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Potential of indigenous fruit-bearing trees to curb malnutrition, improve household food security, income and community health in Sub-Saharan Africa: A review

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ABSTRACT

Sub-Saharan Africa (SSA) has an estimated annual population growth rate of 2.7% making it the highest globally. More than two thirds of the over 800 million people in the region stay in rural areas where they depend on subsistence agriculture. Socio-economic instability, poor soil fertility and unreliable rainfall result in poor crop yields. This exposes the vulnerable to food insecurity and inadequate nutrient intake. Malnutrition is not restricted to undernutrition as in the urban areas the adoption of diets rich in carbohydrates and fats also poses health problems associated with obesity. Malnutrition causes derangements in the immune system, thereby increasing susceptibility to and severity of infections among the affected population. In SSA, indigenous fruit bearing trees (IFBTs) are treasured sources of macro- and micro-nutrients, and health promoting phytochemicals. The phytochemicals have biological and pharmacological activities that mitigate some of the physiological effects of malnutrition. In this paper, the contribution of IFBTs such as *Uapaca kirkiana* and *Adansonia digitata* to household food security, rural economy and community health are highlighted. Examples of community-based projects dependent on fruit from IFBTs are given. Using this evidence the need for unlocking the seemingly hidden potential contribution of the genetically diverse IFBTs to food security is highlighted. In this regard, research should focus on how to tap into health benefits of oils from IFBTs seeds. Residual cakes from oil extraction could be developed into biofuels, bio-fertilisers and animal feed ingredients. Fruit pulp could be exploited to produce more health-promoting natural sweeteners and pectins for industrial use. This beneficiation and value addition of products from IFBTs over and above contributing to the enhancement of household food security and the rural economy would translate into increased community-based sustainable utilisation and conservation of IFBTs.

1. Introduction

Availability and access to nutritionally balanced food are a fundamental tenet that is enshrined in the constitutions of member states signatory to the United Nations charter [Food and Agricultural Organisation (FAO), 1996]. Among the cocktail of challenges facing sub-Sahara Africa (SSA), malnutrition stands out. Malnutrition technically encompasses both under- and over-nutrition. Consequently it is typified by either macro-nutrient (carbohydrate, protein and fats) or micro-nutrient (vitamins, minerals and beneficial phytochemicals) deficiency or an excess intake of calories. Dietary energy, largely derived from carbohydrates, is necessary for normal body function. The proteins which are composed of amino acids constitute about 16% of the human body mass (Brožek, Grande, Anderson & Keys, 1963) and are necessary for the synthesis and maintenance of the enzymes, hormones, neurotransmitters, and body tissues including bone. Unlike non-essential amino acids that can be synthesised de novo, essential amino acids must be supplied in the diet. Fats (lipids) are a more concentrated than carbohydrates as a source of energy for the body. However, some lipid components, for example, essential fatty acids (EFAs) such as the omega-3 fatty acids (n-3 polyunsaturated fatty acids) are required for normal foetal brain and visual development (Neuringer, Anderson & Conner, 1998). In addition, the EFAs play important roles in cellular signal transduction and the immune response. Among the several roles, micronutrients in the body serve as co-enzymes that facilitate a host of physiological reactions and contribute to the natural antioxidant pool. Antioxidants help keep in check the concentration of free radicals (reactive oxygen and nitrogen species) that would otherwise result in oxidative stress (Falowo, Fayemi & Muchenje, 2014) and increase the body's susceptibility to infection (Nkengfack, Torimiro & Englert, 2012).

The human population of SSA is more than 800 million and its annual growth rate is estimated at 2.7% (Ejide, 2012). This makes the SSA's population the fastest growing throughout the world. In 2010, it was

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estimated that about 528 million people out of the total SSA human population lived in rural areas and depended on subsistence agriculture for their livelihoods. In these rural settlements, agriculture is dependent on rainfall. This makes subsistence agriculture a highly risky enterprise. The risk is mainly due to unreliability and the lack of effective rainfall, mid-season dry spells and at times, flooding. The inclement weather conditions predispose the rural population to food insecurity. Inadequacy of food during the dry season and in early summer before the harvest exposes the vulnerable (expecting and nursing mothers, recently weaned and growing children and the sick) to inadequate intake of both macro- and micro-nutrients. In general, as already alluded to, inadequate intake of nutrients especially during the off-season is a characteristic feature of rural SSA. However, in the rapidly expanding urban settlements of the region, there has been an increased consumption of unhealthy carbohydrate and fat rich diets in place of wholesome nutritionally adequate traditional diets. The excess caloric intake by this population segment coupled with sedentary lifestyles have spawned an increase in obesity across all age groups. The child- and adult-hood obesity invariably has and is leading to increased prevalence of metabolic diseases such as type II diabetes mellitus, hypertension and associated cardiovascular diseases (Slyper, 2004). The human population in SSA is thus faced with a twin evil, namely inadequate nutrients especially in the rural areas and excessive caloric intake in some segments of the urban population.

The World Food Programme defines malnutrition as "a state in which physical function of an individual is impaired to the point where s/he can no longer maintain adequate bodily performance processes such as growth, pregnancy, lactation, physical work and resisting and recovering from disease" (World Food Programme, 2000). The problem of malnutrition is overwhelming considering that children constitute more than a third of the total regional population. Malnutrition has been reported to contribute to more than 33% of all child deaths (Bain et al., 2013). In this review attempts are made to highlight the basic forms and physiological effects of malnutrition, the current contribution of indigenous fruit bearing trees (IFBTs) to: (a) household food security, (b) mitigation of the physiological effects of malnutrition, and (c) the local economy. Specific country examples within SSA are used to strengthen the argument. In addition, the review also puts into perspective the untapped potential of IFBTs. Special reference is made to the seeds, which could be exploited and through beneficiation help increase the contribution of IFBTs to household food security, local rural economies and to the gross domestic products of the countries in SSA.

1.1. Forms and effects of malnutrition

Adequate nutrition is critical for normal growth and development and optimal productivity. Under-nutrition could be a consequence of protein–energy deficit or micronutrient deficiency (França et al., 2009). Over nutrition results from excessive intake of energy, which is associated with increased adiposity, obesity and metabolic dysfunction. Under-nutrition characterises rural SSA. In growing children, it presents itself either as marasmus and/or kwashiorkor. Marasmus (oedema absent) and kwashiorkor (oedema present) are two forms of protein energy malnutrition (Bain et al., 2013). Kwashiorkor is caused by inadequate protein intake but with fair-to-normal energy intake whereas marasmus results from inadequate intake of protein and energy. Inadequate dietary iron, iodine, zinc and vitamin A, constitute the most clinically significant micronutrient deficiencies that affect about 2 billion children and child-bearing women throughout the world (Bain et al., 2013). While dietary fortification has been somewhat successful in curbing micronutrient deficiencies, these deficiencies still constitute a significant cause of morbidity in developing countries, especially in rural SSA (Bain et al., 2013). Micronutrient deficiency results in derangement of the natural balance between the endogenous antioxidant pool and free radical production which predisposes the body to oxidative stress.

By itself malnutrition can cause death (França et al., 2009). Epidemiological studies have proven that malnutrition considerably increases susceptibility to severity of infections, concomitantly leading to death (Rice, Sacco, Hyder & Black, 2000; Stephen et al., 2002). While the human immune deficiency virus is known as a cause of secondary immune deficiency, severe malnutrition is regarded as the largest cause of secondary immune deficiency globally (França et al., 2009) with its effects causing derangements of both the innate and adaptive immunity (França et al., 2009). The availability of adequate and appropriate nutrients in SSA is thus crucial in maintaining the health of the population.

2. Current sources of nutrients in rural sub-Saharan Africa

Grassroot communities in rural SSA depend largely on crop and livestock farming and particularly fruit from IFBTs for nourishment and household food security. The bark, leaves and roots of local flora are exploited as sources of nutrients. Wildlife and insects also contribute to the food basket (van Huis, 2003). In addition, the remittances from relatives in urban areas contribute to household food security. Local grocery stores serve as a source of food items. However, the foodstuffs that the local retailers stock tend to be processed and refined.

2.1. Contribution of farmed crops and livestock to household food security

In SSA, cereals (maize and small grains) and tubers (cassava and potatoes), which are sources of energy, farmed legumes and to some extent animal products (sources of protein), constitute the staple human foods (FAO, 2011; Amuna, Zotor, Sumar & Chinyanga, 2000). Amuna et al. (2000) reported that 46% of the dietary energy supply per capita per day in SSA came from a combination of cereals, other grains and legumes. Tubers and roots contribute about 15.6% of the energy. Due to the vagaries of weather, decline in natural pasture, competition between animals and humans for common food resources (Thornton, 2010) and failure of subsistence agriculture to meet the nutritional requirements of the region, the rural human population of SSA experiences nutrient deficits that often result in severe malnutrition. Quite often, fruit harvested from the IFBTs in the miombo forests and savanna woodlands of the region complements the nutrients that subsistence agriculture provides to meet the SSA population's requirements.

2.2. Current status and contribution of indigenous fruit bearing trees to household food security

Sub-Saharan tropical Africa is home to about 1200 species of IFBTs (Sthapit, Rao & Sthapit, 2012). Approximately 477 of them produce fruit and nuts which are eaten (Meregini, 2005). This great diversity in IFBTs makes them an asset base for livelihoods of local communities in tropical SSA. When compared to the diversity in IFBTs in SSA, only 10 annual pulses, oilseeds and cereal grains dominate 80% of the global field crops (Awodoyin et al., 2015). Thus IFBTs offer more genetic potential and diversity to contribute to food security in SSA compared to the conventional farmed crops. Indigenous trees blossom and produce fruit at different times of the year, thus making fruits available throughout the year (Jamnadass et al., 2011). Table 1 shows an example of the diversity in the IFBT portfolio of monthly availability of ripe fruit. Most of the IFBTs provide the fruit between the months of October to June.

Indigenous flora, particularly the fruit bearing trees, has long been exploited for its nutritional value (Saka, Rapp, Akinnifesi, Ndolo & Mhango, 2007). Apart from their great genetic diversity, IFBTs have several advantages over conventional crops. They are widely distributed in SSA, adapted to the local climatic and edaphic conditions (Chivandi, 2012) and tend to be more tolerant to drought, fire and pests (Leakey,