



## **Nutrition in Transition: Current Dietary Trends around Forest Concessions of the Congo Basin**

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### **ABSTRACT**

The goal of this study was to understand the relationship between timber exploitation and changes in dietary patterns of communities adjoining forest concessions in the Congo Basin. About 724 households were randomly selected from thirty four communities living in six forest concessions of the Congo Basin. Food consumption pattern data was collected using a validated food-frequency questionnaire in 2012. Results showed that food consumption patterns varied across the selected communities: In the Democratic Republic of Congo a typical forest-agricultural dependent dietary pattern was noticed consisting of greater intake of corn, banana, caterpillars, bush meat, groundnuts, cassava leaves, wild fruits and lower consumption of processed food. A mixed pattern was noticed in Cameroon consisting of high consumption of cassava, banana, groundnuts, fresh fruits, wild fruits and low intake of bush meat, frozen meat, green leafy vegetables and fats. A westernized dietary pattern was noticed in Gabon characterized by greater intake of tubers such as cassava, coco yam, yam, banana, cassava leaves, moderate consumption of frozen meat, milk, eggs, tomatoes, and lesser intake of green leafy vegetables and fruits. Processed foods of high lipid content like margarine and butter in addition to protein rich cheese were found in the dietary profile of the Gabonese concessions. As observed in our study, nutrition transition is fastest in the forest concessions of Gabon, slow in those of Cameroon, and slowest in the forest concessions of the DRC.

**Keywords:** Dietary trends, forest concession, forest dietary profile, nutrition transition, Congo basin.

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## INTRODUCTION

The Congo basin is a rich natural heritage common to the central African countries: Cameroon, Gabon, the Central African Republic (CAR), the Democratic Republic of Congo (DRC), Equatorial Guinea and Congo. The forest of the Congo basin provides surrounding inhabitants with food, medicine, livelihood, and important services to the global population like habitat biodiversity, carbon storage, and water cycle regulation. The main activities of the indigenous population depending on the forest include hunting and wild harvest of NTFPs<sup>1</sup>. Intensive timber exploitation is very important and is managed by hundreds of foreign enterprises. The exploitation activities have both positive impacts like road construction and urbanization in general as well as negative impacts linked to over exploitation like reduction in ecosystem biodiversity. Changes in forest exploitation often result in dietary variation with both positive and negative repercussions. Adapting to new livelihood strategies, urbanization coupled to food commercialization, and changes in nutritional habits have led to considerable modifications in food intake and natural-resource-use patterns<sup>2</sup>. An extreme example of mal-adaptation to modernization is the difficulty of resettling former hunter-gatherer groups, such as the Baka and Kola Pygmies of Cameroon and the Tubu Punan of Borneo, which often leads to negative nutritional and epidemiological consequences<sup>3,4</sup>. The abandonment of forest based livelihoods and traditional food regimes in these groups has been associated with diets lower in protein and fiber, but higher in salt, milk and sugar - a shift often referred to as nutrition transition<sup>5</sup>. The nutrition transition currently occurring in Sub Saharan Africa is one facet of a more general demographic, nutritional, and epidemiological transition which accompanies development and urbanization. The nutrition transition itself is marked by a shift from relatively monotonous diets of varying dietary quality (based on indigenous staple grains or starchy roots, locally grown legumes, wild vegetables and fruits, and limited foods of animal origin) towards more varied diets that include more preprocessed food, more foods of animal origin, more added sugar and fat, and often more alcohol<sup>6</sup>. These trends have contributed to the dramatic emergence of obesity and associated non-communicable diseases (NCD). Nutrition transition is particularly prevalent among indigenous people, who tend to suffer higher rates of health disparities and lower life expectancy regardless of geographic location. Nutrition transition thus involves economic, demographic, dietary and epidemiological shifts, which are each affected by one another<sup>7</sup>. Dietary trends of communities in the forest concession of the Congo Basin are unknown. This study therefore seeks to examine the food consumption patterns and the contribution of non-

timber forest products (NTFPs) to household nutrition in 34 communities of some forest concessions of the Congo basin and to describe the major dietary shifts using a dietary survey approach.

## MATERIALS AND METHOD

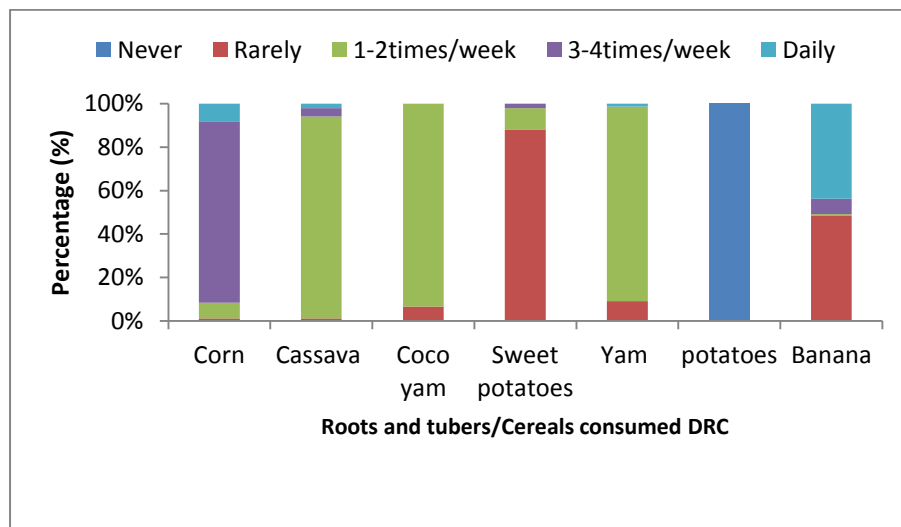
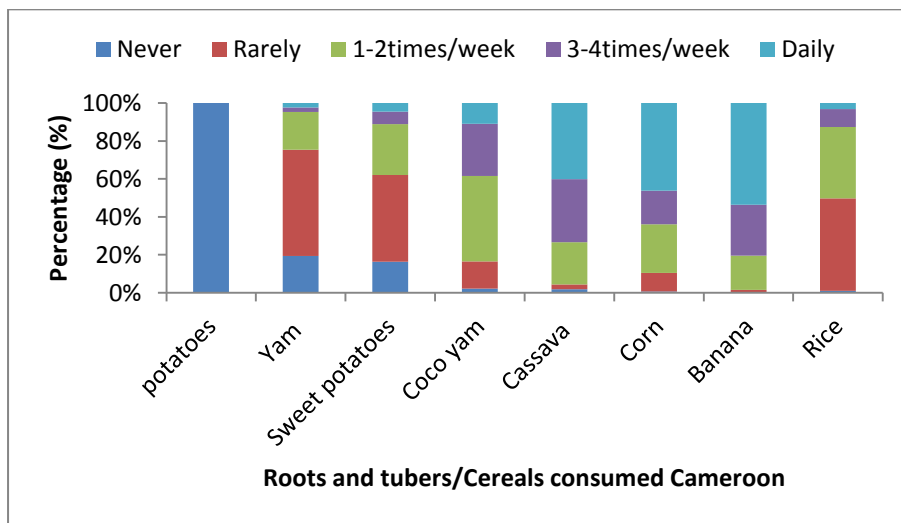
The survey was simultaneously conducted during the year 2012 in the forest concessions of three countries sharing the Congo basin. The survey design focused on the indigenes around forest concessions at the household level, whose occupational status fell in the category of farmer, trader or civil servant (especially teachers) with general information on household food consumption patterns (food types and frequency) targeted. The participating households were selected from 34 Communities in six forest concessions. In each community, 20 households were randomly selected and household heads supplied with a food frequency questionnaire following explanation of the structure of questions by the field supervisor and/or local partner. The food frequency questionnaire was used to assess consumption patterns of cereals, tubers, legumes, meat, fruits and alcohol. The introductory question “did you eat the following foods?” for example required that participants should answer yes for items consumed and no for items not consumed. If yes, then the second question required the consumption frequency of each food item separately (rated on a 5 point scale: daily, 3-4times/week, 1–2 times/week, rarely, and never). These 5 categories were collapsed into two categories: high frequency (daily & 3-4times/week) and low frequency (1-2times/week, rarely, & never).

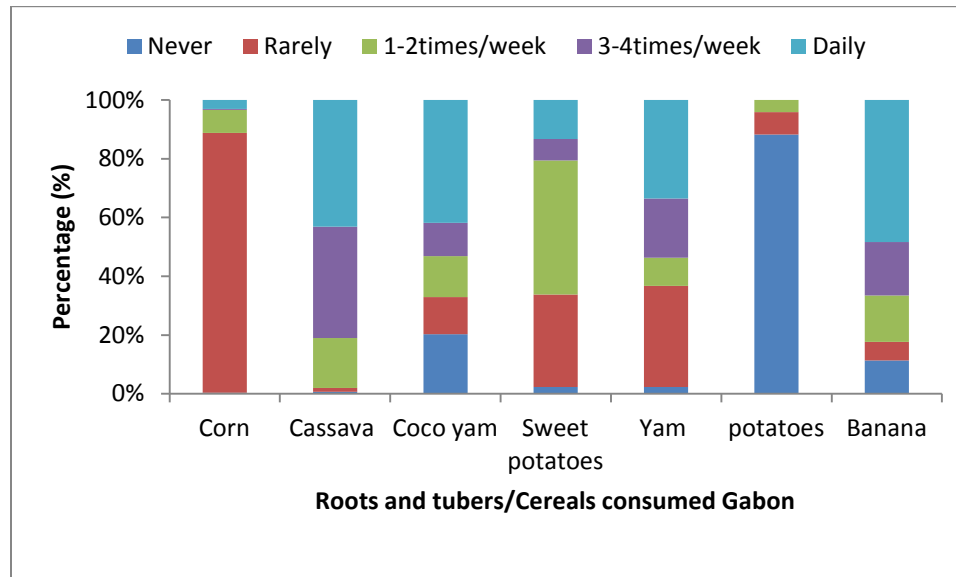
## RESULTS AND DISCUSSION

### **Carbohydrate Consumption Patterns at Country Level**

The results presented in Figure 1 indicate roots and tubers/cereal consumption in the different forest concessions at country level. It reveals that the roots and tubers; banana, cassava, cocoyam, sweet potato and yam were the main source of dietary carbohydrate for the considered population in the forest concessions of Cameroon. Except for Irish potato which was never consumed, banana and cassava were the most consumed with over 55% and 40% of the households respectively consuming these foods on daily basis. In addition to these roots and tubers, corn was also a major source of dietary energy for approximately 47% of households in the SCTB and FIPCAM forest concessions of Cameroon consumed on daily basis. The trend generated from carbohydrate intake patterns in the case of the DRC also has roots and tubers as the leading sources. Banana was the most consumed, satisfying the carbohydrate needs of close to half of the households while cassava, yam, and cocoyam appeared once-twice in the diet of

almost all the households. Sweet potatoes were consumed on rare terms in three quarters of the households while Irish potatoes did not figure at all in their food savings. Like in the case of Cameroon, corn as the major cereal completing energy requirements for people in the forest concessions of DRC was consumed everyday in one tenth and 3-4 times/week in over three quarters of the households. In Gabon, banana, cassava, cocoyam and yam were the main sources of dietary carbohydrate for a large population of the BAYONNE and CEB concessions. The proportion of the households that consumed these foods on daily basis was up to 35%. A larger part of the households rarely substituted these tubers with corn. Being the least consumed of the tubers, only about 15% of the households in the chosen forest concessions of Gabon included Irish potatoes in their diet on a 1-2 times/week or rare basis. On the other hand, sweet potatoes were common in almost all the investigated households.





**Figure 1: Household Consumption Frequency of Roots and Tubers/Cereals in Forest Concessions at Country Level**

### Trends in protein intake

The overall intake of milk and related pulse products contributing to the protein fraction in the diet of participating households in the different forest concessions of the countries varied (Figure 2). Milk and pulse product consumption in the SCTB and FIPCAM forest concessions of Cameroon was low. Though identified in the diet of almost all, only 50% of the households included groundnuts in their diet on a daily basis. A larger proportion of the households fulfilled their protein requirement from beans and milk though on rare occasions. Peas, Sesame, and soya were the least consumed. Minor contributors to the protein requirements of the people living in the forest concessions of the DRC included foods like groundnuts, soya, peas, beans, and milk. These foods rarely appeared in their diets except for a 3-4times weekly record of groundnuts in all the participating households. Most of the households ( $\approx 3/4$ ) in the BAYONNE and CEB concessions of Gabon recognized milk as the main protein food with intake occurring at least once to twice per week. The plant protein foods that figured in the meals of the households here were groundnuts and beans. These foods had very low consumption densities as only about one quarter and nine tenth of the households respectively consumed beans and groundnuts, mostly on rare occasions. Though a minor fraction of the households mentioned the consumption of peas on rare occasions, the depicted data basically reveals zero consumption of peas, soya and sesame.

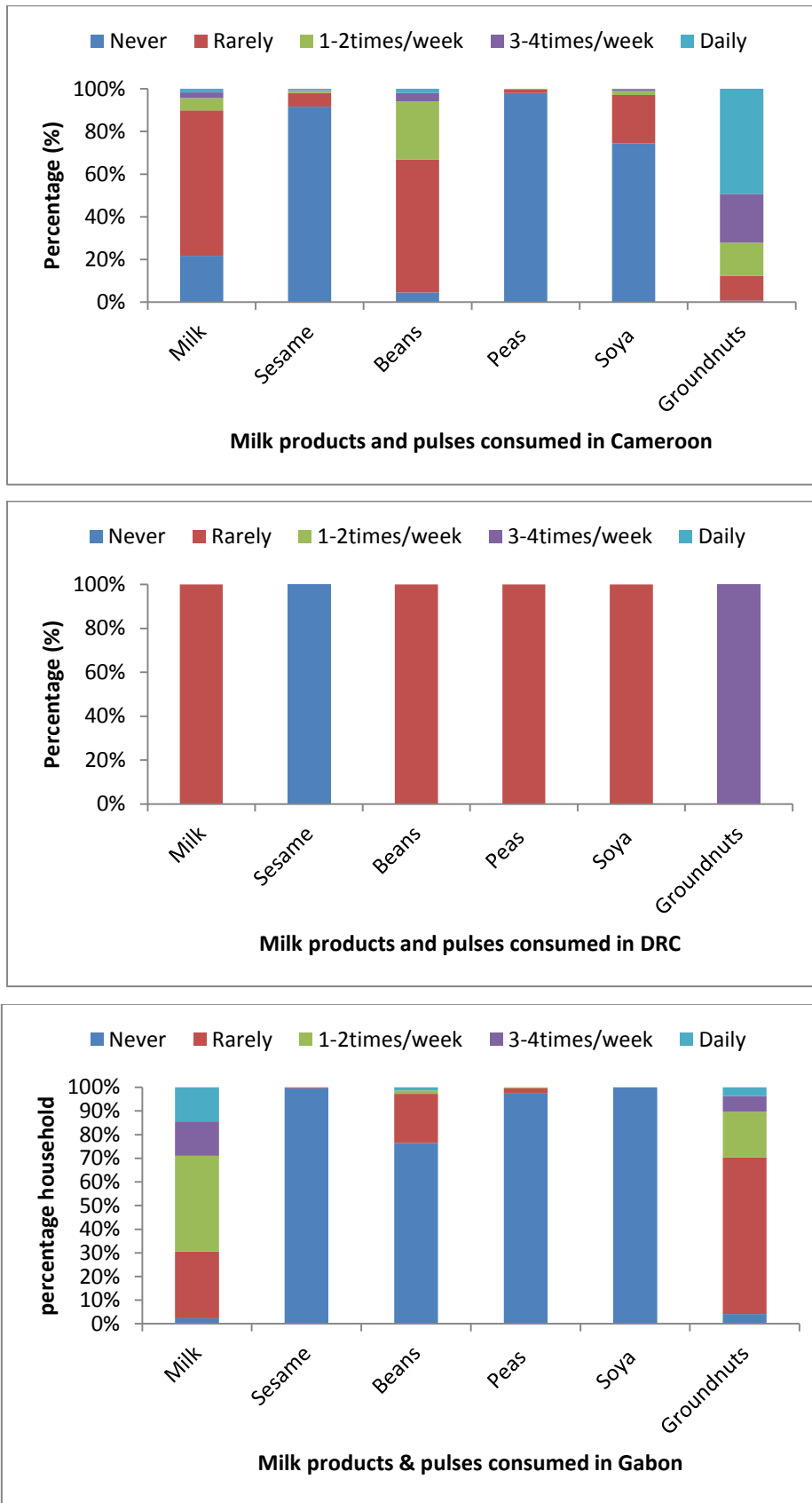
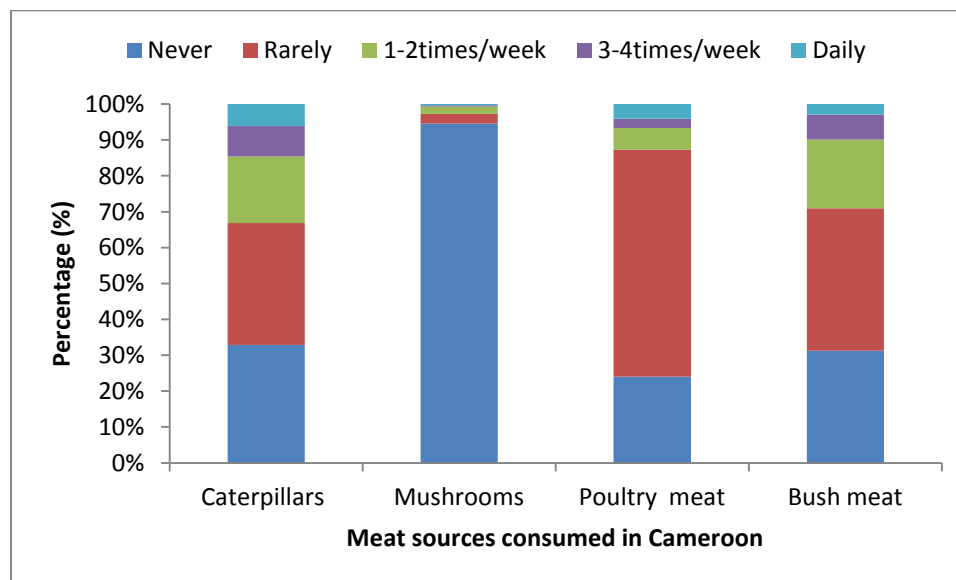
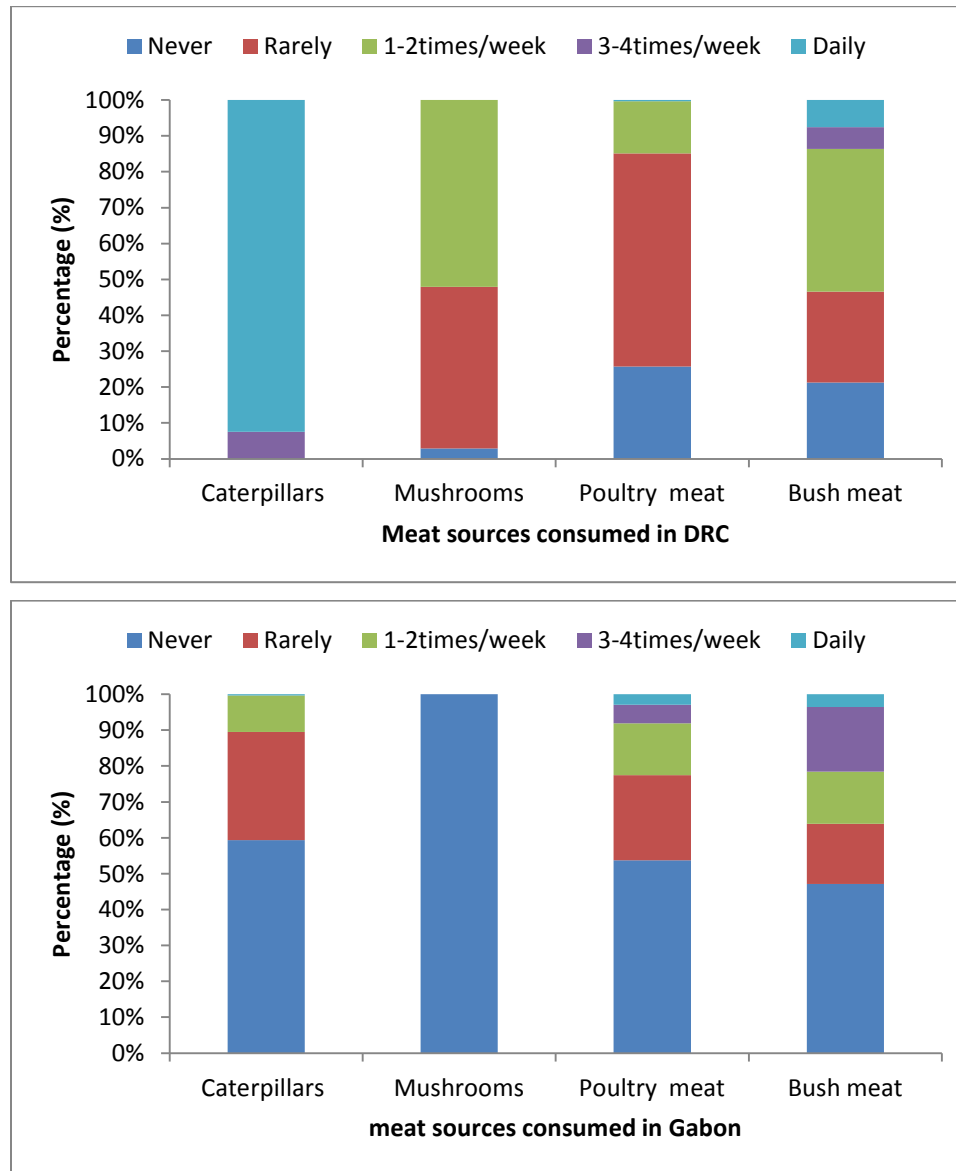


Figure 2(a): Household Consumption Frequency of Milk and Pulse Products in the Forest Concessions at Country Level

## Meat

The meat intake pattern as viewed in Figure 2b by households in the forest concessions were lowest for Gabon, low for Cameroon and moderately high for the DRC. In forest concessions of Cameroon, only 10% of the households were consuming any one form of meat on daily basis. Among the three most consumed forms of meat, poultry was ranked highest with approximately 64%, 7%, 2% and 4% of the households respectively including it in their diet on rare, 1-2times/week, 3-4times/week and on daily basis. Keeping consumption frequency constant, at least 70% and 68% of the households respectively had bush meat and caterpillars in their diet. Mushroom was totally not a source of protein for over 90% of the households as only about 5% consumed it at low frequency rate. Regarding the situation in the DRC, caterpillars, mushrooms, bush meat and chicken were the major sources of protein for the people living in the CFT and COTREFOR concessions. Caterpillar was a major component of their diet and was saved everyday in 95% of the households. Another protein source of interest consumed rarely and 1-2times/week in almost all the households in this zone was mushroom. Mushroom, though can be cultivated was mostly hunted from the wild. It is also worth to note that bush meat consumption rate was higher than that of chicken with close to one tenth of the households consuming bush meat on daily basis. Chicken was only consumed rarely, 1-2times per week or not at all. With respect to Gabon, Less than 5% of the households consumed bush meat and poultry meat on daily basis. In addition to poultry meat and bush meat consumed by approximately half of the population on weekly basis, 40% of households mention a rare intake of caterpillars. Mushroom as observed was not part of the diet of people in the BAYONNE and CEB concessions.





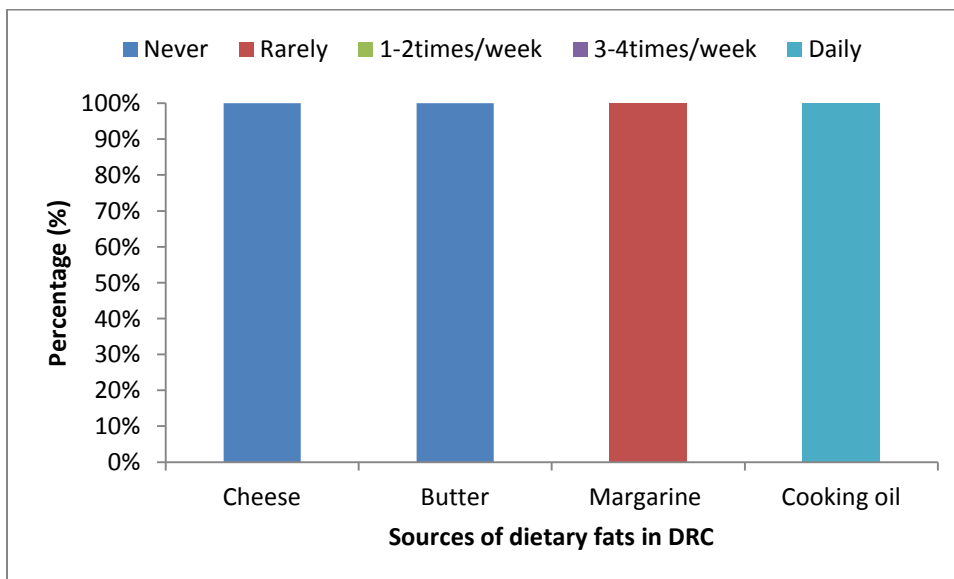
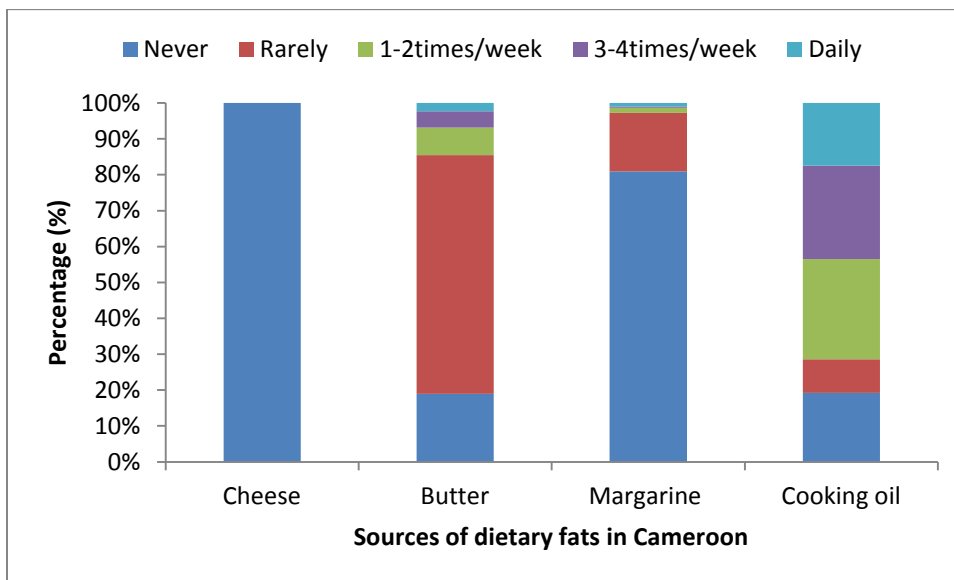
**Figure 2(b): Meat Consumption around Forest Concessions at Country Level**

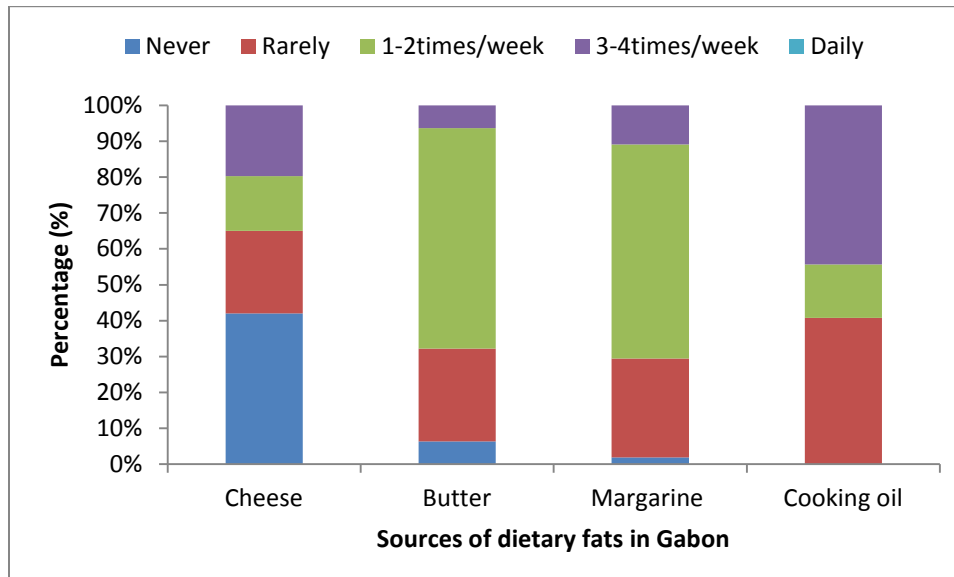
### Dietary fat consumption patterns

The intake of dietary fats for the forest concessions of the different countries differed remarkably (Figure 4). It was found that fats of different sources frequently featured in the nutrition of Gabonese, followed by Cameroon, but with very little fat substitution and finally by the concessions of the DRC who practically had no fat substitutes to palm oil (cooking oil). In Gabon, cheese, butter, margarine and cooking oil featured in the diet of close to 60% of the households. Cooking oil, margarine and butter had intensive consumption in almost all the households at rare and weekly frequencies. The consumption of cheese was common in over two thirds of the households with a 3-4times weekly intake in one fifth of the study population. In the selected forest concessions of Cameroon three main sources; cooking oil, butter, and margarine



in order of intense consumption were identified. Cooking oil was consumed by almost 20% of the households on daily basis compared to less than 1% and 2% for margarine and butter respectively. Although about 30% of the studied population used cooking oil at least once to twice per week, over 65% of the households were consuming butter occasionally. It is important to note that cheese did not feature in the diet of the people in this geographical zone of Cameroon. Cooking oil was identified as the major and permanent source of dietary fat for communities in the sampled concessions of the DRC as all the households did consumed on daily basis. The only substitute rarely varied with cooking oil, was margarine. The gradual substitution of cooking oil by margarine was common in all the households. It was noted that no household consumed butter and cheese.



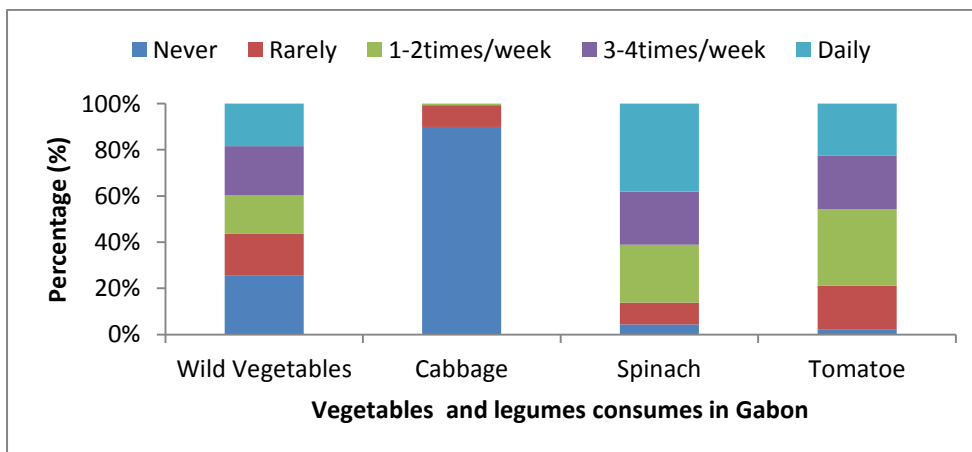
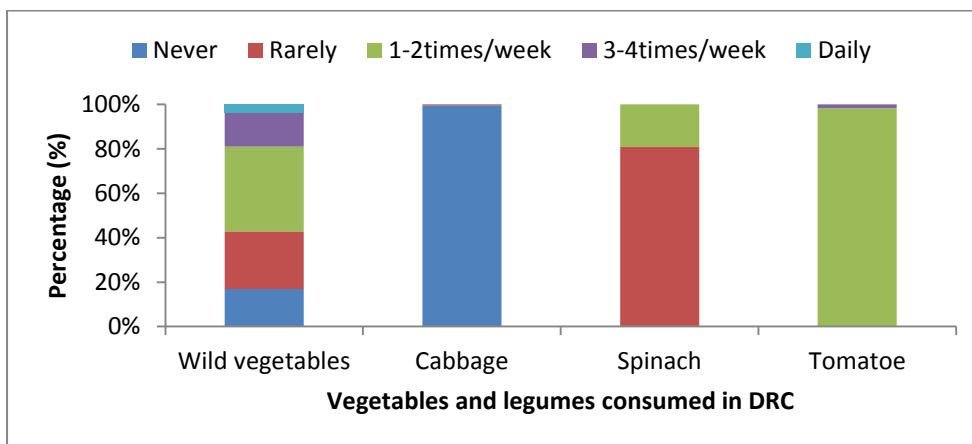
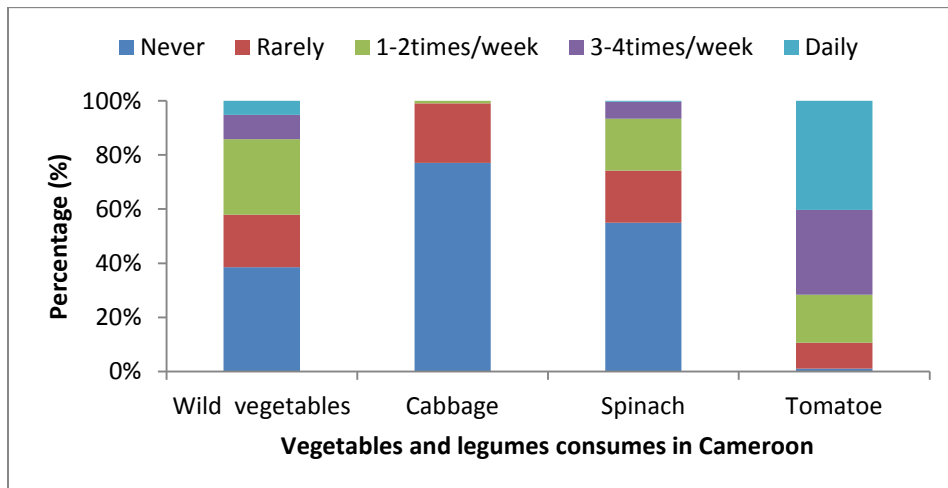


**Figure 3: Consumption Patterns of Dietary Fats in the Different Forest Concessions at Country Level**

### Vegetables and Legumes

Green leafy vegetables and legumes are important sources of vitamin A, vitamin C, folate and phytochemicals in the human diet. The vegetables and legumes that were identified in the nutrition of the studied population for all the three countries in order of intense consumption were wild green leafy vegetable, tomatoes, spinach and cabbage (Figure 5). These food types were moderately consumed in the SCTB and FIPCAM forest concessions of Cameroon. Tomatoes were the most consumed followed by wild green leafy vegetables like cassava leaves, cucumber leaves and sweet potato leaves. Cabbage and spinach though eaten in a few households was never consumed in over 70% and 50% of the households respectively. The vegetables and legumes of preference in the diets of people living in the CFT and COTREFOR concessions of the DRC were wild green leafy vegetables, spinach and tomato. The consumption patterns showed a high reliance on wild green leafy vegetables, a moderate dependence on tomato and a rare consumption of spinach. Despite its intense consumption, wild green leafy vegetables, were not consumed in about 15% of the households where as tomato was consumed in all the households in at least one to two servings per week. Cabbage; a fresh garden legume recorded zero consumption in all the households. The consumption pattern of vegetables and legumes in the forest concessions of Gabon turned more on locally produced legumes like tomatoes and spinach with a moderate preference for wild vegetables. The consumption of spinach presented a remarkable preference as close to one quarter of the households did consume on daily basis. Household intakes reported at weekly and rare occasions amounted to more than

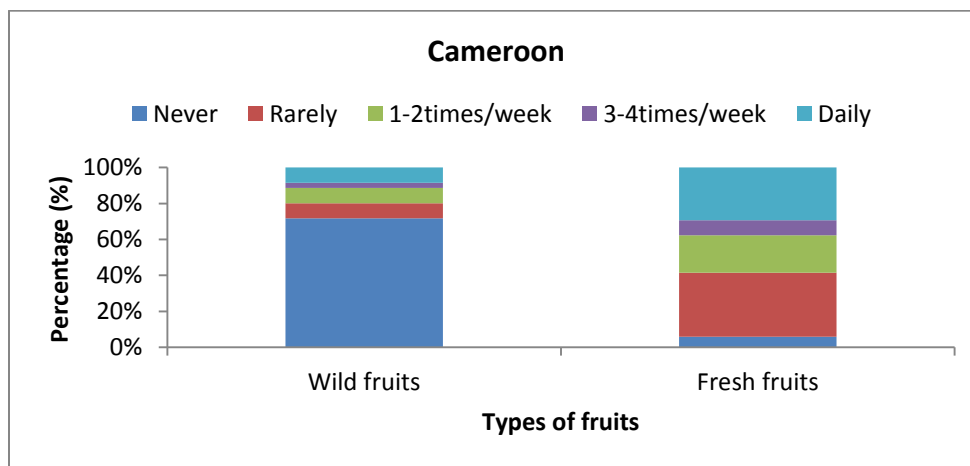
half. Tomato consumption pattern was similar to that of spinach except for the fact that more households consumed spinach on daily basis. The proportion of households consuming vegetables from the wild was approximately three quarters, with daily consumption marked in close to one fifth of the households. Cabbage with the least consumption density saw a basic rare frequency in one tenth of the households.

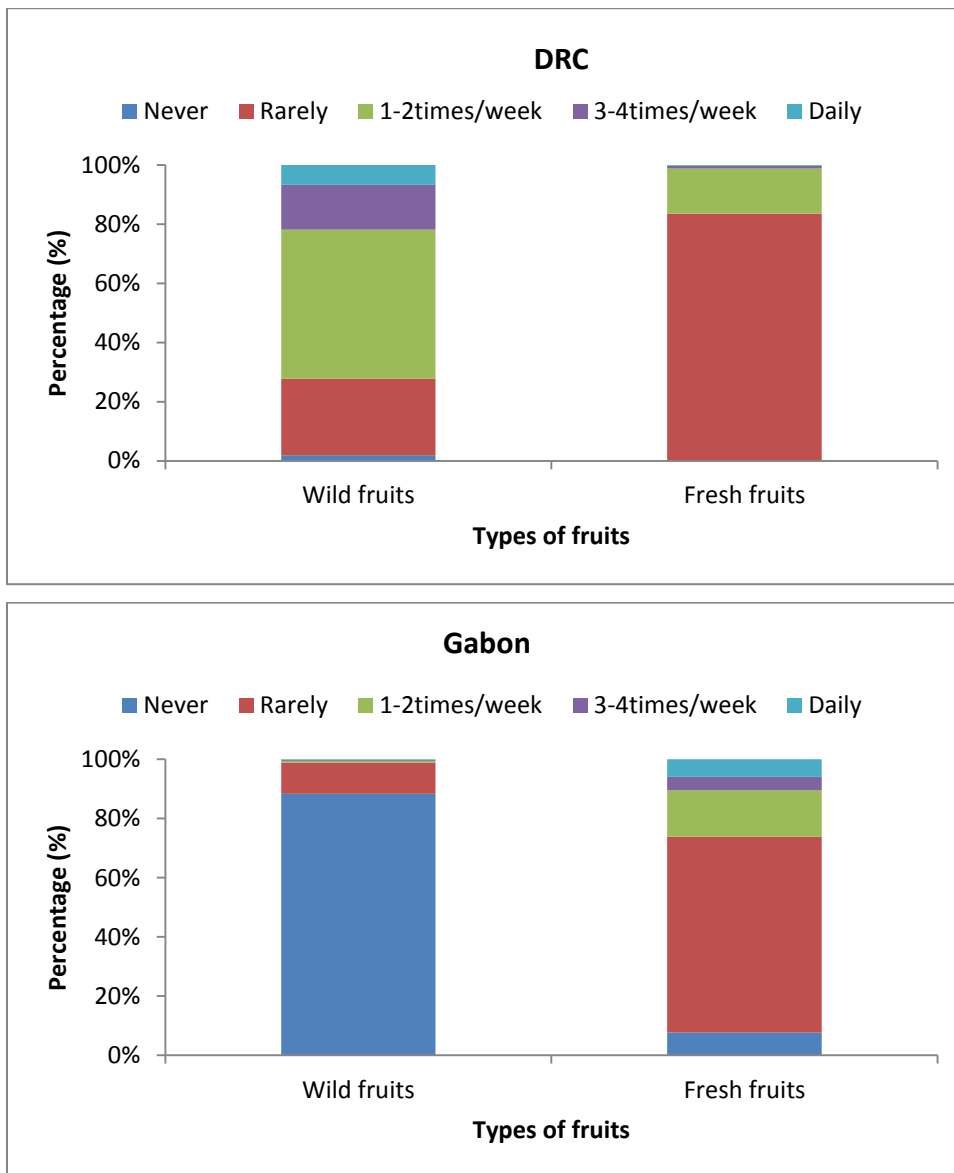


**Figure 4: Consumption Patterns of Vegetables and Legumes in the Forest Concessions at Country Level**

## The Consumption of Fruits

A global view of the results on fruit consumption revealed that all the forest concessions do not consume fruits to the required level as recommended by the World Health Organization (“at least five servings of fruits per day”). As can be read from Figure 5, less than 30%, 10%, and 5% of the households respectively from the forest concessions of Cameroon, the DRC, and Gabon did consume fruits on daily basis. However, More households ( $\approx 95\%$ ) consumed fresh fruits than wild fruits ( $\approx 30\%$ ) in the SCTB and FIPCAM concessions of Cameroon at low frequencies. Fresh fruits like mango, pineapple, pear, pawpaw, orange, and lemon were consumed everyday by approximately one third of the households coupled to an additional 35% on weekly accounts. Wild fruits were consumed in close to 30% of the households and on daily basis in only about one tenth of the households. The consumption trend of fruits in the sampled population of the forest zone of the DRC extended more towards wild fruits. As depicted, at least one fifth of the households consumed wild fruits in frequencies of 3-4times/week and everyday. Wild fruit savings of 1-2times/week occurred in half of the households compared to an approximated one-fifth households consuming fresh fruits in the same frequency. However, the remaining four fifth households all rarely consumed fresh fruits. Fruit consumption frequency in the BAYONNE and CEB forest concessions of Gabon was low, as approximately three quarters of the investigated households rarely or never consumed fresh fruits nor wild fruits in that order. More of fresh fruits like oranges, guavas, pears and mangoes were consumed than wild fruits (Abani, Ovouna, wild Osseille and wild Atanga). Our results also showed that only about one tenth of the households in the studied forest concessions of Gabon consumed wild fruits rarely, compared to nine tenth for fresh fruits with rare, weekly and daily frequency records. Thus, wild fruit consumption dominated in the DRC, moderate in Cameroon, and was least in Gabon.



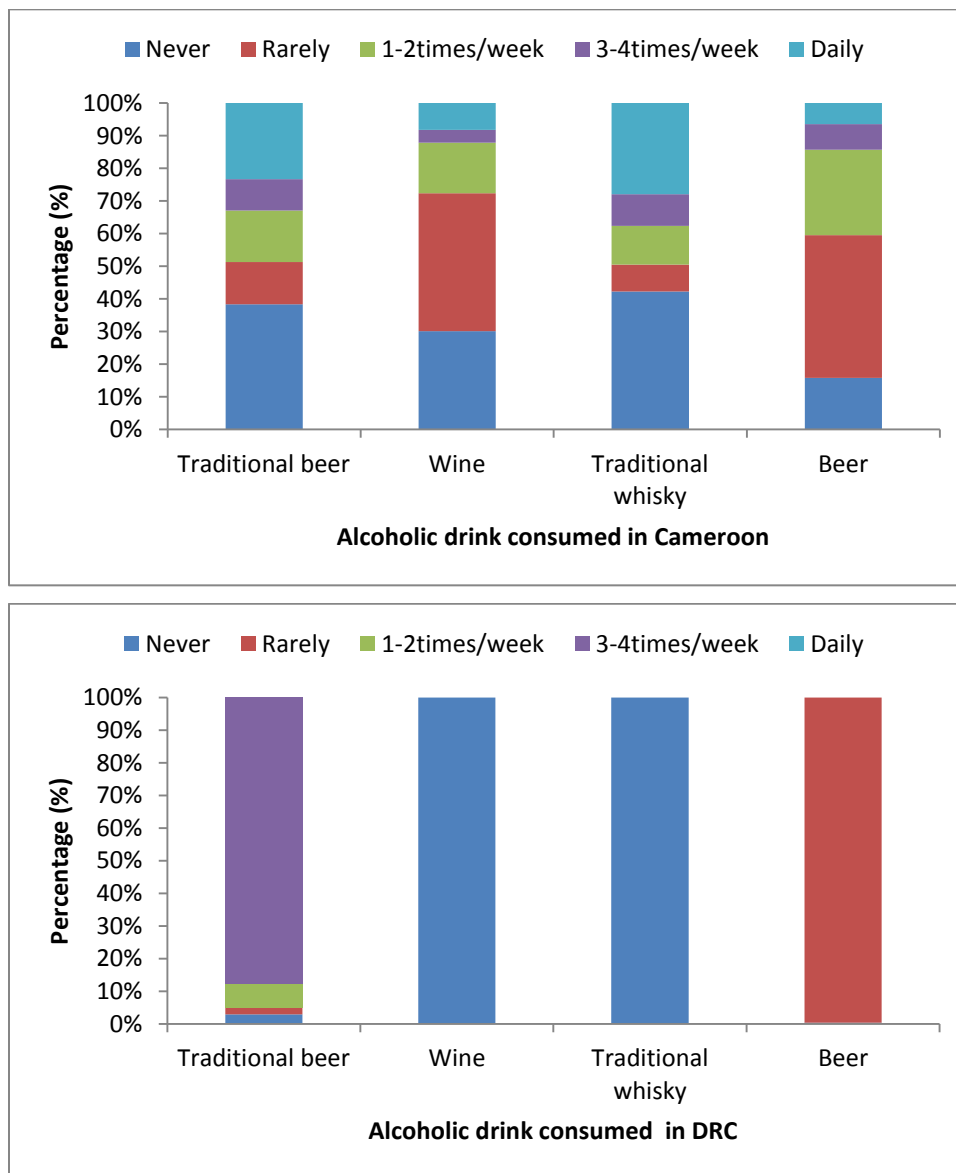


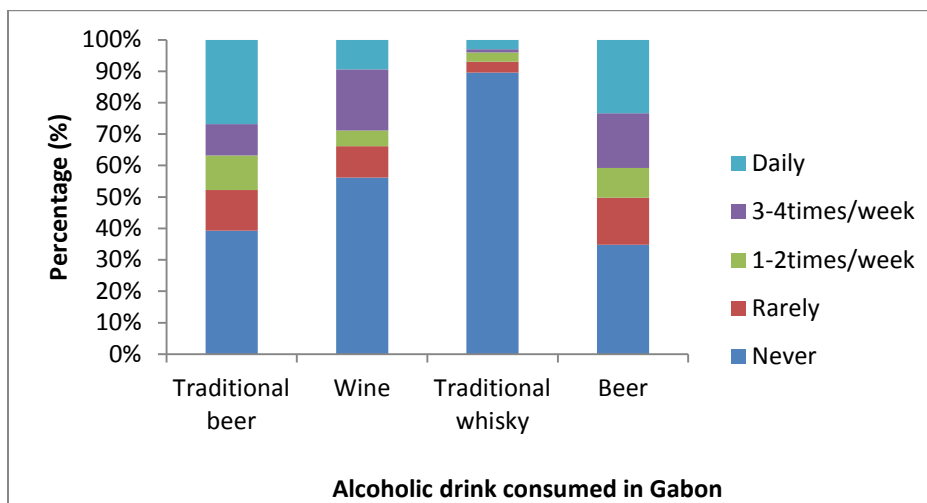
**Figure 5: Fruit consumption patterns in the forest concessions of Cameroon, the DRC, and Gabon**

**Alcohol Consumption Trends at Household Level**

The distribution data of Figure 6 depicts alcohol consumption frequency of households in forest concessions at country level. Alcohol was intensely consumed in Cameroon, moderately consumed in Gabon and mildly consumed in the DRC. Alcoholic drinks encountered in the concessions of Cameroon in order of consumption rate included; beer, wine, traditional beer, and traditional whisky. There was a remarkable consumption of traditional whisky in at least one quarter of the households in the studied concessions of Cameroon. It was equally noted that in all two concessions, about one tenth of households did not consume alcohol at all while none of the households drank palm wine. The alcohol consumption patterns of the CFC and COTREFOR

forest concessions of the DRC isolated traditional beer and palm wine as the major alcoholic drinks of the people. All the households that participated in this study showed alcoholic consumption rates of 3-4times/week of traditional beer and 1-2times/week of palm wine. As clearly shown on Figure 6, the processed buzz drinks; beer and wine did not enter in their drinking habits at all. Alcohol consumption was common in a greater proportion of the households investigated in the forest zone of Gabon and the alcoholic brands included traditional beer, beer, wine, and to a lesser extend traditional whisky. Traditional beer intake on daily basis was recorded in three quarters of the households in the BAYONNE concession. Daily and frequent weekly consumption of the processed alcoholic drinks; beer and wine were also remarkable. Traditional whisky was the least consumed, with a few daily intakes in the CEB concession.





**Figure 6: Alcohol Consumption Trends across the Six Forest Concessions of Cameroon, the DRC and Gabon**

In order to achieve food requirements (quantity and quality), dietary diversity is very important. In this study, 7 food groups were taken into consideration, (cereals/roots and tubers, proteins, dietary fats, vegetables and legumes, fruits and alcohol) to assess food consumption frequency. In general, the foods consumed in the villages around the selected forest concessions of the Congo basin were based on the following staples: cassava, banana, cocoyam and yam as root and tuber; and corn as cereal. The consumption of roots and tubers were more diverse in Gabon than in the other countries, but Cereals were rare in the diet of all the people interviewed. Thus, roots and tubers were the main source of carbohydrate with Cameroon and Gabon concessions recording higher intakes to high intake in the DRC concessions. These results are similar to those obtained in Nigeria and Togo where the most consumed staples were cassava, and yam as root and tubers and corn as cereal<sup>8</sup>. Concerning protein consumption, there were many groups: vegetable and animal sources. For vegetable protein sources, the most consumed were beans and groundnuts. On the other hand, animal protein consumption was divided into two groups: domestic meat and bush meat. Concerning domestic meat, we noticed a rare consumption of small quantities of cow, chicken and pork only common during festivals. For bush meat, the most consumed were rat, porcupine, squirrel, monkey, snake, wild bird, caterpillar and snail. However, bush meats are generally red and thus not suitable when consumed in excess as this will increase the risk to diseases. Again, malnutrition is often highly related to insufficient protein intake; this study presented the different forms of bush meat as the main source of protein for the study population. Bush meats are hunted from the wild and when there is intense hunting coupled to over exploitation of the forest, the quantity of the available bush meat is bound to

decrease. The consequence of a decrease in the quantity of bush meat is the emergence of protein malnutrition deficiencies mostly common in children since they are often marginalized in the process of meat sharing during family meals in favor of adults; despite the fact that children are more vulnerable to protein deficient complications like protein-energy-malnutrition. Insufficient protein intake in particular is of special concern because access to protein rich foods is limited and as such starchy diets are predominant. Millions of children for generations suffer from physical disabilities like stunted growth and mental retardation, limiting their overall potential as a result of lack of sufficient protein in their diets. In fact, “one cannot fully understand the underdevelopment of Africa's human capital without grasping the hidden, yet lifelong effects of protein deficiency”<sup>9</sup>. Milk is a good source of protein through its casein composition. Although the Gabonese milk consumption is higher than the others, the results showed that, its global consumption is very low despite its importance in the diet of children particularly for a safe and healthy growth. The inclusion of protein rich foods like milk and cheese in the diets of the forest concessions of Gabon is reflecting the progress from traditional rural diets towards urban westernized diets. Fats are the most energy dense foods (9Kcal/g). For our study population, the most consumed dietary fat was cooking oil particularly raw palm oil, refined palm oil and groundnut oil. However, we also noticed the consumption of westernized sources of fats like butter, and margarine in the study population of Gabon. Interestingly, the consumption of cheese was also remarkable in their diet showing a clear preference for imported or processed foods by the population. Fat intake in the case of the DRC was lowest, low in Cameroon and high in Gabon. The pattern defined by fat intake across the forest concessions of the three countries shows a typical rural diet in the DRC, a semi-urban diet in Cameroon, and an urban diet in Gabon. One clear fact is that all these forest communities used to live on a completely traditional diet profile but with the accompanying exploitation of the forest coupled to urbanization their diet profiles are gradually changing to the characteristic high fat westernized diet profile. A wide range of leafy vegetables was identified during the survey. The most important were cassava leaves, spinach, eggplant, cocoyam leaves, cucumber leaves, sweet potato leaves and *amaranthus*. In Cameroon, this last one was relatively absent in the studied zone but replaced by a high consumption of cassava leaves. According to a study made in South Africa, some ethnic groups prefer the “stronger” taste of other species, but use amaranth to supply the bulk<sup>10</sup>. In general, amaranth has also been identified as an important leafy vegetable in the lowlands of Africa and Asia<sup>11</sup>. Most importantly, fried and boiled amaranth have considerable quantities of vitamin A ( $\mu\text{g}$  retinol activity equivalents; RAE) per 100g, suggesting



that amaranth can potentially contribute to vitamin A requirements of nutritionally vulnerable communities. For example, a portion of 100g boiled or fried amaranth will provide more than half of the recommended dietary allowance for vitamin A for adult females<sup>12</sup>. Consumption of cooked green leafy vegetables has been shown to improve vitamin A status<sup>13, 14</sup>. African leafy vegetables can potentially contribute towards the dietary requirements of micronutrients other than  $\beta$ -carotene, such as calcium, magnesium, iron, potassium, zinc and vitamin C, although the bioavailability of some of these micronutrients is affected by the anti-nutrients oxalates, phytates and nitrates present in the leaves<sup>15</sup>. Fruits are the principal source of mineral and vitamins, which are very important in the diet. They mostly assist in regulation mechanisms. Their deficiency can lead to some important diseases. In the study zone, many fruits were eaten including wild fruits coming from the forest. The most important fruits were mangoes, oranges, guavas, pears, pineapples, pawpaw, and lemon. Most of these fruits are good sources of vitamin A and C. For wild fruits, there was a great diversity but, in general, the most important were: *I. gabonensis*, *B. toxisperma*, *T. abut*, *C. edulis*, *C. acuminata*, asperge, oseille sauvage, bombi, liboyo, hawula and awouma; which are also good sources of vitamins and minerals. Fruit consumption was moderate in Cameroon and the DRC forest concessions while low in the Gabon forest concession. People of the region, particularly children have to improve the quantity and frequency of these fruits in their diet and at the same time diversify the variety and/or type of fruits eaten, so as to cover the appropriate requirements of vitamins and minerals needed by the organism. It has been found that iron and vitamin A deficiency is prevalent in most parts of Sub-Saharan Africa. Low vitamin A intake is considered to be Africa's third greatest public health problem after HIV/AIDS and malaria with about 50 million children in Africa at risk of deficiency<sup>16</sup>. Concerning alcoholic drinks, the first thing to note is that consumption was common in all the six studied forest concessions. Alcohol consumption was high in the forest concessions of Cameroon and Gabon while lowest in the DRC. The characteristic alcohol for the indigenes in the Cameroon concessions was traditional whiskey while intensive consumption of brewed beer and moderate consumption of wine was common in Gabon. In conjunction with the particularities of rural and urban diets, where urban diets are characterized by high alcohol consumption and rural diets by low alcohol consumption, we can again observe a move towards urban diets from this alcohol consumption pattern across the six forest concessions. The alcohol percentage of some of these drinks like beer and wine is controlled at the time of production in the factory while the traditionally made beer and whiskeys are not controlled. Traditional liquors present dangerous health risks associated to liver damage and fatty liver diseases as the

production temperature favors the obtention of methanol, which is highly toxic to cells. It was also observed that other alcohol symptoms like arthritis and rheumatism were common among the old in the study zone. One outstanding factor promoting intensive alcohol consumption in this region is the construction of new roads, which permits easy access to the strong liquors. A second remark based on field observation is linked to the habit of the indigenes: the indigenes after hunting preferred selling their bush meat to buy alcohol, a practice that needs urgent attention. Thus, the consumption of traditional alcoholic drinks has to be banned on a national level or avoided at the individual level.

### **Recommendations**

#### **The SCTB and FIPCAM concessions of Cameroon**

Corn, the only cereal consumed in the SCTB and FIPCAM concessions is poor in lysine like other cereals and also poor in tryptophan. As such, to meet up the needs for tryptophan and other minerals such as iron, it is recommended that they consume other cereals like wheat, rice, sorghum etc. in addition to the roots and tubers cassava, banana, sweet potato, yam and cocoyam already consumed. It is also strongly recommended that the population of these concessions consume more sesame, soya, and groundnuts in combination with corn and other cereals to increase the quality of protein in their diet. To complete the daily demand of protein, the population should increase their consumption rate of eggs and milk which they are already consuming at a low frequency. Considering the nutritional value of snails and mushrooms, the SCTB and FIPCAM concessions have to increase the levels of these two foods in their diet. With respect to lipid intake, cheese and fish not consumed at all should be introduced in their diet; the functional roles of the essential fatty acids from fish oils would ensure a healthy population. The daily consumption of fresh fruits and vegetables by the considered population is good and should be maintained and even improved. It is also required that the population includes palm wine and red wine among the alcohols they drink and completely avoid traditional whisky which directly leads to arthritis and rheumatism.

#### **The COTREFOR and CFT concessions of the DRC**

The consumption of roots and tubers in the COTREFOR and CFT concessions is normal. Corn; the only cereal considered is the main source of energy with the roots and tubers contributing energy in the low concentrated form. To fill the gap of amino acids limited in corn and the roots and tubers, the populations of the COTREFOR and CFT concessions have to increase the consumption of groundnuts, soya, beans, peas, milk, and sesame to a daily basis. This will improve the tryptophan, lysine, sulfur amino acids, iron and the water soluble minerals/vitamins

availability to the consumers. Domestic meat consumption is normal; however, the consumption of eggs should be increased to at least once per day in the diet of the population. Lipid intake is poor, with cooking oil being the only source. A variation in the different sources of lipids is required so as to improve the quality of the lipids ingested. As such, fish and cheese should be consumed at least 3-4 times per week and margarine and butter 1-2 times weekly. Vegetable consumption is weak compared to the recommended level. So, the different types of green leafy vegetables should be consumed at least daily. There is rare consumption of fruits in the two concessions of the RDC. Thus, the slogan 'eat fruits in five servings per day' has to be highly considered and implemented in these concessions. Alcohol consumption is moderate as expected but necessitates the inclusion of red wine as in the Mediterranean diet.

### **The BAYONNE and CEB concessions of Gabon**

The BAYONNE and CEB populations need to add more cereals in addition to corn in their diet which they rarely consume. Cereals provide a high proportion of concentrated energy needed for a proper functioning of the body and for activities. The consumption of leguminous plants is highly recommended and should include most especially sesame, beans, peas and groundnuts. Domestic meat consumption should be encouraged most especially the consumption of cow meat, goat meat, chicken and eggs. Due to the high nutritional value of snails and mushrooms, it will be a good practice if the populations of BAYONNE and CEB include these two foods in their diets at a 3-4 times saving per week. Lipid intake though moderate needs to be improved on, with emphasis laid on the consumption of cheese, margarine and fish. The consumption of vegetables is not up to the recommended level and so consumption frequencies should be increased to at least once per day; cabbages, tomatoes, eggplant and amaranth consumption need to be encouraged. The consumption of fruits is far from the recommended levels. Thus, in accordance with the 'consume at least five servings of fruits daily', a daily consumption of the fruits pawpaw, mango, orange, pineapple etc. is highly recommended for both the BAYONNE and CEB concessions. With respect to alcohol drinking, the consumers need to completely replace traditional whisky with red wine.

### **CONCLUSION**

The food classes most common to communities in the six forest concessions of Cameroon, Gabon and the DRC adjoining the Congo basin are carbohydrates (roots/tubers and the cereal corn), fats (cooking oils, margarine, butter, and cheese), proteins (bush and domestic meat, legumes and green leafy vegetables), fruits (bush fruits and fresh fruits), and alcohol (traditional beer and whiskey, brewed beer, and wine). The typical African carbohydrate rich diet was

maintained in all the concessions. Fat intake was lowest in the DRC, low in Cameroon, and highest in Gabon. Cooking oils like palm oil, rafinated oil, and groundnut were intensively consumed in all the concessions. In addition to these oils, margarine, butter and cheese were found in the diet profile of Gabonese. Protein intake in the form of bush and domestic meat, legumes and green leafy vegetables was low in the Cameroon and Gabon forest concessions but moderate in the DRC concessions. Alcohol consumption was common in all the six concessions; higher patterns were observed in Gabon, a high pattern in Cameroon, and a lowest pattern in the DRC marked by zero consumption of traditional whiskey. All these observations indicate that the transition from traditional based diets to urban diets is fastest in Gabon, slow in Cameroon and slowest in the DRC.

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