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Assessment of nutritional quality of water hyacinth leaf protein concentrate

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Abstract This study was embarked upon to convert water hyacinth, an environmental nuisance, to a natural resource for economic development. Water hyacinth leaf protein concentrate (WHLPC) was extracted in edible form and determination of its physicochemical characteristics, total alkaloids and phenolic compounds was done. Analysis of proximate composition and amino acid profile of the WHLPC was also done. The level of heavy metals (mg/kg) in WHLPC was found to be Cd (0.02 ± 0.001), Cr (0.13 ± 0.001), Pd (0.003 ± 0.001) and Hg (0.02 ± 0.001) while concentrations of Pb, Pt, Sn, Fe, Cu, Zn, Ni and Co were found to be 0.001 ± 0.00. Level of all heavy metals was found to be within safe limit. Proximate analysis revealed that protein in WHLPC accounted for 50% of its nutrients, carbohydrate accounted for 33% of its nutrients while fat, ash and fibre made up the remaining nutrients. Amino acid analysis showed that WHLPC contained 17 out of 20 common amino acids, particularly, Phe (3.67%), Leu (5.01%). Level of total alkaloids and phenolic compounds was 16.6 mg/kg and 6.0 mg/kg respectively. Evidence from this study suggests that WHLPC is a good source of leaf protein concentrate (LPC); it is nutritious and acutely non toxic.

Introduction

Water hyacinth (*Eichhornia crassipes*) is a free-floating perennial aquatic plant whose origin had been traced to tropical and sub-tropical South America. The leaves are broad, thick, glossy and ovate. The stalks are usually long, spongy and bulbous. The roots are feathery, freely hanging and purple-black in colour. The flowers are attractive consisting of six petals. It grows so fast that it can double its population in two weeks. Its mode of reproduction is by runners or stolons producing daughter plants. It produces seeds in large quantity which may remain viable for up to thirty years. (Simpson and Sanderson, 2002).

E. crassipes was first noticed in Nigeria in September 1984 when it invaded Badagry creek in Lagos State forming a 'mat' over the water surface. In less than six months, it had spread to other creeks and lagoons in Lagos and its environs. The weed was believed to enter Nigerian Coastal waters through the Porto-Novo creek in the Republic of Benin (Kusemiju et al., 1988). Water hyacinth is so stubborn that it will cover the entire water surface preventing adequate sunlight and oxygen from reaching aquatic lives thereby leading to death of fishes

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and turtles. It also creates a breeding ground for mosquitoes and other vectors (Opande et al., 2004).

Nevertheless, a careful review of biochemistry and physiology of water hyacinth suggests that it could have useful application as raw materials in industries. This study is an effort to harness the inherent benefits in water hyacinth to prevent wasteful spending on its control. Water hyacinth leaf protein concentrate (WHPLC) may be used as supplementary food. It is likely to be nutritious because of the high protein content and the content of unsaturated fats, carotenes, xanthophylls, starch and minerals such as iron, calcium and phosphorus (Kateregga and Sterner, 2007). However, extraction of WHLPC in edible form has been scanty in literature. The concentrated form of proteins that are found in plant leaves are referred to as leaf protein concentrate (LPC). Due to its availability and affordability, LPC are being considered as for human and animal consumption. This idea was first coined in the 1960s although not much success was achieved (Simpson and Sanderson, 2002). Pirie (Pirie, 1971, 1975) Nobel Laureate, reviewed the idea. The search of replacement for animal protein tremendously increased the interest in LPC.

Report showed that LPC is a good source of amino acids except methionine. It is also rich in polyphenols. Although cassava and Lucerne are viable protein source for humans, the high fibre content together with other antinutrients such as phytate, cyanide and tanins posed a major challenge (Ayodeji, 2005). The dearth of animal protein and high cost of production of food as well as rapid growth in population, necessitated the search for alternative sources of protein such as the LPC from water hyacinth (Ogunlade et al., 1988). The water hyacinth leaf protein concentrate combined with other feeds has been reported to be a good quality protein source for animal feed formulation (Igbinosun and Talabi, 1982). Recently, substances derived from plant have attracted much interest due to their wide application in agriculture, medicine and pharmaceuticals (Ncube et al., 2008).

Toxicological studies nowadays are making immense contribution to human health and these studies abound (Abo-Bakr et al., 1984; Bolenz et al., 1990; Kateregga and Sterner, 2007). The aspects discussed are dietary safety, and daily dose. In the present time where natural resources are quickly depleting, it is our interest to determine the possibility of using water hyacinth leaf protein concentrate for food production, food additives, pharmaceuticals and raw materials for agro-allied industries. The present investigation describes the use of water hyacinth for the preparation of leaf protein concentrate and determines its value as food for humans.

Materials and methods

Reagents

Reagents and solvents were of analytical grade and are products of British Drug House, Poole, England.

Study area

Warri is the commercial capital of Delta State, located in the Niger-Delta region of Nigeria. It is situated on the north bank of the Warri River. River Ijana, where the water hyacinth were collected from, is located within longitude 5.54°E and 5.7°W and latitude 5.31°N and 5.6°S. River Ijana runs Ubeji and Ughuotor in Warri. It flows in one direction and infested with dense population of water hyacinth making transportation difficult and fishing activity is almost coming to a halt. The water hyacinth samples were collected during the early rainy season, in the month of June.

Sample collection

The *E. crassipes* (Mart.) Solms samples were collected from points along the shoreline of Ijana River in Ekpan. Afterwards, the plant materials were taken in a polyethene bag to the laboratory for further treatment.

Extraction of water hyacinth leaf protein concentrate (WHLPC)

The water hyacinth leaves collected from Ijana River were thoroughly washed in water, and blanched for 5 mins with 5% acetic acid, in a heating mantle. The leaves were then rinsed in de-ionized water and allowed to dry at room temperature. Furthermore, the leaves were soaked in 95% ethanol for 6hrs to remove the fat and then dried in an incubator at 45 °C to obtain the water hyacinth leaf protein concentrate (WHLPC). The now formed water hyacinth leaf protein concentrate (WHLPC) was ground in a Teflon base grinder and stored in an air tight container, for further analysis (Pirie, 1971).

Physicochemical analysis of WHLPC

Heavy metal analysis

Heavy metal analysis of WHLPC was done with an Atomic Absorption Spectrophotometer (AAS), using the American Public Health association (APHA, 1995) guidelines. In the analysis for heavy metal, the following metals were analysed: Cadmium (Cd), Chromium (Cr), lead (Pb), Platinum (Pt), Palladium (Pd), Tin (Sn), Mercury (Hg), Iron (Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Nickel (Ni) and Cobalt (Co).

Determination of total alkaloids

Concentration total alkaloids of WHLPC was determined by the method described by Harbone (Harbone, 1973).

Determination of total phenolic compounds

Concentration of total phenolic compounds of WHLPC was determined following the method described by Edeogal et al. Edeoga1 et al. (2005).

Proximate analysis of WHLPC

The proximate analysis of water hyacinth leaves was carried out according to the method described by AOAC (AOAC, 2005). The parameters considered were crude protein, crude fibre, ash, moisture content, fat and carbohydrate.

Amino acid analysis

Amino acid analysis was done using the techno sequential multi-sample amino acid analyser (TSM). The quantity of amino acid contained in the sample was calculated in g/100 g protein from the chromatogram produced.