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Review Article

NUTRITIVE VALUES,PHYTOCHEMICAL AND HEAVY METAL COMPOSITIONS OF GREEN LEAFY VEGETABLES: A REVIEW

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Abstract

Green leafy vegetables occupy an important place among the food crop as they provide adequate amount of many vitamins and minerals like calcium, iron and phosphorous. Green leafy vegetables constitute an indispensable constituent of human diet. Dark green leafy vegetables are an excellent source of fiber, folate and carotenoids. These vegetables also contain vitamins C and K and the minerals iron and calcium. In addition, dark green leafy vegetables act as antioxidants in the body. The substances in dark green leafy vegetables remove free radicals from the body before they become harmful. There is evidence that the carotenoids found in dark green leafy vegetables can stop the growth of certain types of breast, skin, lungs and stomach cancer. Also foods containing folates reduces risk of pancreatic cancer while foods containing dietary fiber reduces risk of developing colorectal cancer. However, both vital and lethal elements are present in green leafy vegetables.

Keywords: Green leafy vegetables,Vitamins,Minerals,Heavy metal,Phytochemicals.

Introduction

Bacillary dysentery and enteric fevers continue to be Green leafy vegetables occupy an important place among the food crop as they provide adequate amount of many vitamins and minerals like calcium, iron and phosphorous (Fasunyi, 2006). Green leafy vegetables constitute an indispensable constituent of human diet in Africa generally and West Africa in particular (Osagie and Offiong, 1998). For example, green leafy vegetables are used in diets of post partum women to aid contraction of the uterus (Chinma and Igyor 2007).

Protein, vitamin and mineral needed in diet as well as roughages which promotes digestion and prevents constipation are supplied by vegetables (Aliyu, 2006). He also reported that young leaves freshly picked contain 4-10% protein unlike the older leaves that contain 1-2%. Vegetables differ from fruits in chemical composition namely because most vegetables contain more starch than sugar in contrast to fruits which are higher in sugar than starch especially when ripe.

Green Leafy Vegetables (GLVs) are predominantly known for their high nutritional content and are mostly consumed for their health and nutritional benefits. In the South region of Nigeria, domestic vegetable gardening is a common practice because GLVs constitute a major component of the diet and is of great economic value (Otitoju *et al.,* 2012).

Composition and nutritional value of vegetables

The carbohydrates in vegetables consist mainly of indigestible fibrous materials such as cellulose, hemicelluloses and lignin, in addition to small quantities of sugar such as glucose, fructose, sucrose and in some cases, starch. The proportion of the fibers

in the vegetables also depends on the stage of maturity. The turgidity or rigidity of the vegetables also depends on the water content which may be between 78-98% (Enwere, 1998). Leafy vegetables are ideal for weight management as they are typically low calorie and are useful in ameliorating cancer and heart diseases since they are low in fat, high in dietary fiber and rich in folic

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acid, vitamin C, potassium, magnesium as well as containing a host of phytochemicals (Watchtower, 1996).

Dark green leafy vegetables are an excellent source of fiber, folate and carotenoids. These vegetables also contain vitamins C and K and the minerals iron and calcium. In addition, dark green leafy vegetables act as antioxidants in the body. The substances in dark green leafy vegetables remove free radicals from the body before they become harmful (American Institute for Cancer Research). There is evidence that the carotenoids found in dark green leafy vegetables can stop the growth of certain types of breast, skin, lungs and stomach cancer. Also foods containing folates reduces risk of pancreatic cancer while foods containing dietary fiber reduces risk of developing colorectal cancer (Steinmetz and Potter, 1996).

Uses of vegetables

Generally, the use to which vegetables are put in the diet depends on the purpose to be achieved. They may be used as major ingredients in soups, sauces, stews, pottage, porridges and salad to serve the following purposes:

1) To enhance flavor of food. In this case they are used in small quantities for example onions, pepper, utazi leaves.
2) To garnish prepared dishes so as to enhance eye appeal for example raw ripe tomatoes, carrot, cabbage, garden egg leaves. These vegetables contribute nutrients when used.
They may be used as filling for sandwiches, pies and eggrolls for example potatoes, carrots, green pepper, etc.
They may be used as a critical part of the ingredient in the preparation of certain dishes such as vegetable soup, yam and vegetable pottage and vegetable salad.

Vegetables and their potentials as functional foods

According to Hippocrates, 447-368BC, our food should be our medicine (Serge, 2007). The quality of food is based on the natural composition, the balance between the nutrient and anti nutrient composition.

It is this uneasy concern over the chemical composition or contamination of foods and the effect this has on its value to the consumer that generates the need for analysis.

Functional foods are foods or dietary components that may provide a health benefit beyond basic nutrition (FDA, 2004).

Besides functional properties such as carotenoids, dietary fibers, flavonoids, isothiocynates, phenols, lignans and lutan (Bender and Bender, 2005), they contain components that provide physical benefit to health, general well being, physical fitness, or disease resistance above the benefit expected from its nutritional components such as protein, minerals and vitamins. Phenols in vegetables have potentials to bolster cellular antioxidants defects may contribute to the maintenance of healthy vision and heart as functional food (Bender and Bender,2005). In addition, diet fiber lignin, found in vegetables can be converted to mammalian lignans by colonic bacteria.

Cruciferous vegetables include cauliflower, watercress, radish, rapini, arugula, spinach, turnip and kale. Packed with vitamins and minerals, these vegetables boast impressive nutritional qualities and potent anticancer properties. Nutrition experts often refer to these vegetables as "functional foods." Like all vegetables, crucifers possess high levels of antioxidants, including vitamin C, vitamin A, calcium, iron, folate, soluble fibre, and lignans. All these compounds may help reduce the risk of cardiovascular disease. Most findings on crucifers support their cancer- fighting abilities. Researchers have isolated sulfur- containing phytochemicals called glucosinolates that are abundant in cruciferous vegetables and that have the potential to inhibit cancer.

These glucosinolates, when chopped, chewed, and digested, are converted into compounds called isothiocyanates, which act to prevent normal cells from becoming cancerous cells by stimulating the body to clear potential cancer-causing agents (carcinogens). While they are loaded with beneficial nutrients, it should be noted that cruciferous vegetables also contain goitrogens and nitriles. In large quantities, goitrogens can reduce thyroid activity. Very high quantities of nitriles, which are found especially in Brussels sprouts, can have negative effects on the liver and kidneys.

Heavy metals in green leafy vegetables

Green leafy vegetables are key component of a balanced diet. These vegetables are valuable sources of vitamins, minerals, dietary fiber and anti oxidants (Abdulazeeza and Aziz, 2014; Sobukola *et al.,* 2010). Recently, there is an increased trend of consumption of green leafy vegetables, particularly among the urban community. However, both vital and lethal elements are present in green leafy vegetables. Vegetables constitute essential diet components by contributing protein, vitamins, iron, calcium and other nutrients, which are usually in short supply (Thompson and Kelly, 1990). They also act as buffering agents for acidic substances produced during the digestion process.

However, they contain both essential and toxic elements over a wide range of concentrations. Metal accumulation in vegetables may pose a direct threat to human health (Türkdogan *et al.,* 2003; Damek-Poprawa and Sawicka-Kapusta, 2003). Vegetables accumulate

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heavy metals in their edible and non-edible parts (Shuaibu *et al.,* 2013). Absorption capacity of heavy metals depends on the nature of the vegetable and some of them have a greater potential to accumulate higher concentrations of heavy metals than others (Akan, *et al.,* 2009) Vegetables take up metals by absorbing them from contaminated soils, as well as from deposits on different parts of the vegetables exposed to the air from polluted environments (Zurera-Cosano *et al.,* 1989). They can absorb heavy metals through contaminated soil and irrigation water sources. Furthermore, green leafy vegetables have the ability to absorb the metals deposited on plant surfaces exposed to the polluted environments (Sharma *et al.,* 2009).

Although certain heavy metals (Cr, Mn, Ni, Zn, Cu, and Fe) are essential components for various biological activities within the human body, elevated levels of them can cause numerous health consequences to mankind. In contrast, Pb, Cd, Hg and As are non essential, toxic elements which are associated with many chronic diseases in human beings (Chen *et al.,* 2014). A number of studies have shown the heavy metal contaminations of fruits and vegetables collected from production sites of various countries (Hu *et al.,* 2013). Nankishore shows increased levels of heavy metals in leafy vegetables from selected markets in Guyana due to atmospheric deposition (Nankishore, 2014). Lately Mebale, reported the occurrence of heavy metal contamination in leafy vegetables sold in markets of Libreville,

Gabon, is also due to the atmospheric deposition (Mebale *et al.,* 2014). Metal concentrations in four leafy vegetables sold in markets of Abraka, Delta State, Nigeria was investigated by Agbogidi and Erhenhi (2013), while Sobukola *et al* (2010) reported the concentrations of heavy metals in fruits and leafy vegetables sold in selected markets of Lagos in Nigeria.

Rapid industrialization and urbanization have caused increased traffic activities which subsequently contributed to substantial accumulations of heavy metals in the environment. In addition, wide range of small scale industries including textile, battery production, galvanizing, metal products, and cable coating industries; brick kilns; diesel generators; re- suspended road dust etc. have also contributed to the heavy metal accumulation in the environment. Consequently, these toxic metals can be deposited on the vegetable surfaces during their production, transport and marketing (Sobukola *et al.,* 2010; Sharma *et al.,* 2009).

These green leafy vegetables may also be contaminated from heavy metals while farmers wash them with polluted water before taking them to the markets. It is therefore anticipated that the most consumed green leafy vegetables marketed along the roadside open markets in urbanized areas are contaminated with heavy metals. Further, due to the persistent nature and cumulative behavior of heavy metals they have the ability to concentrate through food chains and cause toxic effects to the human (Sharma *et al.,* 2009). Hence, there is a need to analyze these food items to ensure that the levels of these trace elements comply with permissible limits specified by local and international requirements.

This is particularly important for green leafy vegetables, where only limited data on heavy metal contents of such highly consumed agricultural materials are available (Kananke *et al.,* 2014). It has been reported that nearly half of the mean ingestion of lead, cadmium and mercury through food is due to plant origin (fruit, vegetables and cereals). Moreover, some population groups seem to be more exposed, especially vegetarians, since they absorb more frequently 'tolerable daily doses'. Food contamination by heavy metals depends both on their mobility in the soil and their bioavailability. Though some of the mobility and bioavailability factors are easy to measure, determination of the food risk contamination is tricky (Ejaz ul Islam *et al.,* 2007).

Heavy metal pollution is of significant ecological/environmental concern. This is due to the fact that they are not easily biodegradable or metabolized, thus precipitating far reaching effects on the biological system such as human, animals, plants and other soil biota (Yoon, 2003). Researchers have also stressed that these metals could bioaccumulate in crops, especially when cultivated along construction sites and are consumed by man and livestock (Tulonen *et al*., 2006).

Human exposures to heavy metals have been the focus of increasing attention among researchers, health and nutrition experts due to their impact on public health. Intake of vegetables is an important path of heavy metal toxicity to human being and based on persistent nature and cumulative behavior as well as the probability of potential toxicity effects of heavy metals as a result of consumption of leafy vegetables, it is imperative to determine the level of some of these metals in the selected vegetables (Shuaibu *et al.,* 2013). Green Leafy Vegetables (GLVs) are important part of diets in the South-South Region of Nigeria. Consumption of vegetables exposed to heavy metal contamination may be of serious health consequences.

Anti-nutrients in green leafy vegetables

Green leafy vegetables are an essential part of the Nigerian diet and about 60 different species of green leafy vegetables are consumed in Nigeria (Kubmarawa *et al*., 2009). These vegetables generally have high nutritional contents, and they are consumed for health and nutritional benefits (Otitoju *et al*., 2012).

However, vegetables contain anti-nutritional factors that can affect the availability of nutrients to the human body. These anti-nutritional factors interfere with metabolic

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processes and reduce the bioavailability of nutrients from plants or plant products used as human foods (Abara, 2003; Agbaire and Emoyan, 2012). Plants generally contain chemical compounds (such as saponins, tannins, oxalates, phytates, trypsin inhibitors and cyanogenic glycosides) which are known as secondary metabolites and which are biologically active (Soetan and Oyewole, 2009).

However, a substance cannot be classified as an anti-nutritional factor based on the intrinsic characteristic of the compound; an anti-nutrient exerts its adverse effects generally at the level of the digestive process of humans (Kumar, 1992; Udousoro *et al.,* 2013). Tannins are water-soluble phenolic compounds (Akande *et al*., 2010) that chelate Fe and Zn and limit the absorption of these nutrients. Tannins may precipitate proteins from aqueous solution by inhibiting digestive enzymes (Soetan and Oyewole, 2009) and have been found to interfere with digestion by displaying anti-trypsin and anti-amylase activity. Phytate decreases the bioavailability of proteins and essential elements such as Ca, Mg, Zn, Fe, and P by forming insoluble complexes, which are not readily absorbed by the gastrointestinal tract (Akande *et al*., 2010; Agbaire and Oyewole, 2012).

Oxalates interfere with magnesium metabolism and react with proteins to form complexes, which have an inhibitory effect in peptic digestion (Akande *et al*., 2010). Oxalate binds to calcium to form insoluble calcium oxalate crystals; these prevent the absorption and utilization of calcium by the body thereby causing diseases such as rickets and osteomalacia (Ladeji *et al*., 2004; Agbaire, 2012). Cyanogens glycosides on hydrolysis yields toxic hydrogen cyanide (HCN). The cyanide ions inhibit several enzyme systems and depress growth through interference with certain essential amino acids and utilization of associated nutrients (Soetan and Oyewole, 2009). A high level of hydrogen cyanide has been implicated in cerebral damage and lethargy in man (Ekop, 2007; Agbaire and Emoyan, 2012).

Conclusion

Green leafy vegetables constitute an indispensable constituent of human diet. Protein, vitamin and mineral needed in diet as well as roughages which promotes digestion and prevents constipation are supplied by vegetables. Green Leafy Vegetables are predominantly known for their high nutritional content and are mostly consumed for their health and nutritional benefits. Leafy vegetables are ideal for weight management as they are typically low calorie and are useful in ameliorating cancer and heart diseases since they are low in fat, high in dietary fiber and rich in folic acid, vitamin C, potassium, magnesium as well as containing a host of phytochemicals. However, they contain both essential and toxic elements over a wide range of concentrations. Metal accumulation in vegetables may pose a direct threat to human health. Vegetables accumulate heavy metals in their edible and non-edible parts. Absorption capacity of heavy metals depends on the nature of the vegetable and some of them have a greater potential to accumulate higher concentrations of heavy metals than others.

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