%) in solar garden while their own farm is noted for growing local mangoes (89.2%), cashew apple (59.2%), and papaya (46%).

Variables	n (%)
Types of fruits cultivated in the solar garden	
Orange/Tangerine	1(0.40)
Pineapple	5(2.00)
Mango	6(2.40)
Avocado	15(6.00)
Pear	1(0.40)
Papaya	**249(99.60)**
Watermelon	2(0.80)
Coconut	1(0.40)
Guava	1(0.40)
Types of fruits cultivated in their own farm	
Banana	19(7.60)
Orange/Tangerine	5(2.00)
Pineapple	1(0.40)
Mango	**223(89.20)**
Avocado	1(0.40)
Papaya	**115(46.00)**
Coconut	1(0.40)
Guava	12(4.8)
Shea fruits	33(13.2)
Cashew apple	**148(59.2)**
Types of fruits consumed	
Banana	20(8.00)
Orange/Tangerine	6(2.4)
Pineapple	2(0.80)
Mango	**230(92.00)**
Pear	1(0.40)
Watermelon	**171(68.4)**
Coconut	1(0.40)
Guava	8(3.2)
Shea fruits	12(4.8)
Cashew apple	**140(56.00)**
Frequency of consumption of fruits	
Daily	180(72.00)
Once per week	46(18.40)
Tree times per week	20(8.00)
Seasonally	4(1.60)

Table 3: Fruits produced and consumed by mothers/caregivers of children 4-12 years

Vegetable Consumption and Production

In Table 4, over 90% of the respondents consumed okra, onions, pepper, wario; 82-85% consumed Moringa and sorrel of Guinea, 64-75% consumed tomatoes, amaranths, and leafy eggplant, 44% consumed sesame leaves whilst 20-26% consumed lettuce, carrots, and cabbage. With the frequency of consumption, 89.2% ate vegetables on daily basis, whilst 2% ate them once a week; 8.8% ate vegetables 3 times a week. As for vegetables production in Table 5, except of waterleaf, cassava leaves as well as krin krin and basil that are cultivated by less than 5% of respondents, all the other vegetables are cultivated by more than 50% of respondents in the solar garden. Similar results were observed in their own farm, however the percentage of respondents who grow vegetables were higher in the solar garden: onions 26.8 vs. 83.2% and lettuce 4.8 vs. 64.8%.

Discussions

Results from this survey on the consumption pattern of F&V in Kalalé district of northern Benin revealed the number of women producing vegetables was higher in the solar garden compared with their own farm, suggesting that SMGs can increase access to fresh, culturally acceptable produce [19]. The participation to SMGs was also associated with increased diversity of vegetables produced as observed by Birdi *et al*. in India [20]. Stuetz in 2019 [9] even highlighted the potential importance of gardens to improve anemia and micronutrients status. Indeed, inadequate consumption of micronutrient-dense foods such as F&V are an important contributing cause for anemia, ID and VAD [21,22]. Papaya, mango, bananas, cashew fruits, shea fruits, green leafy vegetables, onions, and okra are good sources of micronutrients [23]. Therefore, increased their production provides the participating households with direct access to required nutrient that otherwise may not be readily available or within their economical means [23,24], which may result in greater consumption [25].

Variables	n (%)
Types of vegetables consumed	110 (44.00)
Sesame leaves	**232(92.8)**
Wario	**248(99.2)**
Okra	**246(98.4)**
Onions	186(74.4)
Tomatoes	162(64.8)
Amaranths	11(4.4)
Cassava leaves	**212(84.8)**
Moringa leaves	**206(82.4)**
Sorrel of Guinea	162(64.8)
Eggplant	**245(98.00)**
Hot pepper	64(25.6)
Lettuce	64(25.6)
Carrots	58(23.2)
Cabbage	4(1.6)
Others (krin krin/basil)	
Frequency of daily vegetables consumption	
Sesame leaves (n=110)	53(48.18)
Wario (n=232)	92(39.66)
Okra (n=248)	52(20.97)
Onions (n=246)	222(90.24)
Tomatoes (n=186)	18(9.68)
Amaranths (n=162)	8(4.94)
Cassava leaves (n=11)	3(27.27)
Moringa leaves (n=212)	61(28.77)
Sorrel of Guinea (n=202)	15(7.28)
Eggplant (n=162)	6(3.70)
Red pepper (n=245)	242(98.78)
Lettuce (n=64)	5(7.81)
Carrots (n=64)	2(3.13)
Cabbage (n=58)	2(3.45)
Others (krin krin/basil) (n=4)	1(25.00)
Frequency of consumption of vegetables	223(89.20)
Daily	5(2.00)
Once per week	22(8.80)
3 times per week	

Table 4: Vegetables consumed by mothers/caregivers of children 4-12 years

Variables	n (%)
Types of vegetables grown in the solar garden	
Sesame leaves	**136(54.40)**
Wario	**224(89.60)**
Okra	**249(99.60)**
Onions	**208(83.20)**
Tomatoes	**218(87.20)**
Amaranths	**224(89.60)**
Waterleaf	1(0.40)
Cassava leaves	8(3.20)
Moringa leaves	**229(91.60)**
Sorrel of Guinea	167(66.80)
Eggplant	**219(87.60)**
Chili pepper	**246(98.40)**
Lettuce	162(64.80)
Carrots	**231(92.40)**
Cabbage	**220(88.00)**
Others (krin krin/basil)	5 (2.00)
Types of vegetables grown in their own farm	
Sesame leaves	98(39.20)
Wario	**185(74.00)**
Okra	**247(98.80)**
Onions	67(26.80)
Tomatoes	**183(73.20)**
Amaranths	**162(64.80)**
Leaf of water	1(0.40)
Cassava leaves	13(5.20)
Moringa leaves	62(24.80)
Sorrel of Guinea	**212(84.80)**
Eggplant	**195(78.00)**
Chili pepper	**241(96.40)**
Lettuce	12(4.80)
Carrots	9(3.60)
Cabbage	8(3.20)
Others (krin krin/basil)	4(1.6)

Table 5: Vegetables produced by mothers/caregivers of children 4-12 years

However, based on consumption patterns, although different types of F&V were produced by women's groups, the frequency of daily consumption was low, suggesting that F&V are often sold for income and not kept for household consumption as reported in Mozambique [26]. The low consumption of fruits can also be explained by their seasonal availability. Further research is thus needed to better understand how gardening can increase F&V consumption to close the nutrient consumption gap. Several studies point to gardens as a means of educating the community about healthy eating. Laird *et al* [27] found that garden-based nutrition education increased F&V consumption. However, combining health education (knowledge) with the mastery of skill attainment and reinforcement is crucial for helping people establish lifelong health habits and skills. This is of great national importance due to health concerns that results from current diets in Benin, which are based predominantly on starchy staples with few fresh fruits and vegetables [19,27,28].

We also found that the most frequently consumed vegetables were pepper and onions, followed by Moringa leaves, sesame leaves and okra. Similar results were observed in Ada-East district of the Greater Accra region in Ghana where dark green leafy vegetables and okra were the most frequently consumed vegetables asides tomatoes, onions and pepper [29]. Raju *et al.* [30] reported that fresh onions contain 16.9 mg beta-carotene/100g (Table 6). Pepper has 13.10 mg/100g [31]. Pepper and onions are consumed normally as part of all salty foods in the community, and are normally available for consumption during the cropping season in the district. However, onions and pepper are used as spices, so although they contain some level of β-carotene, they may contribute only negligible amounts to the diet of the people. M. oleifera has been reported to contain 18.9 mg β-carotene/100g dried leaves [32] whilst Glover-Amengor and Mensah [33] reported 31 mg/100g in dried leaves. Sesame also has 0.88 mg/100g of fresh weight [32] with okra containing 0.69 mg/100g [33]; thus, M. oleifera is potential sources of β-carotene for the district as observed by Glover-Amengor in Ghana.

	Vitamin A B carotene(mg)	**Vitamin C** Ascorbic acid (mg)	**Calcium** (mg)	**Iron** (mg)	**Potassium** (mg)	**Protein** (g)
Fruits						
Mango	3.2	60	11	0.16	168	0.8
Cashew, raw	0	0.5	37	6.7	660	18.2
Banana,	1	14	0	0.26	358	1.1
Guava	0.31	228.3	18	0.26	417	2.55
Vegetables						
Fresh M. oleifera leaves	6.8	220	440	7	259	6.7
M. oleifera leaves powder	18.9	17.3	2003	28.2	1324	27.1
Pepper	13.1	134	1	1	175	0.9
Onions	16.9	7.4	23	0.21	146	1.1
Sesames leaves	0.88	43	23	9	0	0
Okra	0.69	23	82	0.62	299	1.9

*per 100g of edible portion from US Department of Agriculture Database and [31-35]

Table 6: Nutrient content of M. oleifera leaves and mangoes compared to commons foods*

As for fruits consumption patterns, mango is the fruit that could be promoted in SMGs to increase vitamin A consumption. About 89% of the participants consumed mango, which has 3.21mg β-carotene per 100g of fresh weight [34]. Drammeh *et al.* [35] found that a combination of dried mangoes with a source of fat could be used to help improve vitamin A status of children in LMICs where there is a severe seasonal shortage of carotenoid-rich foods. As with mango, 59% of households consumed cashew apples. Cashew could provide 51% daily value of dietary iron. However, nuts played an important role in diets of many cultures and civilizations for centuries due to their high energy and nutritional value. Furthermore, to date, very little research was conducted on cashews [36]. In comparison to mango and cashew apple, the number of women consuming banana, guava or shea fruits are much lower. However, fortification of these foods would significantly contribute to filling the gaps in current micronutrients intakes, especially if it is implemented in combination with other interventions, such as dietary diversification and supplementation.

There are some limitations in the present study. First, like all self-reported data, survey responses might be subject to social desirability bias, in which respondent reports are influenced by norms about the most socially acceptable response to survey questions. Second, F&V consumption assessed only in three short separate questions may cause the under or overestimation of intake. However, this tool was validated in a sample group from another village, which had the same characteristics as the participating women. These limitations notwithstanding the present study also have strengths. This study identified F&V that could be promoted in the district for improving children vitamin A status. In addition, the results of this study can be useful to design intervention to promote fruit and vegetable consumption among this target group.

Conclusion

In sum, growing Moringa and mangoes are potential sources of β-carotene to promote in Kalalé district of Northern Benin since mango production is seasonal (two seasons per year) and M. oleifera is a perennial crop that can serve as a stable source for dietary vitamin A. They are already grown in the district and hence its promotion could help reduce VAD. In addition, Moringa oleifera leaves are rich in

iron and other essential nutrients, thus they can simultaneously help decrease the high prevalence of anemia in the district [37]. However, nutrition educational messages should include behavior change campaigns that will make the women see the need for consuming F&V on daily basis. Innovations in food processing could be to fortify snacks and convenience foods with M. oleifera leaf powder [38]. A possible intervention to assist in improving nutrition status of children in the study area will be to combine SMGs with food fortification programs, which will simultaneously address F&V availability, access, demand and use, especially among poor rural households vulnerable to micronutrients deficiencies [39-41].

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