

Knowledge and knowledge sources on the importance of fruits for nutritional security are unaffected by deforestation status in Cameroon

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Summary

Introduction – The Congo basin forest is experiencing increasing rate of deforestation, and is prone to inconsistent food supply and sporadic food shortages with corresponding high levels of malnutrition. Maintenance or planting of fruit trees can help mitigate deforestation while supplying fruits for home consumption. However, data on rates of fruit consumption are lacking for many developing countries, including Cameroon. **Methods** – Through a household survey, we investigated awareness and sources of knowledge that determined the consumption of fruits from planted and wild trees, in areas experiencing different deforestation levels. **Results and discussion** – The results showed that deforestation levels had no impact on fruit intake in forest areas. Although the majority of households reported that fruits were eaten by all household members, that vitamins were important and that fruits were an important source of vitamins, most households were not aware of the necessity for a daily intake of fruits. On average, households said they needed fruits 2.4 ± 1.5 times per week. The consumption of wild fruits was widely practiced and was not considered a sign of poverty. However, adults regarded fruits largely as snacks for children or as a source of income. Mouldy and blemished fruits were reserved for home consumption while healthy ones were sold. **Conclusion and recommendations** – These fruit consumption patterns suggest that present efforts to fight undernourishment may be undermined by poor fruit consumption practices. Thus, there is a need for sensitisation of households in Cameroon on fruit consumption to promote improved health outcomes in the Congo basin area.

Keywords

humid forest area, deforestation, food security, frequency of fruit consumption, household, information

Introduction

Curbing undernourishment is a significant global development challenge, especially in sub-Saharan Africa (Vicenti *et al.*, 2013; Arnold *et al.*, 2011; Goenster *et al.*, 2011). Central Africa, in particular, is regarded as a region where un-

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Significance of this study

What is already known on this subject?

- Despite its rich ecosystem, people in the Congo basin area are amongst the poorest and most affected by food insecurity and malnutrition. Since 2003, people are being sensitized and advised to consume 400 g of fruits and vegetables each day for the alleviation of several micronutrient deficiencies and a healthier life. Horticultural research has promoted the production and consumption of fruits in many areas.

What are the new findings?

- Most households were not aware of the necessity of a daily intake of fruits and said they required fruits 2.4 ± 1.5 times per week. Mouldy and blemished fruits were reserved for home consumption while healthy ones were sold, posing a danger to human health.

What is the expected impact on horticulture?

- The study is important to articulate the role of the horticultural sector in contributing to food and nutrition security and human wellbeing amongst forest adjacent populations of the humid forest area in Cameroon. Results have revealed a high level of ignorance on the importance and frequency of fruit consumption irrespective of people's location. This re-echoes that fruit availability does not guarantee fruit consumption amongst forest dwellers. Thus, to create impact, using more robust tools and approaches, horticultural research needs to increase sensitisation and information sharing on the importance of fruit consumption amongst forest people.

der-nourishment will continue to rise in the next decade (FAO *et al.*, 2015), as a consequence of both insecure food supply as well as imbalanced diets. Fruit can serve as a nutritional safety net in the diet when staple crops are scarce and households are vulnerable to food shortages (Cruz-Garcia and Price, 2012; Paumgarten and Shackleton, 2011). Fruit trees (FT) are particularly advantageous given that they are perennial and can contribute to fruit supply over several decades and at the same time help in environmental conservation, carbon storage and soil fertility (Tee *et al.*, 2009; Degrande *et al.*, 2006; Ambe, 2001; Duguma *et al.*, 2001).

Many studies have reported the diversity of wild and planted FTs and their contribution to rural diets and econ-

omies (Luczaj *et al.*, 2013; Vicenti *et al.*, 2013; Matig *et al.*, 2006; Ruel *et al.*, 2005). In Cameroon, Ingram and Schure (2010) reviewed the use of non-timber forest products (NTFPs) and reported a wide range of FTs to be useful in household food security. Additionally, through a socioeconomic and ecological assessment, Van Dijk (1999) distinguished as many as 39 species producing edible fruit in the Bipindi-Akom II region of Cameroon, whilst Matig *et al.* (2006) inventoried and classified 74 edible species in the forest areas of Cameroon. These corroborate findings elsewhere, such as in Benin, where Assogbadjo *et al.* (2013) inventoried 43 fruit species in farmer agroforestry systems. In the drier savannas, Shackleton *et al.* (2008) inventoried 45 indigenous and 83 exotic species of trees in home gardens of six villages in South Africa and 57% were used primarily for fruits. According to Cruz-Garcia and Price (2012), of 87 wild food plants inventoried amongst rice farmers in Thailand, 39% were used for fruits. The study of wild food plants use in Belarus by Luczaj *et al.* (2013) is particularly interesting because they used the same questionnaire that was first used in 1883 and so could track changes through time. Of the 58 edible plant species on the list from the 19th century, only 32 species were mentioned to be used in the 20th and 21st centuries (a 45% reduction), but with 98 new plants being added, used mainly as children's snacks or exotic species of fruit. This suggests a decline in use or knowledge of many local species and replacement with exotic species.

Globally, the consumption of wild and home-grown fruit is gaining recognition on the international agenda around food security (Ruel *et al.*, 2005). First, in 2008, the *Fruit Journal* dedicated a special issue to underutilised fruits and presenting an inventory of indigenous species and characterisation of species for 'improvement' (Jaenicke, 2008). Later, in 2011, the editorial of the *International Forestry Review* Vol. 13(3), emphasised the importance of forest foods dominated by fruit, which are particularly important in coping with seasonal and transitory food shortages due to drought, illness or other external shocks. Furthermore, the editorial of the *Fruit Journal* 2013, Vol. 68, 1–2 (Ganry, 2013) stressed that fruit and vegetables have been recognised by WHO and FAO as important components of healthy diets. However, the sources of information on fruits were scarce and are often limited to traditional communication channels. Thus, it is necessary to design improved strategies to share information on FT propagation, management and sound fruit consumption and processing practices within local communities (Leakey, 2012). Shackleton and Shackleton (2012) recommended that in poor regions, more effort should be made to make available cheap and reliable sources of micronutrients, especially for poverty-afflicted and vulnerable groups, especially, women and children.

A fruit and vegetable intake of 400 g per person per day is recommended for the prevention of chronic diseases as well as in the prevention and alleviation of several micronutrient deficiencies (Ganry, 2013; Grutzmacher and Gross, 2011; WCRF/AIRC, 2007; WHO, 2003). Ganry (2013) reported that individuals with limited consumption of fruit and vegetables have a greater the risk of chronic disease. Thus, increasing consumer awareness of the recommended daily intake of fruit for good health is a priority (Ganry, 2009; Beydoun and Wang, 2008; Braun and Venter, 2008). This is because knowledge of fruit availability, accessibility, and the recommended intake would in part determine an individual's ability to assess the adequacy of their current intake (Beydoun and Wang, 2008; Jaenicke, 2008; Blanchette and Brug, 2005).

However, it is not just the quantity consumed because the vitamin and micronutrient content varies between species. For example, in a review of wild fruits by Stadlmayr *et al.* (2013), the highest vitamin C contents were found in *Adansonia digitata* (237 mg 100 g⁻¹), *Sclerocarya birrea* (167 mg 100 g⁻¹) and *Irvingia gabonensis* (56 mg 100 g⁻¹), whereas the other fruit species contained only about 3–25 mg 100 g⁻¹. Additionally, while ripe and raw bush butter/African pear pulp, (*Dacryodes edulis*) had a mean fat content of 21%, the fat content of the other listed species was below 1%. It is therefore advised to consume a variety of different fruits (Stadlmayr *et al.*, 2013; Van Wyk, 2005). Wild harvested fruits provide necessary minerals and vitamins (Vicenti *et al.*, 2013; Arnold *et al.*, 2011) especially to children who pick them when playing outside (Maseko *et al.*, 2017; Jaenicke, 2008) and gatherers who eat them while in the forest (Levang *et al.*, 2015), as well as urban foragers and dwellers (Shackleton *et al.*, 2017; Kaoma and Shackleton, 2015). Thus, activities to promote fruit consumption also need to focus on diversifying the variety of fruit consumed. This could be aided by increasing access to fruit markets and through processing into different products or dried fruit so they are available throughout the year (Trefry *et al.*, 2014).

Fruit can be eaten fresh or in preserved form, such as dried, canned and jams and juices (Van Wyk, 2005). Poor households and those in remote areas do not usually have access to fruit processing techniques and equipment (Trefry *et al.*, 2014; Banwat *et al.*, 2012; Edoum *et al.*, 2011). They also often have limited access to markets, and even when they do, many lack the financial resources to purchase fruit (Kehlenbecket *et al.*, 2013; Ganry, 2009). In Cameroon, Edoum *et al.* (2011) demonstrated that most fruit processing industries use gas for drying and have very small capacities that can contain only 50 kg of wet fruit and have a long drying time of up to 10 hours. This compels in-season patterns of fruit consumption which limits the frequency and quantity of fruit consumption among vulnerable groups. Thus, people tend to eat more fruits when they are available in the home or farms (Arnold *et al.*, 2011; Gregory *et al.*, 2005), leading to inconsistent intake throughout the year. Most food consumption studies in central Africa, including Cameroon, mention fruit in passing, and, even when included, it is usually oil-palm fruit (Georgius *et al.*, 1993). Several studies (Ingram and Schure, 2010; Ndikumagenge and Ngome-Tata, 2009; Matig, 2006; Van Dijk, 1999) have listed the fruit species available, with some limited information on their nutritional value, but none have investigated fruit consumption patterns, frequency and quantities harvested or purchased and consumed by households. The report of the Cameroon Forum on Nutrition (2011) entitled "Nutrition and public health in Cameroon: combating the crisis" mentioned the word 'fruit' only seven times (Tanya *et al.*, 2011). The discussions during this forum centred on evaluating malnutrition in Cameroon and its associated problems and diseases (heart disease, cancer, diabetes and obesity, *etc.*), amongst different groups (infants, children, active adults, vulnerable groups, and older people). In the report, it was clear that in the forest zone of Cameroon, the diet is monotonous and dominated by starchy foods. However, no empirical data were presented or work reported on the importance and frequency of fruit consumption by local people to supplement and diversify their diets. Thus, even at the expert and decision-making level, there is a need for sensitisation on the importance of monitoring and data on the levels of fruit consumption. Germaine *et al.* (2011) reported that in Cameroon, information on nutritional habits is

limited and suggested that research is needed to determine the level of consumption of specific food groups to better address and target malnutrition concerns.

The lack of food and nutrient consumption information not only constrains any national or local assessments of dietary adequacy, but undermines the ability to monitor changes, either in the response to policy interventions or to external drivers of change. Currently a significant driver of land uses and access to NTFPs in Cameroon is deforestation (de Wasseige *et al.*, 2014; FAO, 2014). Although little studied, the forest transition potentially has considerable implications for the availability of NTFPs such as wild fruits (Gillet *et al.*, 2016) and hence local diets and nutrient intakes as forests are cleared for crops, frequently swapping nutrient-rich foods for carbohydrate-rich ones. Indeed, Ickowitz *et al.* (2014) concluded, based on national levels surveys that there is a strong positive relationship between tree cover and dietary diversity, as well as with fruit and vegetable consumption. Similarly, in Malawi, Maseko *et al.* (2017) showed a lower diversity of wild species in children's diets at sites with low tree cover. Thus, it is important to assess awareness

and practices in the face of deforestation pressures with the aim of mitigating any decline in dietary diversity and food security.

Within the context of the above, we sought to investigate local factors that determine access to and consumption of fruits from planted and wild trees within zones of differing deforestation levels. The objective was to investigate households' awareness on the importance of fruit consumption. Specific aims were to (1) determine fruit consumption patterns, (2) assess knowledge on the importance of fruit consumption, and (3) investigate the awareness of the internationally recommended norms regarding the required frequency of fruit consumption.

Methodology

The study sites

This study was located in a forested area of the Humid Forest Zone (HFZ) of Cameroon. This supposes that the use of foods and fruit from trees may differ from one area to another depending on the level of change in the forest

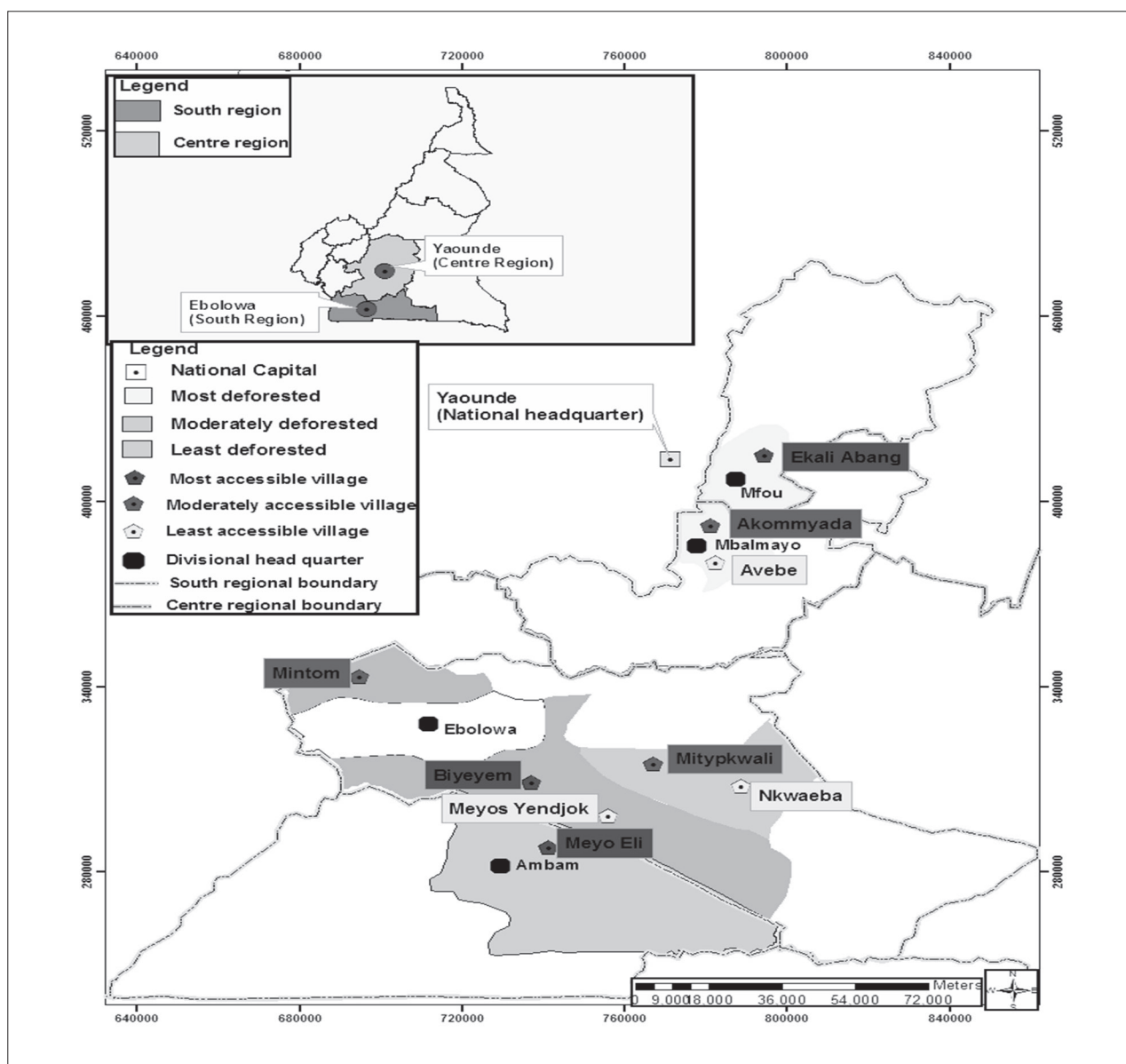


FIGURE 1. Location of study villages (Source Tata Ngome, 2016).

area and/or the level of agricultural development and prevailing agroforestry system. Thus, the axis of vulnerability/stability was the deforestation gradient, which indicated the location of a household per level of forest cover. Robiglio *et al.* (2010) note that “deforestation is not a uniform process and depending on the way in which the direct and underlying factors that control land use change dynamics combine in a specific locality or region, dramatically different trends can be observed”. Accordingly, in this study, deforestation gradients were examined at two levels-between villages and at the level of the humid forest area following the north south direction as in Figure 1.

A two-stage stratified random sampling procedure was used for selecting deforestation zones and villages. At the first stage of the sampling, three levels of deforestation were established using results from Robiglio *et al.* (2010) on deforestation and forest degradation in the humid tropics forest areas in Cameroon (Figure 1).

The first stratum was the most deforested zone, which due to infrastructural development, population growth and urbanisation, has lost most of its forest. Here the canopy cover was less than 30% and old growth forest cover was less than 10%. The second stratum was the moderately deforested zone in which the forest is fast disappearing, although it still contains some patches of forest with average canopy cover of $\pm 50\%$ and old growth forest cover around 30%. Finally, was the least deforested zone with canopy cover of $\pm 70\%$ and old growth forest cover of more than 50%. Because this site still contains much forest, there are active forestry activities like logging companies and forest management operations going on there (Levang *et al.*, 2015). The study area starts from around the capital city of Cameroon in Yaounde in the Centre region. This is the most deforested area. It passes through Ebolowa, the capital city of the South region which is moderately deforested zone and runs down to the Biwong-Bulu sub-division that is still forested with the presence of timber exploitation companies like “Fabrique camerounaise de parquets (FIPCAM)”, located also in the South region (Levang *et al.*, 2015). This is the least deforested area.

Sampling approach and data collection

This study was carried as part of a Ph.D. research work during the period of July 2013 to September 2014. Ballot-

ing following a combination of stratified and clustered sampling approach (Bryman, 2012) was conducted to choose the households for the study. The sampling considered first location of households in the village and also social status of households in case they faced some specific difficulties. An information meeting was organised at the beginning of field work during which a list was prepared of the households that participated in the meeting by their location of residence in the village. Later on, with the help of key informants, other households that indicated their interest to take part in the study, but who were absent, were also registered and the female-headed households and households with distinctive difficulties were identified. In each case there were a maximum of five households in such a situation and therefore all such households were automatically retained for the interview. The rest of the households were drawn from a total of 50–120 households that were registered in each village. We registered households following their residential areas to take account of the residential area in doing the balloting, so that households from all parts of the village were to be represented in the draws. In case a household refused to take part in an interview, the next available household in the same residential area was interviewed. The questionnaire was modified to suit the local context in Cameroon from a similar one that was implemented in Kenya by ICRAF in 2013 (Table 1).

The questionnaire had two sections with both closed- and open-ended questions. Section one considered the profile of the respondent and his/her household (such as age, gender, education, and household size). Section two covered aspects relating to: (i) knowledge and perceptions on fruit consumption frequencies, (ii) fruit consumption by vulnerable groups, and (iii) the awareness on the importance of fruit consumption. Likert scale items (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree) were used to measure respondents’ attitudes to particular statements regarding fruit consumption, wild fruit harvesting and impressions of purchased and harvested fruits.

The questionnaire was pilot tested and corrections made. The corrected questionnaire was then tested before being adopted. Data were collected from 141 households across nine villages spanning three levels of deforestation. In the most deforested zone, the villages were Akomnyada, Awebe, Abang/Ekali (17, 17, and 15 households, respectively). In

TABLE 1. Variables recorded via the household questionnaire.

Group of variables	Aspects being investigated
Village/accessibility; Deforestation	Location of household (HH)
Age of respondent, Sex of respondent, Type of household, Marital status, Level of education of hh head, hh size, No. of children under two years of age, Gender of hh head.	HH demographics
How do you eat this fruit? Who in the house consumes? How many times (in season) eaten? What quantity eaten? Fruits eaten by children under two years of age?	In season fruit consumption practices
How many times do you need fruit per week? Do you satisfy your fruit needs? If not, why? Are there people who should not eat much fruit? Do you wish to eat fruit daily? If not, why not?	Perceptions of fruit intake and desired frequency of fruit consumption
Have heard about vitamins? Do you know why vitamins are important? If yes, why? Do you know vitamin C rich-fruit? List the vitamin C rich-fruit you know. Do you know vitamin A rich-fruit? List the Vitamin A rich-fruit you know.	Awareness on the nutritive value of fruit and the importance of fruit consumption
Do household members harvest wild fruit? Did you sell these fruit? Do you eat these fruit? Are you ashamed when people see you eating wild fruits? If I had more money, I will not eat wild fruit.	Harvesting and use of wild fruit
Household declaration on fruit.	Perception on fruit sources and the use of fruits from various sources
Source of information on FT production.	Perspectives <i>vis a vis</i> increasing fruit consumption in rural areas
Best way to share information on FT activities.	

the moderately deforested zone, the villages were Biyeyem, Mbong/Mintom and Meyos Yedjock (15, 14, and 18 households, respectively) and for the least deforested zone the villages were Meyo Elie, Mitypkwali, and Nkpwaeba (15 households per village). A household was considered as people living and eating together in one pot and in each household, information was provided by the mother or the person that cooks food, assisted by children when they were present.

Data analysis

Codes were generated for all open-ended questions. Data were captured in Excel and later transferred to SPSS 20.0 for analysis, including totalling of citations, Likert scale summaries, descriptive statistics, χ^2 -test, means and simple ANOVA between the deforestation zones. Correlation tests employing the Pearson coefficient were used to examine the relationship between two-by-two quantitative variables. Associations between selected qualitative variables were examined by means of χ^2 -test and Cramer's V.

Results

Awareness on the importance of fruits and recommended consumption frequency

Perceptions of and gaps in the recommended frequency of fruit consumption

Households' knowledge on the recommended frequency of fruit intake was assessed by asking them the number of times per week they think they should eat fruit and if they were able to satisfy this requirement. At all levels of deforestation, households said they should eat fruit between one and seven times a week. Almost half of the households (48%) said they needed fruit twice a week. Of the remainder, some said fruit should be consumed once per week (21%), three times per week (21%), four times (3.3%) and daily (7%). On average, households said they required fruit 2.4 ± 1.5 times per week (Table 2). However, there were significant differences between deforestation zones ($F = 3.28$, $p = 0.041$), with the highest frequency in the least deforested zone. The range was every 1–7 days for the most and least deforested zones but was 1–3 days for the moderately deforested zone. Most are consuming fruit at less than half the recommended frequency and less than one-fifth (18%) were able to satisfy their fruit needs. Only 7% knew that they needed fruit daily.

These results indicate that the respondents were either not aware of the recommended frequency of fruit consumption, or they are aware but are unable to fulfil the recommended requirement.

Households said they were unable to satisfy their weekly fruit needs due to a lack of resources (39%), insufficient production (33%), seasonal availability of fruit (5%), forgetfulness (4%) and in some cases it was not a habit (1%), while 18% did not provide a reason. This means that fruit consumption could be greatly influenced by enhanced availability and accessibility, as well as sensitising the communities on the recommended rate of fruit consumption.

To further verify respondents' knowledge of the daily requirements for fruit, households were asked if they needed fruit daily (Figure 2). Households that replied negatively were asked to give reasons. Whereas 72% said they needed fruit daily, 28% said they did not (Figure 2). The main reasons provided for not needing fruit daily was because fruits were seasonal (42%), there was insufficient production (20%) and a lack of resources (20%). There were no differences in the reasons offered across the deforestation zones ($\chi^2 = 2.55$, $p = 0.863$; Cramer's V = 0.096, $p = 0.863$). While all these reasons reflect problems of fruit availability and accessibility at the local level, they also depicted that although people said they were aware of the importance of fruits consumption, they were not fully conscious of the health benefits of fruits and the need for their regular intake.

Knowledge about vitamins and daily fruits consumption

Respondents were asked if they had heard about vitamins, if they knew why vitamins were important, and if they could name vitamin A and vitamin C rich fruits. In all, 93% of respondents said vitamins were important. First 29% they thought it was because they promote good vision/healthy growth and provide calcium and iron (15%), combat diseases (12%), ease digestion/reduce stress (8%), promote blood circulation (2%), impede illness/fortifies the body (3%), provide energy and good health (10%), while 15% of the respondents had no reason. Almost three-quarters (74%) said they could name vitamin C rich fruit, which included lemon (12%), lime, mandarin, guava, orange, pawpaw, palm nut (22%), orange (25%), orange, banana, mandarin, guava, mango, pawpaw, pineapple, and palm nuts (14%). Most respondents (61%) listed vitamin A rich fruits as lemon (16%), lime, mandarin, guava, orange, pawpaw, lemon, palm

TABLE 2. Number of times respondents reported they required fruits per week.

Deforestation zone	Do you satisfy your fruit needs	No. of times fruits were required per week			No. of households
		Mean \pm Std. Dev.	Range	% of households	
Most	No	2.5 \pm 1.5	1–7	30.3	37
	Yes	2.6 \pm 1.8	1–7	6.6	8
	Total	2.5 \pm 1.6	1–7	36.9	45
Moderate	No	1.9 \pm 0.8	1–3	27.0	33
	Yes	2.2 \pm 0.8	1–3	4.1	5
	Total	2.0 \pm 0.8	1–3	31.1	38
Least	No	2.9 \pm 1.9	1–7	23.8	29
	Yes	2.5 \pm 1.7	1–7	8.2	10
	Total	2.8 \pm 1.8	1–7	32.0	39
Total	No	2.4 \pm 1.5	1–7	81.1	99
	Yes	2.5 \pm 1.5	1–7	18.9	23
	Total	2.4 \pm 1.5	1–7	100.0	122

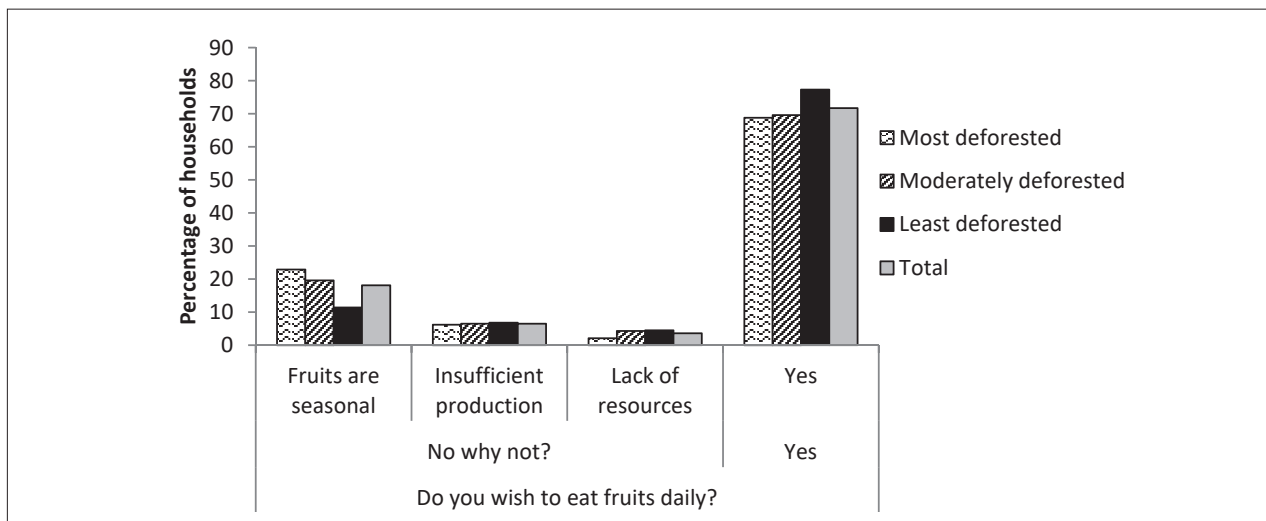


FIGURE 2. Reasons why households did not consume fruit daily.

nut (31%), orange (6%), orange, banana, mandarin, guava, mango, pawpaw, pineapple, and palm nuts (7%). This long list shows that farmers are aware that vitamins come from a variety of fruits, even though some of the listed ones were not particularly rich in vitamin A or C. Thus, it should be easy to promote fruit consumption by emphasising the importance of vitamins.

Awareness of the importance of fruit consumption by vulnerable groups

Most respondents (97%) reported that fruits were eaten by all household members. To assess awareness on the fruit consumption by different groups respondents were offered three statements and were requested to indicate their level of agreement using a Likert scale. The majority of respondents did not agree with the first statement, “fruits are good only for children”, with 28% disagreeing and 39% strongly disagreeing, 8% were uncertain and the remainder agreeing or strongly agreeing. The second statement was “some fruit are not good for children under two years of age”, for which 27% strongly agreed, 20% agreed, 19% disagreed, 17% strongly disagreed, and 26% were unsure. The third

statement was “some fruits are not good for pregnant women” with which 14% strongly agreed, 21% agreed, 16% disagreed, 19% strongly disagreed, while 30% were uncertain. There was no significant difference between deforestation zones (Figure 3) for any of the three statements (statement 1: $\chi^2=9.89$, $p=0.273$; Cramer’s $V=0.194$, $p=0.273$; statement 2: $\chi^2=1.21$, $p=0.19$; Cramer’s $V=0.205$, $p=0.19$, and statement 3: $\chi^2=6.919$, $p=0.545$; Cramer’s $V=0.16$, $p=0.545$).

These results confirm that most respondents were conscious of the importance of fruit for children and all household members. From the field discussions, some fruits were considered more suitable for children under the age of two, such as avocado (*Persea americana*), safou (*Dacryodes edulis*), oranges (*Citrus sinensis*) and banana (*Musa sp.*). Fruits like pawpaw, mango, grapefruit and most wild fruits were eaten by children less than two years in smaller quantities because, according to their mothers, consuming too much fruit could lead to diarrhoea. However, some people said that they did not give children fruit very often, due to scarcity and lack of money to buy fruit. Therefore, they gave children fruits when opportune from the farm or when they are able to buy. Others said that, even when they had money, it was

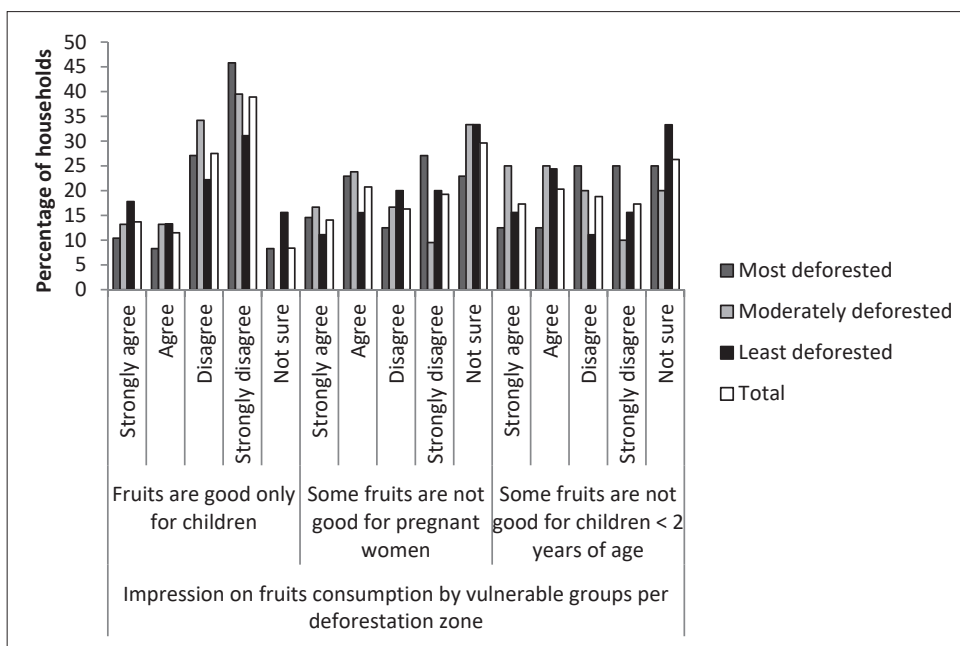


FIGURE 3. Impression of fruits consumption by vulnerable groups.

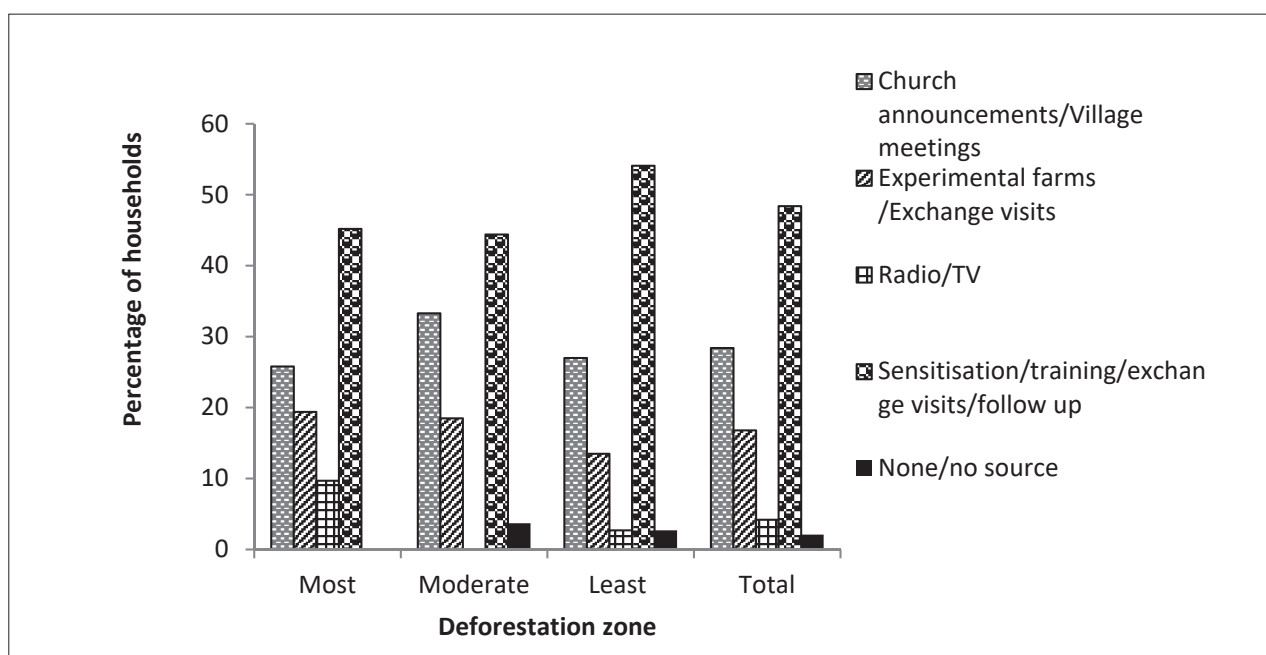


FIGURE 4. Respondents' suggestions regarding ways to share information about fruit trees in rural villages.

difficult to find fruit to buy in the villages. Thus, they only could buy fruits when they went to an urban centre.

Sources of information on fruit trees

We considered the sources of information and ways to share information about FTs. A high non-response rate was observed regarding sources of information on FTs (14%) and the best ways to share information on fruits (33%). This initially suggests the possibility of lack of information on FTs and a limited presence of agricultural extension programs in the communities. However, a wide variety of sources were used, with one-quarter (27%) stating that their primary source of information on fruit was through word of mouth, church announcements/village meetings (23%), experimental farms/exchange visits (19%), research institute (IRAD) (6%), radio/TV (8%), whilst 17% had no source although they accepted that they know how to get information on FTs. In contrast, respondents felt that the best way to share information on FT activities was through church announcements/village meetings (28%), experimental farms/exchange visits (17%), radio/TV (4%), and sensitisation/training/exchange visits/follow up (48%) while 2% of households had no suggestion (Figure 4). There was no difference between the ways to share information on FTs between deforestation zones ($\chi^2=5.71$, $p=0.679$; Cramer's $V=0.173$, $p=0.679$).

Discussion

Knowledge on awareness on fruit consumption was low

The present and desired frequency of fruit consumption by the respondents was well below the daily requirement as recommended by the WHO (WCRF/AIRC, 2007; WHO, 2003), indicating constrained knowledge in this regard. However, there was high knowledge on the importance of fruits for micronutrients, vitamins and health. Additionally, processing of fruits was limited (Edoum *et al.*, 2011) which obliged people to rely on the seasonal availability of fruit supply.

Households agreed that fruits were suitable for pregnant women and children under the age of two, although they noted that some specific fruits should not be eaten by these

groups. This means that culturally, people were aware of some dangers that might occur from excessive consumption of some fruit species, as also reported by Van Wyk (2005). Dindyal and Dindyal (2003) reported how personal factors, including culture and ethnicity, affect the choices and selection of food. Therefore, it is necessary to appreciate and acknowledge the large impact of culture and ethnicity on food choices, eating styles and patterns to design appropriate and context specific education materials to help people adopt healthier dietary habits.

Informal and inconsistent information on fruit consumption

A daily intake of 400 g of fruit and vegetables per person per day is recommended (Ganry, 2013; Vicenti *et al.*, 2013; WHO, 2003). Given the low frequencies of consumption amongst the study participants is it unlikely that this recommendation is met by all but a few. Efforts to adequately address problems of malnutrition and micronutrient deficiency are constantly hindered by limited understanding on the availability, accessibility and utilisation of micronutrient rich foods like fruit (Ickowitz *et al.*, 2014; Motzke *et al.*, 2012; Tetry *et al.*, 2011; Dindyal and Dindyal, 2003). This could potentially be aggravated by environmental change, such as through deforestation, for which information on the relationship between fruit consumption, fruit diversity and deforestation is limited (Maseko *et al.*, 2017; Levang *et al.*, 2015; Ickowitz *et al.*, 2014; Robiglio *et al.*, 2010; Georgius *et al.*, 1993). However, this study has demonstrated that the sources of information on fruit do not vary with increasing deforestation and most households rely on informal information outlets such as church announcements and word of mouth.

It also shows that State supported sources of information on fruit and fruit consumption are absent or lack a profile. This corroborates the significant neglect of the importance of fruit consumption and its contribution to human health in Cameroon, as also noted by Germaine *et al.* (2011), who commented that data, monitoring and sensitisation on micronutrient deficiency was not a public health priority in Camer-

oon. Furthermore, the report on the national forum on nutrition showed that obesity has increased by 54% and 82% for women and men, respectively, in the rural areas of Cameroon and that obesity among school children aged 3 to 14 years was 16.2% (Tanya *et al.*, 2011). Yet, in proposing solutions, the report lacked any proposals related to fruit consumption (frequency and quantities) and other questions related to micronutrient deficiency. This is despite WHO and FAO estimates that globally 2.7 million lives per year could be saved through better nutrition with fruit and vegetables, emphasising that low fruit and vegetable consumption is among the top 10 selected mortality risk factors globally (WCRF/AIRC, 2007; WHO, 2003). Therefore, it is of paramount importance for the public health departments to embark on the promotion of and sensitisation on the importance of daily fruit consumption. Results from this study show that the rural villagers thought that the best ways to share FT information locally were through sensitisation/training/exchange visits/follow up, and church announcements/village meetings, and experimental farms/exchange visits. It is likely that a diversity of channels would be more successful than any single one.

Deforestation status had little influence on fruit consumption or knowledge

On the whole, deforestation status had no influence on fruit consumption and knowledge. Household perceptions of and gaps in the recommended frequency of fruit consumption did not differ with deforestation zone and only 7% knew that they needed fruit daily. The reasons for not needing fruits daily was the same across the deforestation zones, mainly being that fruits were seasonal. Looking at the range on the number of times respondents reported to need fruits per week, it was similar in the least and the high deforested zones but different for the moderately deforested zone. This paralleled the response patterns regarding the importance of vitamins wherein all households reported vitamins were important although they did not quite know the vitamin A and the vitamin C rich fruits. Moreover, people did not know at all levels that fruits were more important to vulnerable groups. Therefore, people gave children fruits when opportune from the farm or when they were able to buy.

Conclusion and recommendations

In this paper, the perceptions of and gaps in the recommended frequency of fruit consumption and rural people's knowledge on the importance of fruits was investigated. Data were collected through a structured questionnaire administered to 141 households in nine villages located at three levels of deforestation. Most variables did not differ with deforestation level. At all levels of deforestation, households said they should eat fruit between one and seven times a week. Almost half of the households (48%) said they needed fruit twice a week with a quarter saying fruits should be eaten once per week. These results show that people were uninformed about the recommended frequency of fruit consumption. This means that even when fruits were available, people in rural areas in Cameroon might not consume them.

Respondents were asked if they had heard about vitamins and if they knew why vitamins were important and if they could name vitamin A and vitamin C rich fruits. Most respondents said vitamins were important because they promote good vision/healthy growth, provided calcium and iron, combat diseases, ease digestion/reduce stress, promote blood circulation, impede illness/fortifies the body, provide energy and good health. However, most of them did not

know vitamin A and vitamin C rich fruits. This means that people are not aware of the nutrient value of each fruit and ate fruits blindly. On a positive note, people knew fruits were important for their health meaning it was easy to introduce programs to promote the consumption of fruits.

On the awareness of the importance of fruit consumption by vulnerable groups, most respondents were conscious of the importance of fruit for children and all household members. However, some people said that they did not give children fruit very often, due to scarcity and lack of money to buy fruit. Others said that, even when they had money, it was difficult to find fruit to buy in the villages. Thus, they only could buy fruits when they went to an urban centre. Finally, analysis on sources of information on fruit trees suggests the possibility of lack of information on FTs and a limited presence of agricultural extension programs in the communities. A majority of people stated that their primary source of information on fruit was through word of mouth, church announcements/village meetings, experimental farms/exchange visits, research institute (IRAD). This result brings some explanation on the high level of ignorance on the importance and frequency of fruits consumption. Therefore, the importance of fruits to overcome nutrient deficiency at all levels in forest areas may be undermined by poor consumption patterns even when fruits are available. This means that insufficient nutrient intake might prevail due to lack of information rather than due to lack of food. Thus, government and food security and nutrition programs need to introduce specific strategies on rural sensitisation on fruits consumption. In such a scheme, if properly managed, information can easily be disseminated in the whole forest area since word of mouth was an important form of information dissemination.

Compliance with ethical standards

Ethics approval was provided by Rhodes University. Village meetings were organised at the beginning of data collection so as to share the idea of the project with community members and present the research team. Participating households provided informed consent for the work.

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Conflict of interest

The authors declare that they have no conflict of interest.

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