A Review of Nutrition in Cameroon: Food Supply, Factors Influencing Nutritional Habit and Impact on Micronutrient (Vitamin A, Iodine, Iron) Status

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Abstract
Over the years, it has become evident that healthy nutritional habits have beneficial effects on health. This paper reviews available data from nutritional and epidemiological studies on natural food resources and nutritional habits in Cameroon. Of the fifteen studies available, seven reported on the natural food resources and nutritional habits in Cameroon. These studies showed that, although Cameroon is rich in natural food resources, factors like climate, household income, nutritional knowledge, urbanisation, gender and age and health have a great impact on the nutritional habits of the inhabitants. Poor nutritional habits in some parts of Cameroon has lead to high prevalence of protein-energy-malnutrition and micronutrient deficiency (vitamin A, C, E, iodine, iron, zinc etc.) especially during infections with HIV/AIDS, tuberculosis and malaria. However, data on micronutrient deficiency in Cameroon was very limited, except for public health relevant micronutrient (vitamin A, iron, iodine deficiency).

Key words:
Nutritional habit, micronutrient deficiency, vitamin A, iron, iodine, Cameroon

INTRODUCTION

In many developing countries including Cameroon, nutritional habits are gradually changing, increasing the incidence of nutrition related conditions such as obesity, diabetes and cardiovascular diseases (Kengne et al., 2005). Moreover, the high prevalence of infectious diseases (HIV/AIDS, tuberculosis, malaria) and micronutrients deficiency (vitamin A, ion and iodine deficiency) in Cameroon has substantially increased the rate of morbidity and mortality (National Institute of Statistics Cameroon, 2003). In order to carry out effective interventions in the area of nutrition, it is necessary to have a good knowledge of the nutritional habits, factors influencing nutritional habit and common micronutrient deficiencies. Of the fifteen studies available, seven reported on the natural food resources and nutritional habits in Cameroon.This paper reviews available data from nutritional and epidemiological studies on natural food resources and nutritional habit in Cameroon.

Food supply in Cameroon

Cameroon is located between the tropical regions of Nigeria and the gulf of guinea, on latitude 6 o 00' N and longitude12 o 00' E. The climatic condition within Cameroon alters with altitude and locations. Cameroon is made up of ten regions divided in 4 climatic zones. The coastal zone covering the southwest and littoral regions is generally sultry and humid. The plateau zone (far north, the north and adamaoua regions) is significantly warm and dry, while the sahelian (west and northwest regions) and forest (centre, south and east regions) zones are humid and wet, influencing natural food resources and nutritional habits. In this paper, the food supply in Cameroon has been stratified according to main nutrients (carbohydrate, fibre, lipid, protein, vitamin and mineral).

Main sources of carbohydrate

Table 1[a] presents the main carbohydrate rich food cultivated in Cameroon. Cassava for example, is very cheap and available year round, but has the lowest protein to energy ratio compared to other tubers. Plantain and yam are the most expensive products in terms of price per energy unit (kcal), compared to cassava and sweet potatoes (Dury et al., 2002). Studies have shown that yams and orange fleshed sweet potatoes are nutritionally superior to other tubers, due to high carotenoid and vitamin C content. (Wanasundera and Ravindran 1994, Jaarsveld et al., 2005). Cereals on the other hand are richer in nutrients compared to tubers but are limited in some essential amino acids. Maize is limited in lysine and tryptophan while rice is limited in lysine and threonine. Millet for example is known for its high protein content compared to maize and rice but limited in tryptopan (Ejeta et al., 1987). Other sources of carbohydrate in Cameroon include: traditional alcoholic beverages like maize beer, millet beer and palm wine. (Tambi, 1999; Mbaku, 2005).

Dietary fibres

Two types of dietary fibres (DF) are known; soluble dietary fibres (SDF) and insoluble dietary fibres (IDF). Studies by Tanya et al., (1997), shows that green vegetables like huckleberry, bitter leaves, okro etc provides the highest total DF in food, followed by legumes and seeds such as beans species, bush mango, fruits like green banana, tubers like cocoyams-taro, cassava and finally cereals with the least DF. However, ood in Cameroon are richer in IDF compared to SDF.

Dietaty fibres especially SDF are known for their therapeutic and beneficial effect on the carbohydrate and lipid metabolism (Theuwissen and Mensink, 2008). A study by Ngondi et al., (2006), showed that bush mango seeds commonly used in Cameroon could significantly decrease the level of low density lipoprotein (LDL) cholesterol and triglycerides, because of its high SDF level. Meanwhile, IDF like lignin present in most cereals and legumes may interfere with the absorption of micronutrients such as iron and zinc (Hemalatha et al., 2006). This could be one of the factors increasing the prevalence of iron deficiency in Cameroon.

Main sources of lipids

Table 1[b] presents the main sources of lipid in the Cameroonian diet. In most African countries including Cameroon, palm oil (*Elaeis guineensis)* with its high content of saturated fatty acids, (SFA) (50%), mono-unsaturated fatty acids (MUFA) (39%) and poly-unsaturated fatty acid (PUFA) (10%) is the cheapest and most available source of lipid in the diet (Mennen et al., 2001, Ponka et al., 2005). Studies show that although palm oil is rich in SFA, its content in MUFA, PUFA and antioxidants could reduce the adverse effects of SFA on total and LDL cholesterol (Sundram and Top, 1994). Palm oil is also rich in carotenoides, α and β carotene being the major components and γ tocotrienol (vitamin E) (Edem, 2002). Apart from palm oil, carotenoids are also found in colored fruits and

vegetables. Carotenoids together with vitamin E and ascorbic acid are antioxidants. Antioxidants protects the body against oxidative damage of cells by scavenging the reactive radical and free fatty peroxy radicals (Krinsky, 1992). Moreover, β carotene can be converted to vitamin A, which plays an important role in the visual process and the differentiation of cellular epithelium (Morriss-Kay, 1992).

Besides palm oil, other sources of lipids used in Cameroon are cotton, soy, groundnut and maize oil. These oils are rich sources of unsaturated fatty acids which could help to prevent heart diseases, but are expensive and unaffordable for most Cameroonians. Fruits like avocado, African pear also called bush butter; coconut, cocoa and prûne are rich sources of lipids and are extremely cheap and available in season. While avocados are rich in monounsaturated oleic acids, (Ikhuoria and Maliki, 2007), African pear is rich in PUFAs, flavanols, anthocianins and polyphenols (Silou et al., 2002, Missang et al., 2003). Futhermore, lipid-rich nuts and seeds like groundnut, pumkin seeds locally called egussi and bush mango seeds, are rich sources of oleic and linoleic acids, vitamin E and protein (Fokou et al., 2004, Ponka et al., 2005). Pumkin seeds are also rich sources of of zinc, selenium, iron and calcium (Glew et al., 2006). Mbofung et al., (1994) showed that local spices like njangsa (*Ricinodendron heudelotii*), mbongo (*Aframomum citratum*), pebe (*Monodora myristica*), felong (*Scorodophloeus zenkere*), esese (*Tetrapleura tetraptera*), could be rich sources of linoleic acid. Meanwhile, lipid-rich fish varieties like mackerel, cat fish, tuna, and sardine are cheaper and available in Cameroon. Lipid rich fish are rich sources of omega-3 fatty acids, known for their important role in the prevention of cardiovascular diseases and rheumatoid arthritis etc.(Levitan et al., 2009; Calder and Yagoob 2009).

Main sources of protein

Table 1[c] presents the main sources of protein in the Cameroonian diet. The protein content of Cameroonian dishes is low compared to carbohydrates. Leguminous plants with its high protein content are the most available and cheapest sources of protein in Cameroon compared to meat and fish. Meanwhile, bush meat is highly consumed in some parts of Cameroon. Bush meat varieties include animals from antelope, monkey, porcupines, pythons and pangolins etc, which are hunted for food (Nathan et al., 2005).

Main sources of minerals and vitamins

Table 1[d] presents the main fruits and vegetables available in Cameroon. In tropical countries including Cameroon, fruits and vegetables are the main sources of vitamins (β-carotene and vitamin C), and minerals (calcium, phosphorus, potassium and iron) and dietary fibres (Ejoh et al., 1995, Mennen et al., 2001, Fokou et al., 2004).

While banana is known to be a good source of potassium, avocado, African pear and prûne are rich sources of lipids. Colanuts are also widely consumed by elders in Cameroon. They are rich sources of plant polyphenols like caffeine, theobromin, catechin, epicatechin, procyanidine and tannins etc. Due to its high anthocyanin content, it is thought to have anti-oxidative activities. More over, its high content in anti-nutrients like tannins could interfere with protein digestion (Morton, 1992).

However, while cooking enhances the digestibility of protein and carbohydrates, the vitamin C and carotenoid content of vegetables, is negatively influenced by the cooking method. In most African countries and Cameroon, the cooking time is usually long with high temperatures, affecting the nutrient content of vegetables. Also, traditional methods of preservation like sun-drying, considerably reduces the content of vitamin C and carotenoids (Osunde and Makama, 2007).

Factors influencing nutritional habits in Cameroon

Investigations on the nutritional habit of Cameroonians clearly indicates major differences in dietary intake, varying according to climatic zone, urbanization, nutritional knowledge, household income, health (Dapi et al., 2005).

Food availability

Cameroon is made up of 4 climatic zones divided in ten regions. The coastal zone covering the southwest and littoral regions is generally sultry and humid. The plateau zone made of the far north, the north and adamaoua regions is significantly warm and dry, while the sahelian (west and northwest regions) and forest (centre, south and east regions) zones are humid and wet. This climatic variety influences food availability. The plateau zone of Cameroon are made up of dry savanah plains and the steppe, favouring pasturage and breeding of animals like sheep and cows, goats for food and pig for sale. Fishing is also common and used both for food and a source of income. This climate also favours the

growth of cereals. Cotton and goundnut are the most important sources of lipids, while palm oil is scare. Because of limited rainfall, fresh vegetables are also rare and expensive, thus the high rate of vitamin A deficiency and seasonal vitamin C deficiency (Bascoulergue and Leberre, 1963, Gouado et al., 2005). Meanwhile, the forest zone are dominated by the tropical climate, with long rainy seasons. Tubers, fresh green vegetables and fruits etc are available year round. Especially in these regions, bush meat is highly consumed although the government of Cameroon has officially clamped down the hunting and trading of bush meat. Previous studies on the origin of HIV showed that man first got infected with HIV in West Africa precisely in the South-Central region of Cameroon where *Pan troglodyte*s *strain* of Simian Immunodeficiency Virus (SIVcpz) was found (Gao et al., 1999). Fish varieties are available and highly consumed in these regions all year round. The sahelian and part of the coastal zone (southwest region) with its volcanic high lands, is the most fertile zone in Cameroon. Tubers are available all year round in these regions, bean species are the main sources of plant protein are available all year round while cows, goats and pigs are reared as a source of income. Meanwhile fishing is rare and expensive. Also, the coastal region is the richest part of the country in fish supply. See tables 1a,b,c and d.

Urbanization and Lifestyle

The rapid change in nutritional habit in developing countries is due to increase urbanisation and changes in lifestyle (Chauliac et al., 1998). Because the percentage of school children, students and office workers in urban Cameroon is high, eating of junk food (doughnut, fried groundnuts, sweet beverages) outdoors is very common compared to rural areas (Sobngwi et al., 2002, Dapi et al., 2005). Previous studies showed that the consumption of tuber fibre, fat and alcohol is higher in rural areas compared to urban areas with high cereals consumption (Sharma et al., 1996, Mennen et al., 2001). Meanwhile Tambi et al., (1999) showed that protein consumption from animal origin was higher in urban areas compared to rural areas.

Household income

In most developing countries including Cameroon, high carbohydrate-food such as cassava, maize and rice are the lowest cost options for consumers with low household incomes (Dury et al., 2002, Drewnowski and Specter, 2004). In Cameroon, consumption of meat, fish, and dairy products are related to high-income households while the consumption of vegetables and legumes are related to poor households (Tambi et al., 1999).

Nutritional knowledge

There are strong evidences supporting the influence of nutritional knowledge on nutritional habit. Dapi et al., (2007) showed in a qualitative interview that pupil from urban areas had a better knowledge on nutrition compared to those in rural areas. Meanwhile, studies also show that, the nutritional knowledge of Cameroonians is lacking (Sharma et al., 1996, Dapi et al., 2005). Improving on nutrition education in schools as well as increased access to nutritional information through media (newspapers, television and radio) and nutritional education of adults especially in rural areas will go a long way to improve the nutritional habits of Cameroonians.

Gender and age group

Studies show that the nutritional habit of a population may vary according to gender and age group. A study by Mennen et al.,(2001) showed that the energy intake from carbohydrate by women in rural Cameroon was higher than for rural men compared to those in urban Cameroon. Meanwhile in the same study, energy intake from saturated fat and protein was higher for men aged above 60 years compared to those below 60. Also, the energy intake from saturated fat by urban women aged between 24 and 44 years was higher than for urban men of the same group.

Main micronutrient deficiency in Cameroon

Although Cameroon is rich in food stuff, the prevalence of nutrition related conditions are still high (Lowé et al., 1993, Mbaku, 2005). Besides protein-energy-malnutrition in children, micronutrient deficiency is also a problem both in children and adults. Because data on deficient micronutrient in Cameroon was very limited, only Public Health relevant micronutrient deficiency are reported (vitamin A, iron, and iodine deficiency (Gouado et al.,2005).

Vitamin A deficiency

Vitamin A deficiency among children and preschool children is still a major problem in developing countries (WHO, 2000). In Cameroon, palm oil is the most important source of α and β carotene (vitamin A precursor). The highest prevalence of Vitamin A deficiency is found in the plateau zone of Cameroon, where vitamin A intake with food is low. Immune suppressive infections like HIV/AIDS,

tuberculosis, with its high prevalence in Cameroon could interfere with the antioxidative status of the body, thus increasing demand for antioxidants (β-carotene, vitamin C, E, Zinc, selenium) (Evans and Halliwel, 2001). Other causes of Vitamin A deficiency could be infections like measles and intestinal parasites, onchocerca volvolus etc. (FAO/WHO 1992, Zambou et al., 1999)

Iron deficiency

Iron (Fe) deficiency, is one of the most common micronutrient deficiencies world wide. In Cameroon, iron deficiency is the main cause of anaemia. Anaemia is caused by low intake of food rich in bioavailable iron and high intake of food rich in iron inhibitors and dietary fibre (Stolzfus, 2003, Kana et al., 2004). Another important cause of iron deficiency in Cameroon is the malaria parasite, which causes a massive destruction of red blood cells. Iron deficiency is severe in pregnant women leading to low birth weight and increased maternal morbidity and mortality (Achidi et al., 2005). Iron deficiency leads to decreased physical capacity and work performance in adolescents and adults, stunting in children, lowered immune status, increased morbidity from infections in all age groups, and affects body-temperature regulation in severe cases (Scrimshaw et al., 1990).

Iodine deficiency

Iodine is one of the most important minerals known for its effects on the function of the thyroid gland. Iodine stimulates the thyroid gland to produce a hormone thyroxine (T4) and triiodothyronine (T3). Iodine deficiency is endemic in the inland regions of Cameroon. The highest prevalence is found in the East and Northern regions. (Taga et al., 2004, 2008). Iodine deficiency is mostly caused by insufficient intake of iodine in the diet. A study by Tahboub et al., (2005) shows that thiocyanate (SCN) could competitively inhibit the action of human thyroid sodium/iodide symporter. (goitrogenic compound). Cassava, is a rich source of SCN and is widely consumed in the southern regions of Cameroon. This could explain the high prevalence of iodine deficiency in this area. Also, the iodine content of food is proportional to the quantity of iodine in the soil. Taga et al., 2004 reported low levels of iodine in the soil and food harvested in the East and North regions compared to that in West and South. Iodine deficiency during the foetal development can cause iodine deficiency disorders (IDD) such as mental retardation, brain damage, impaired physical development, spontaneous abortions, low birth weight, infant mortality cretinism and goitre in adults (Delange et al., 2001).

Future trends and conclusion

This paper reviews the nutritional habits in Cameroon, in relation to food supply and relevant micronutrient deficiency. The review showed that the nutritional habits of Cameroonians could be influenced by factors like climate, urbanization, household income, nutritional education, Gender and age group and health. Studies also show that nutritional knowledge in Cameroon is lacking. Moreover data on nutritional habit is very limited (Dapi et al., 2005, Sharma et al.,2007). Also the rate of public health relevant micronutrient deficiency (vitamin A, iron, iodine) is very high. Data on micronutrient deficiency except for those mentioned above is limited. In addition, most of the studies available described the nutrient profile of already prepared dishes. Nutritional interventions are needed to determine the nutrient profile of the single foodstuffs, since methods of processing and cooking the same foodstuffs differs from one region to the other. For example, in the southern regions, groundnut paste are used to soften "*Gnetum africanum* and called *"Okock"* while in the south western region leaves of "*Talinum triangulareare"* is used and called *"Eru"* (Sharma et al., 2007).

Thus, re-enforcing nutritional education in clinics, hospitals, health care centres and schools would be very beneficial to the population. For example, education on ways of combining food in order to cover the need for all essential amino acids and methods of cooking especially green vegetables without destroying water soluble vitamins like β-carotene, vitamin C, folic acid etc will go a long way to boost the antioxidative system. Furthermore, people should be encouraged to consume fishes like makerel, tuna, sardine, since they are rich sources of essential fatty acids like omega 3- fatty acids.

Studies show that the high fibre content of Cameroonian dishes could also be a cause of some micronutrient deficiencies such as iron and zinc. Further research in this area will increase the nutritional knowledge of the population and reduce the rate of micronutrient malnutrition in Cameroon.

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Group	Main source	Scientific name	Food availability
Carbohydrate[a]	Cassava	*Manihot esculenta*	a
	Cocoyams-taro	*Colocasia esculenta*	s
	Sweet potatoes	*Ipomoea batatas*	f, p, s
	Yams	*Dioscoreaceae sp*.	p, s
	Potatoes	*Solamum tuberrosum Musa*	s
	Banana	*sapientum*	f, s
	Plantains	*Musa paradisiaca*	f, s
	Maize	*Zea mays*	p, s
	Millet	*Sorghum bicolor*	p
	Rice	*Oryza sativa*	p
Lipids[b]	Palm oil	*Elaeis guineensis*	f, s
	Avocado	*Persea americana*	s
	African pear	*Dacryodes edulis*	f, s
	Prûne	*Prunus domesticus*	s
	Soy oil	*Glycine max*	s
	Groundnut oil	*Arachis hypogea*	f, p, s
	Cotton oil	*Hibiscus gossypum*	p
	Coconut	*Cocus nucifera*	c, f
	Cocoa	*Theobroma cacao*	s
	Pumkin seeds	*Cucurbita maxima*	p, s
Proteins[c]	Beans varieties	*Vigna sp*	f, s
	Bambara beans	*Vigna subterranea*	p
	Beef	*Bos tauros*	p, s
	Sheep	*Ovis Aries*	p

	goat	*Capra aegagrus hircus*	p
	Pork	*Sus scrofa*	f, p, s
	Snails	*Helix aspersa*	c, f, s
	Bush meat		f, p
	Poultry		f, p
	Fish		c, p
	Schrimps		c, p
Vitamins/ minerals[d]	Oranges	*Citrus sinensis*	f
	Mandarine	*Citrus reticulate*	f
	Lime	*Citrus aurantiifolia*	f
	Grape fruits	*Citrus paradisi*	f
	Mango	*Mangifera indica*	f
	Bush mango	*Irvignia gabonensis*	f
	Papaya	*Carica papaya*	f, s
	Watermelon	*Citrullus, edulis*	f, s
	Banana	*Musa sapientum*	f
	Pineapple	*Ananas comosus*	f
	Guava	*Psidium guajava*	s
	Avocado	*Persea americana*	f, s
	African pear	*Dacryodes edulis*	s
	Prûne	*Prunus domesticus*	a
	Cola	*Cola sp*	f
	Datte	*Phœnix dactylifera*	p
	Eru	*Gnetum africanum*	f
	Folong	*Amaranthus cruentus*	c, f, s
	Water leaf	*Talinum triangulare*	c, f, s
	Huckleberry	*Solanum nigrum*	c, f, s
	Okra &leaves)	*Hibiscus esculentus*	c, f, s, p

Taro leaves	*Colocasia esculenta*	c, f, s
Bitterleaf	*Vemonia amygdalina*	c, f, s
Pumkin leaves	*Curcumbita pepo*	p, s
Folere	*Hibiscus sabdariffa*	p
Cassava leaves	*Manihot esculenta*	a
Egg plant	*Solanum melongena*	f, s
Tomatoe	*Lycopersicon esculentum*	c, f,s
	Allium cepa	
Onion	*Daucus carota*	p
Carrots	*Brassica oleracea*	s
Cabbage		s

Plateau zone (p), coastal zone (c), forest zone (f), sahelian zone (s), All 4 zones (a)