CHARACTERIZATION OF FAT-SOLUBLE VITAMINS AND MINERAL NUTRIENT OF THE SEEDS OF *Senna occidentalis* FROM REGIONS AROUND ZARIA

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Abstract: The seeds of *Senna occidentalis* were collected from a farmland in Jama'a village, Zango-Shanu along Samaru road, Zaria, Kaduna State. The samples were prepared and analyzed using UV-visible and AAS, respectively for contents of fat-soluble vitamins (A, D, E, and K) and minerals (Na, P, K, Mg, Ca, Fe, Zn and Cu) compositions. The study showed that the vitamins A, D, E, and K contents were 2.432 mg/L, 0.487 mg/L, 17.459 mg/L, and 0.067 mg/L, respectively. Sodium (Na), phosphorus (P), potassium (K), magnesium (Mg), calcium (Ca), iron (Fe), zinc (Zn) and copper (Cu) compositions of the seeds were 0.013 mg/L, 0.782 mg/L, 9.700 mg/L, 116.084 mg/L, 231.133 mg/L, 19.600 mg/L, 7.5947 mg/L and 457.965 mg/L.

Keywords: *Senna occidentalis*, fat-soluble vitamins, organic nutrients, Caesalpiniaceae, lipids.

Introduction

Vitamins are organic substances necessary for metabolism. They are essential organic nutrients, most of which are not made in the body, but mainly obtained through food (Amani, 2006). Deficiency or excess of vitamins can cause serious human health diseases and sometimes, small concentrations are required for maintenance of good human health (Hussain *et al*., 2006). They are required as vital nutrients in tiny amounts by an organism. Vitamins serve as biocatalysts in many chemical reactions as well as precursors to various body factors. They are also needed for a variety of biological processes, niacin for mental alertness, vitamin C for resistance to infections, Vitamin A is necessary in vision, gene transcription (Duster, 2008; Daniel and Krishnakumari, 2016), immunity, dermatology (Nelson *et al*., 2008), growth and development (Solomon and Orozco, 2003), vitamin E as antioxidants (Thiollet, 2001), and so on. Thiamine (VB_1) derivatives and thiamine dependent enzymes are present in all cells of the body, thus a thiamine deficiency would seem to adversely affect all of the organ systems. However, the nervous system and the heart are particularly sensitive to thiamine deficiency because of their high oxidative metabolism (Daniel and Krishnakumari, 2016).

Vitamins are classified as either water-soluble or fat-soluble. In humans, there are 13 vitamins: 4 fat-soluble (A, D, E, and K) and 9 water-soluble (8 B vitamins and vitamin C). Fat- soluble vitamins A, D, E and K are insoluble in water and are utilized only if there is enough fat in the body and intake in excess of daily need is stored in the body (Thiollet, 2001). Fat-soluble vitamins are absorbed through the intestinal tract with the help of lipids (fats). Fat-soluble vitamins are stored in the liver and fatty tissues, allowing accumulation over time (Combs, 2008).

Mineral nutrients also known as dietary minerals are the chemical elements required by living organisms.They are inorganic elements that are contained in food. They are the most important factors in maintaining all physiological processes, constituents of the teeth, bone, tissues, blood muscle and nerve cells (Daniel and Krishnakumari, 2016). Characterization of mineral elements present in plants is important because the concentration and type of minerals present must often be stipulated on the label of a food. The quality of many foods depends on the concentration and type of minerals they contain and also play a very significant role against a variety of degenerative diseases and processes. They may also prevent and reduce injury from environmental pollutants and enhance the ability to work and learn; some minerals are essential to a healthy diet (e.g. calcium, phosphorus, potassium and sodium) whereas some can be toxic (e.g. lead, mercury, cadmium and aluminium). Bioactive chemical compounds found naturally in plants work with nutrients and dietary fibre to protect against diseases (John, 1996; Criag, 1999; Daniel and Krishnakumari, 2016).

Senna occidentalis (L.) is a small shrub about 3 ft. high belongs to Leguminosae family. It is native to the tropical regions of America and naturalized in Australia, Eastern Africa, Southern and Eastern USA (Isah and Mujib, 2013; Odeja *et al*., 2014). Typically, *Senna* species have yellowish flowers, they may be herbs, smallish trees or even a kind of liana, but typically are shrubs or subshrubs. Many of *Senna* species have extrafloral nectarines (Nassar *et al*., 2011). It belongs to family Caesalpiniaceae, subfamily Caesalpinioideae. It is anayurvedic plant with huge medicinalimportance (Shittu *et al*., 2014). Flat pods of *S. occidentalis* seeds are 10-12 cm long with 10-30 seeds. Areolate seeds are pointed at the end and blunt at the other end (Reeta and Ravindra, 2013).

Bisby *et al.* (2011) in their catalogue of life stated that the accepted scientific name is *Senna occidentalis* (L.) Link. *Cassia occidentalis* L. is one of many synonyms, commonly known as Coffee Senna and it is called *ewe oriesi* in Yoruba. It is distributed as a weed throughout the tropical and subtropical regions of the world. It can be found at low and medium altitudes, as a weed in waste places, in open pastures and in fields cultivated with economic crops such as soybean, cotton, corn, sorghum and others. Thus, during the harvest it is almost impossible to prevent this plant from mixing with the cultivated crops. It grows also luxuriantly in all available spaces, such as neglected gardens, roadsides, near lakes or streams and unused grounds of public buildings (Egziabher *et al*., 1989; Vashishtha *et al*., 2009).

Leaves of *S. occidentalis* plant have ethnomedicinal importance like paste of leaves isexternally applied on healing wounds, sores, itch, cutaneous diseases, bonefracture, fever, ringworm, skin diseases and throat infection. Previouspharmacological investigations showedthat *S. occidentalis* leaf extracts haveantibacterial (Saganuwan and Gulumbe, 2006), antimalarial (Tona *et al*., 1999), antimutagenic (Jafri *et al*., 1999; Sharma *et al*.,

2000), anticarcinogenic (Sharma *et al.*, 2000) and hepatoprotective *(*Yadav *et al.*, 2009*)* activity. Moreover, studies on this plant showed that the nature and amount of the phytochemicals varies according to the season and geographical location *(*Yadav *et al.*, 2009*;* Shittu *et al*., 2014*)*. It is also used against stomach disorders, rheumatism and in treatment of liver diseases (Jafri *et al*., 1999). Despite its great importance, *Senna occidentalis* plant is one of the most toxic plants of veterinary interest as regards contamination of animal rations. Its poisoning effects include ataxia, diarrhea, myoglobinuria and sternal recumbency leading to death depending on the animal (Tasaka *et al*., 2000). Studies have shown that histopathological tests of animals fed with the plant revealed that the heart and liver were the main organs affected with myocardial necrosis and centrolobular development (Tasaka *et al*., 2000).

Soaring prices of food items recently have triggered an increase in hunger worldwide, especially in Sub-Sahara African countries like Nigeria. This hike has been attributed to several factors including but not limited to production shortages as a result of drought and flood, climate change, high biofuel demands (FAO, 2008). Because much work has not been done on this particular genus (Yadav *et al*., 2009), this paper therefore reports on the fat-soluble vitamins and mineral nutrients of *Senna occidentalis* seeds from Zaria, Nigeria.

Materials and Methods

Collection of sample and preservation

The seeds of *Senna occidentalis* were collected from a farmland within Jama'a village, Zango-shanu along Samaru road, Zaria, Kaduna state and were identified in the Department of Biological Science, Ahmadu Bello University, Samaru, Zaria. The samples were dried and opened to get the seeds which were then dried at room temperature and ground using a Thomas-Wiley laboratory mill to fine powder and sieved with a 0.01 mm sieve size and kept in a dried grease free polyethylene bag.

Samples pre-treatment and analysis

Pretreated samples were prepared for analysis for both fat-soluble and mineral nutrients according to procedure described by AOAC (1999). Two grams of the sample was weighed and poured into a beaker, then diluted with 10 mL of water and allowed for 4 h and filtered. The fat-soluble vitamins in the sample were determinedspectrophotometrically (using a Jenway 6305) at the National Research Institute for Chemical Technology (NARICT), Zaria. A 5 g aliquot of the pretreated sample was weighed into 100 cm kjeldahl digestion flask and 2 g of catalyst mixture (K_2SO_4 + $anhCuSO_4$) was added to speed up the reaction. 70 mL of concentrated sulphuric acid was added into the flask. The content in the kjeldahl digestion flask was heated slowly at first in kjeldahl digestion heating unit until fretting subsides and then it was shaken vigorously with occasional rotation of the flask to ensure even digestion and to avoid over heating of the sample at a particular point.

Results and Discussion

The results of fat-soluble vitamins determined in *Senna occidentalis* in the sample is presented in the Table 1. The result shows that the seeds contained an appreciable content of fat-soluble vitamins. The vitamin A content of the seeds is 2.432 mg/L. Vitamin A is important for normal vision, gene expression, growth and immune function by its maintenance of epithelial functions (Lukaski, 2004). The quantity of vitamin E quantitatively estimated is 17.451 mg/L. Vitamin E is a powerful antioxidant which helps to protect cells from damage by free radicals and it is vital for the formation and normal function of red blood cell and muscles. Vitamin D helps to regulate bone health, muscle health, immune response, insulin and blood sugar (Annweiler *et al*, 2010). The seeds contained vitamin D at a concentration of 0.487 mg/L. The *Senna occidentalis* seeds contain vitamin K content of 0.067 mg/L. Vitamin K is important in clotting or coagulation of blood (Bender, 2003).

Table 1: Fat-soluble vitamins content in *Senna occidentalis* seeds from Zaria

Vitamins	Concentration (ppm)
A	2.432
D	2.432
E	2.432
K	2.432

Table 2: Mineral compositions of the *Senna occidentalis* seeds

Mineral	Symbol	Concentration (ppm)
Sodium	Na	0.013 ± 0.0003
Potassium	K	9.700 ± 0.0030
Phosphorus	P	0.782 ± 0.0016
Magnesium	Mg	116.084 ± 0.0016
Calcium	Ca	231.133 ± 0.0003
Copper	Cu	457.964 ± 0.0037
Iron	Fe	19.660 ± 0.0003
Zinc	Zn	7.597 ± 0.0059

Values are expressed by mean ± SD of 3 Samples

The result reveals that the seeds contained essential minerals with abundance in copper, calcium and magnesium. Sodium (Na) is an essential element that regulates plasma volume and acid-base balance required in maintsining the osmotic pressure of blood fluids, preserve the normal functioning of the muscles and cell permeability amongst other functions (Soetan *et al*, 2010). Phosphorus (P) is indispensable for the structure and function of all living beings, its mainly involved in biological energy transfer mechanisms and cell growth (Feng, 2015). The seeds contained sodium and phosphorus concentrations of 0.013 mg/L and 0.782 mg/L, respectively. This reveals that both elements are in least abundance concentration of the minerals. Potassium (K) helps in co-regulating adenosine triphosphate (ATP) with sodium. The seeds contain 9.700 mg/L of potassium. Magnesium (Mg) plays an important role in regulating the muscular activity of hearth, maintains normal heart rhythm and also converts blood sugar into energy. The concentration of magnesium in the seeds is 116.084 mg/L. The calcium composition of the seeds was found to be 231.133 mg/L. Calcium (Ca) is an essentialconstituent of bones and teeth, helps in normal blood clotting and for the regulation of nerve and muscle functions (Soetan *et al*, 2010).

The Zinc and iron compositions of the seeds were found to be 7.5947 mg/L and 19.660 mg/L respectively. Zinc (Zn) is important in wound healing and also functions as an important antioxidant. Iron (Fe) serves as the core of the hemoglobin molecule and helps to transport oxygen, it also helps in cellular respiration, functions as essential componentof the enzymes involved biological oxidationsuch as cytochromes c, c_1, a_1, etc (Malhotra, 1998). Copper (Cu) is an essential micronutrient necessary for the haematologic and neurologic systems (Tan *et al*,

2006). The seed sample has a copper composition of 457.964 mg/L. This reveals that it is the most abundant elements evaluated in the seeds of *Senna occidentalis*.

Conclusion

Vitamins and minerals are both essential materials needed by the body to trigger thousands of chemical reactions necessary to maintain good health. This research work has shown that the seed of *Senna occidentalis* contains an appreciable content of fat – soluble vitamins (A, D, E and K) in good concentrations. The seeds also contained essential minerals with abundance of them in copper, calcium and magnesium, while they are very low in sodium and phosphorus. The results also revealed that if we take into account the recommended dietary allowance (RDA) for vitamins and minerals by the Food and Agricultural Organization (FAO) (FAO, 2004), the seeds of *Senna occidentalis* can provide about 40% of RDA of the vitamins and minerals analyzed. Also, the low value placed on the seeds of *Senna occidentalis*as it is an under-utilized resource, can therefore be reconsidered based on the findings of this work.

References

Annweiler C, Schott AM, Berrut G, Chauvire V, Le Gall D, Inzitari M & Beauchet O 2010. Vitamin D and ageing: Neurological issues. *J. Neuropsycho.*, 62(3): 139-50.

AOAC 1999. *Officail Methods of Analysis*. Association of Official Analytical Chemists, 16thEdn. Washington DC, USA. ISBN: 0-935584-42-0, p. 200-210.

Bender DA 2003. *Nutritional Biochemistry of the Vitamins*. 2nd Edition, University College London.

Bisby FA, Roskov YR, Orrell TM, Nicolson D, Paglinawan LE, Bailly N, Kirk PM, Bourgoin T, Baillargeon G & Ouvrard D eds. 2011. Species 2000 and IT IS Catalogue of life, 3rd January 2011; Reading, UK.

Combs Gerald F 2008.*The Vitamins: Fundamental Aspects in Nutrition and Health*. Third Edition. Library of Congress Cataloging-in-Publication Data.

Criag W 1999. Health-promoting properties of common herbs. *American J. Clin. Nutr.*, 70(3): 491-499.

Daniel G & Krishnakumari S 2016. Proximate and essential nutrients evaluation in *Eugenia uniflora* (L.) leaves. *Int. J. Appl. & Pure Sci. & Agric*., 2(2): 1-8.

Delgado C, Rosegrant M, Steifeld H, Ehui S & Courbois C 1999. *Livestock to 2020, the Next Food Revolution*. IFPR/FAO/ILRI, International Food Policy Research Institute, Washington DC.

Duster G 2008. Retinoic acid synthesis and signaling during organogenesis. *Cell*, 134(6): 921-93.

Egziabher TBG, Hedberg O, Tadesse M, Frils I, Hedberg I & Edwards S (Eds) 1989. *Flora of Ethiopia*, Vol. 3. Institute of Botany, Uppsala University. Addis Ababa and Asmara, Ethiopia and Uppsala, Sweden, pp. 49-63.

Feng TY 2015. Examination of metabolic responses to phosphorus limitation via proteomic analyses in the marine diatom *Phaeodactylum tricornutum. Scientific Reports* 5, Article number:10373. Doi:10.1038/srep10373.

Food and Agricultural Organization (FAO) of the United Nations, Rome, 2008.

Hussain I, Salam M, Iqbal Y & Khahil S 2006. Comparison of vitamin C in commercial tea brands and fresh tea leaves. *J. Chem. Soc. Pak.*, 28(5): 421-425.

Isah T, & Mujib A 2013. *In vitro* plant regeneration of coffee senna (*Senna occidentalis*) from hypocotyl-derived callus. *Acta Biol. Cracoviensia*, 55(2): 120–125.

Jafri MA, Subhani MJ, Javed K & Singh S 1999. Hepatoprotective activity of leaves of *Cassia occidentalis* against paracetamol and ethyl alcohol intoxication in rats. *J. Ethnopharmac*., 66: 355-61.

John T 1996. Phytochemicals as evolutionary mediators of human nutritional physiology. *Int. J. Pharmac*., 34(95): 327-334.

Lukaskis HC 2004. Vitamin and mineral status: Effects on physical performance. *Nutrition*, (7-8): 632-44.

Malhotra VK 1998. *Biochemistry for Students*. Tenth edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, India.

Nassar MAA, Ramadan HRH & Ibrahim HMS 2011. Morphological characteristics of vegetative and reproductive growth of *Senna occidentalis* (L.) Link (Caesalpiniaceae). *Res. J. Agric. & Biol. Sci.*, 7(2): 260-270.

Nelson A, Jenkins O & Merran P 2008. Neutrophil gelatinase associated lipocasin mediated B-cis retinoic acid-inducedapoptosis of human sebaceous gland cells. *J. Clin. Investigation*, 118(8): 1468-1472.

Odeja OO, Obi G, Ogwuche CE, Elemike EE & Oderinlo OO 2014. Phytochemical screening, Antioxidant and Antimicrobial activities of *Senna occidentalis* (L.) leaves. *Int. J. Herbal Medi.*, 2(4): 26-30.

Reeta M & Ravindra S 2013. Kasamarda (*Senna occidentalis* Linn) Ayurvendic approach. *J. Pharmac. &Sci. Innovation*, 2(2): 25-27.

Saganuwan AS & Gulumbe ML 2010. Evaluation of *in vitro* antimicrobial activities and phytochemical constituents of *Cassia occidentalis*. *Life Sci. & Medi. Res.*, 3: 566-569.

Shittu OB, Olabode OO, Omemu AM, Oluwalana SA, Adeniran S & Akpan I 2014. Phytochemical and antimicrobial screening of *Spondiasmombin, Senna occidentalis* and *Musa sapientum* against *Vibrio cholerae*O1. *Int. J. Curr. Microbiol. App. Sci.*, 3(5): 948-961.

Soetan KO, Olaiya CO & Oyewole OE 2010. Importance of mineral elements for humans, domestic animals and plants: A review. *African J. Food Sci.*, 4(5): 200-222.

Solomon NW & Orozco M 2003. Alleviation of vitamin A deficiency with palm fruits and its product. *Clinical Nutrition*, 12(3): 373-384.

Tan JC, Burns DL & Jones HR 2006. Severe ataxia, myelopathy and peripheral neuropathy due to acquired copper deficiency in a patient with history of gastrectomy. *J. Parental Nutr.*, 30: 446-450.

Tasaka AC, Weg R, Calore EE, Sinhorini IL, Dagli MLZ & Haragudri M 2000. Toxicity testing of *Senna occidentalis* seed in rabbits. *Vet. Res. Commun.*, 24: 573–82. Doi:10.1023/A:1006448103889.

Tona L, Ngimbi NP, Tsakala M, Mesia K, Cimanaga K, Apers S, De Bruyne T, Pieters L, Totte J & Vlientinck AJ 1999. Antimalaria activity of 20 crude extract from nine African medicinal plants used in Kinshasa Congo. *J. Ethnopharmac.*, 68: 193-203.

Vashshtha VM, John TJ & Kumar A 2009. Clinical and pathological features of acute toxicity due to *Cassia occidentalis* in vertebrates. *Indian J. Medi. Res.*,130: 23-30.

Yadav JP, Arya V, Yadav S, Panghal M, Kumar S & Dhankhar S 2009. *Cassia occidentalis*: A review on its ethnobotany, phytochemical and pharmacological process. *Fitoterapia*, 81(4): 23-30.