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Nutritional and phytochemical compositions of fireweed (*Crassocephalum crepidioides*)

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The stems and leaves of fireweed were cut into smaller pieces, dried and ground into very fine powder. The powdered sample was analyzed for proximate and mineral constituents and this was further subjected to extraction using acetone, chloroform, ethylacetate, methanol and water. The powdered sample as well as its solvent-extracts was screened for phytochemicals. The result revealed that moisture, crude protein, lipid, ash, crude fibre, carbohydrate and food energy value were 10.16±0.22%, 15.09±0.42%, 2.48±0.21%, 13.15±0.18%, 13.27±0.14%, 56.01±0.17% and 306.72±1.02Kcal/100g respectively. The mineral composition of fireweed was calcium (105.09±0.62mg/Kg), sodium (64.86±0.43mg/Kg), potassium (791.40±1.08mg/Kg), magnesium (20.34±0.17mg/Kg), iron (1.92±0.01mg/Kg), manganese (2.16±0.09mg/Kg), while zinc, lead, copper and selenium ranged between 0.09±0.00mg/Kg and 0.14±0.00mg/Kg. It was found out that the powdered sample contained flavonoid, phenol, oxalate, tannin, saponin, phytate and ascorbic acid but no alkaloid was present. Water extract contained all the phytochemicals present in the sample but methanol extract contained all the phytochemicals present in the sample except flavonoids. It was only phytate found in ethylacetate extract. Chloroform extract contained phytate and ascorbic acid while acetone extract contained oxalate, saponin, phytate and ascorbic acid. Fireweed is very rich in nutrient and methanol as well as water is very effective in extracting bioactive materials from the sample than ethylacetate, chloroform and acetone.

Key words: Fireweed, Proximate, Mineral, Solvent-Extracts and Phytochemicals.

Introduction

Fireweed is one of the neglected and under-utilized vegetables among the Yorubas in Nigeria. One of the major reasons among others for neglecting the plant is because of the unpleasant odour (aroma) that is inherent in the

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vegetable and this might be because of the certain phytochemical constituent of the plant. Due to this, it is considered as weed, commonly found in abandoned farmlands, wastage places, plantations and backyard gardens that are rich in organic matter (Zollo *et al*., 2000). The plant's temperature requirement is 23-30^{0}C and annual rainfall of 600-1500 is suitable. It prefers well-drained, dogged condition and grows well under shade in cocoa or tea plantation (Burkilli, 1995). It belongs to the family of *Asteraceae* (sunflower family) and taxonomically known as *Crassocephalum crepidioides* (Cronquist, 1981). Its English names are thickhead, red flower ragleaf while the Yoruba tribe in South-West of Nigeria calls it "Efo Ebolo or Ebire" (Burkilli, 1995).

Generally, vegetables are those herbaceous plants whose part or parts are eaten as supporting food or main dishes and they may be aromatic, bitter or tasteless (Mensah *et al*., 2008; Edema, 1987). Okafor (1983) reported that vegetables are the cheapest and most available sources of important protein, vitamins, minerals and essential amino acids. They are included in meals mainly for their nutritional value; however, some are reserved for the sick and convalescence because of their medicinal properties (Mensah *et al*., 2008). Phytochemicals are plant secondary metabolites which are naturally occurring biological active plant compounds that have potential disease-inhibiting capabilities. It is believed that phytochemicals may be effective in combating or preventing diseases due to their antioxidant effect (Akinmoladun *et al*., 2007; Farombi *et al*., 1998). Arawande *et a.l* (2012) reported that the availability of these phytochemicals in vegetables and other plants is not unrelated to their antioxidant potentials and medicinal properties of the plants and their extracts.

Fireweed contains fleshy, mucilaginous leaves and stems which are eaten as vegetable. A lotion of the leaves is used as a mild medicine that strengthens the stomach and excites its action. The plant is said to contain antiseptic compounds (which inhibit bacterial growth) and anti-inflammatory substances (Small and Catling, 1999). Nigerian and British researchers have confirmed that high intake of local vegetables prevent, correct or treat health disorders such as diabetes, cancers, arthritis, obesity, high blood pressure, haemorrhoids and gallstone (Auld and Medd, 2003). Considering the various ways of fireweed usage by ancient and local people suggest that the plant contains nutritional and bioactive substances. Therefore, the aim of this study is to evaluate the nutritional and mineral composition as well as qualitative phytochemical screening of the plant and the extracts obtained from it using different solvents with the view of sensitizing people on the need for the consumption of the plant as well as establishing the best solvent for phytochemical extraction.

Materials and methods

Source and Preparation of Fireweed

Fireweed (stems and leaves) was obtained from an open land near an ancient dilapidated building in Iyere Owo, Ondo-State, Nigeria. The stems and leaves of fireweed were rinsed in water, cut into smaller pieces for easy drying. The dried plant parts were ground using electric blending machine and the powdered sample was packed into a black polyethene bag prior to further analysis and extraction.

Determination of Nutritional Composition and Food Energy Value of Fireweed

The proximate composition (moisture, fat, protein, ash, crude fibre and carbohydrate) of powdered sample of fireweed were determined according to the methods described by AOAC (2005). The gross food energy value was estimated by multiplying the crude protein, crude fat and carbohydrate contents by Atwater factor of 4, 9 and 4 respectively (Osborn and Vooget, 1978).

Determination of Mineral Composition of Fireweed

The sample was ashed and digested with 2M HNO_3. The mixture was filtered and the filtrate was made up to 100ml with de-ionized water in a 100ml volumetric flask. Jenway Digital Flame Photometer (PFP7 Model) was used in reading the concentration of calcium, potassium and sodium while Buck Scientific Atomic Absorption Spectrophotometer (BUCK 210 VGP Model) was used in reading concentration of magnesium, iron, zinc, manganese, lead, copper and selenium at their respective wavelengths (Osborn and Vooget, 1978).

Solvent Extraction of Fireweed

Ten gram of the powdered sample was weighed into five cleaned and dried reagent bottles and 100ml of each solvent (methanol, ethhylacetate, acetone, water and chloroform) was separately added to each bottle and left for 72hours during which it was intermittently shaken on a shaking orbit machine. The mixture was filtered through a 0.45μm Nylon membrane filter. The extracts were evaporated to dryness under reduced pressure at 40^0C by a rotary evaporator (Amir *et al*., 2005).

Qualitative Phytochemical Screening of Powdered Fireweed sample and its extracts

Phytochemical screening was carried out on the powdered sample of fireweed and its acetone, chloroform, ethylacetate, methanol and water extracts using standard procedures as described by Sofowora (2008), Trease and Evans (1989), Odebiyi and Sofowora (1978) and Harborne (1973)

Test for Flavonoid

About 0.2g of sample was dissolved in dilute NaOH solution and HCl solution was added. A yellow solution that turns colourless indicates the presence of flavonoids. Extracts were equally screened.

Test for Phenol

About 0.5g of sample was added to 1ml of 10% $FeCl_3$ solution. A deep bluish green colouration was an indication for the presence of phenol. Extracts were equally screened.

Test for Oxalate

About 0.5g of sample was boiled with 1ml of 2% H_2SO_4 solution on water bath. It was filtered while warm and few drops 1% $KMnO_4$ was added. Pink colour confirms the presence of oxalate. Extracts were equally screened.

Test for Tannin

0.5g of sample was mixed with 2ml of water and heated on water bath. The mixture was filtered and 1ml of 10% $FeCl_3$ solution was added to the filtrate. A dark green solution indicates the presence of tannin. Extracts were equally screened.

Test for Saponin

About 0.2g of sample was shaken with 4ml of distilled water and then heated to boil. Appearance of creamy miss of small bubbles (Frothing) shows the presence of saponin. Extracts were equally screened.

Test for Alkaloid

About 0.5g of sample was warmed with 2ml of 2% H_2SO_4 solution on water bath for two minutes. It was filtered and few drops of Dragendoffs reagent were added. Orange red precipitate confirms the presence of alkaloids. Extracts were equally screened.

Test for Phytate

About 0.5g of the sample was mixed with 2ml of 2% HCl solution. It was filtered and two drops of 0.3% ammonium thiocynate (NH_4SCN) solution and 2ml of distilled water were added and shaken. 3 to 4drops of 10% $FeCl_3$ solution were then added. Yellow colouration indicates the presence of phytate. Extracts were equally screened.

Test for Ascorbic acid

About 0.5g of sample was added to 2ml of acetic acid and it was shaken for 3minutes, and then filtered. Few drops of 2, 6-dichlorophenolinddophenol solution were added to the filtrate. The presence of faint pink colour confirms that ascorbic acid is present. Extracts were equally screened.

Results and discussions

Table 1. Proximate Composition (%Dry weight) and Energy Value of Fireweed

Parameter	Value
Moisture (%)	10.16±0.22
Crude Protein (%)	15.09±0.42
Lipid (%)	2.48±0.21
Ash (%)	13.15±0.18
Crude Fibre (%)	13.27±0.14
Carbohydrate (%)	56.01±0.17
Energy Value (Kcal/100g)	306.72±1.03

Values represent means of triplicate determination±standard deviation.

The result of the proximate analysis and energy value of fireweed as shown in Table1 revealed that moisture, crude protein, lipid, ash, crude fibre, carbohydrate and energy value were 10.16±0.22%, 15.09±0.42%, 2.48±0.21%, 13.15±0.18%, 13.27±0.14%, 56.01±0.17% and 306.72±1.03Kcal/100g respectively. The crude protein value was lower than 20.71%-22.50% crude protein for some prawns reported by Abulude *et al*., (2006); 17.28% and

17.50% crude protein reported for *Ocimum gratissium* and *Pengluria extensa* respectively (Okwu, 2006) and 23.8%-27.6% protein for jack beans as reported by Eke *et al.* (2007). However, fireweed crude protein value was higher than 5.7% protein for chaya (tree spinach) reported by Booth *et al* (1992) and 7.44% crude protein for *Tetraplueura tetraptera* fruit (Okwu, 2006). The lipid content of fireweed fell within 0.79% and 3.18% fat content of some Nigerian cowpea varieties (Chinma *et al*., 2008) but far less than 11.18% and 20.36% reported for *Pengluria extensa* leaves and *Tetraplueura tetraptera* fruit (Okwu, 2006).

The ash content was higher than 2.72%-3.26% reported for some Nigerian local varieties of cowpea seeds (Chinma *et al*., 2008) and 8.40% and 5.00% reported for ash content for *Pengluria extensa* leaves and *Tetraplueura tetraptera* fruit respectively (Okwu, 2006). The crude fibre content of fireweed fell within 11.12%-16.23% reported for some prawns (Abulude *et al*., 2006) but less than 18.50% and 25.50% reported for *Gongronema latifolium* and *Gnetum africana* vegetables respectively (Mensah *et al*., 2008). The high fibre content of fireweed promotes bowel regularity and enhances frequent waste elimination including bile acids, sterols and fat. Regular intake of fireweed will help to reduce the intake of starchy food, enhances gastrointestinal function, prevents constipation and may reduce the incidence of metabolic diseases like aging, diabetic mellitus etc (Mensah *et al*., 2008; Egwaikhide *et al*., 2007). The carbohydrate content of fireweed is higher than 47.9% reported for *Vernonia amygdalina* (Mensah *et al*., 2008). Fireweed energy value was lower than 337.57- 360.67Kcal/100g for some cowpea seeds (Chinma *et al*., 2008) but higher than 234.42 and 273.34Kcal/100g for *Ocimum gratissium* and *Pengluria extensa* leafy vegetables respectively (Okwu, 2006).

Table 2. Mineral Composition of Fireweed

Parameter	**Value (mg/Kg)**
Ca	105.09±0.63
Na	64.86±0.43
K	791.40±1.08
Mg	20.34±0.17
Fe	1.92±0.01
Zn	0.09±0.00
Mn	2.16±0.09
Pb	0.10±0.00
Cu	0.14±0.00
Se	0.09±0.00

Values represent means of triplicate determination±standard deviation

Table 2. depicts the mineral composition of fireweed. Calcium, sodium, potassium, magnesium, iron and manganese contents (mg/Kg) were 105.09±0.63, 64.86±0.43, 791.40±1.08, 20.34±0.17, 1.92±0.01 and 2.16±0.09 respectively while zinc, lead, copper and selenium fell within 0.09±0.00 and 0.14±0.00Mg/Kg dry. Among the minerals determined, potassium had the highest value while zinc and selenium had the lowest value. The high content of calcium in fireweed makes it good for bone and teeth formation in children because calcium in conjunction with other minerals (magnesium, manganese and phosphorus), vitamins (A, C and D) as well as protein are involved in bone formation and strengthening, although calcium is the principal contributor (Abulude *et al*., 2006). Fireweed is much richer in calcium, magnesium and iron than *Celosia argentea*, *Ocimum gratissum*, *Vernonia amygdalina*, *Telferia occidentalis*, *Gnetum africana* and *Piper guineense* (Mensah *et al*., 2008). The calcium content of fireweed was lower than 152.0mg/Kg -162.5mg/Kg reported for *Penaeus notialis* and *Procambanis clarkia* respectively but the potassium, sodium and iron contents were higher in fireweed than some prawns found in coaster areas of Ondo-State, Nigeria (Abulude *et al*., 2006). The high content of potassium in fireweed suggests among other things that potassium-rich chemical fertilizer would be required for planting in order to replace the large intake of potassium by the plant. Potassium is primarily an intracellular cation, in large part, this cation is bound to protein with sodium to influence osmotic pressure and contribute to normal pH equilibrium. The calcium, sodium, potassium, magnesium, iron and zinc contents of fireweed were lower than the values obtained for chaya leaf (tree spinach)(*Cnidoscolus aconitifolius*) (Oboh, 2005).

Table 3. Qualitative Phytochemical Screening of Powdered and Solvent-Extracts of Fireweed

Constituents	**Powdered Sample**	**Solvent- Extracts of Powdered Fireweed Sample**				
		Acetone	Chloroform	Ethylacetate	Methanol	Water
Flavonoids	+	-	-	-	-	+
Phenol	+	-	-	-	+	+
Oxalate	+	+	-	-	+	+
Tannin	+	-	-	-	+	+
Saponin	+	+	-	-	+	+
Alkaloids	-	-	-	-	-	-
Phytate	+	+	+	+	+	+
Ascorbic acid	+	+	+	-	+	+

+ = Present - = Absent

Qualitative phytochemical screening of powdered and solvent-extracts of fireweed is shown in Table 3. The phytochemical screening of the powdered sample of fireweed revealed that the plant contained bioactive plant chemicals such as flavonoids, phenol, oxalate, tannin, saponin, phytate and ascorbic acid. Water was able to extract 100% of the phytochemicals found in the powdered sample of the plant; methanol was capable of extracting 86% of the phytochemicals found in the powdered sample of the plant while acetone was able to extract about 57% of the phytochemicals found in the powdered sample of the plant. Chloroform extracted phytate and ascorbic acid amounting to about 29% of the phytochemicals found in the powdered sample of the plant while ethylacetate was able to extract phytate amounting to about 14% of the phytochemicals found in the powdered sample of the plant. It is obvious that as the polarity of the solvent increases so also is their extractive value increases. This is because most of these plant chemicals (bioactive matter) are polar in nature and they are best extracted by polar solvents (Arawande and Komolafe, 2010; Egwaikhide and Gimba, 2007). The presence of these phytochemicals in powdered sample, methanol and water extracts of fireweed suggests that they have therapeutic significance while acetone, chloroform and ethylacetate extracts of fireweed had less or no therapeutic significance.

Flavonoids are natural biological response modifiers because of strong experimental evidence of their inherent ability to modify the body's reaction to allergen, virus and carcinogens (Eghareva and Kunle, 2010). It is known to inhibit platelets aggregation (Formica and Regelson, 1995), and could exert a membrane stabilizing action that may protect liver from injury. Its detoxification and antioxidant activities have been established (Iweala and Obidoa, 2009). Phenol and phenolic compounds are anti-microbial agents hence it is extensively used in disinfections and remain the standard with which other bactericides are compared (Okwu, 2006). Tannin has biological activities that are of benefit in the production and management of many aliments owing to their antiviral, antibacterial and anti-tumor activities (Eghareva and Kunle, 2010). Saponin is being used as mild detergent and in intracellular histochemistry staining to allow antibody access to intracellular proteins. It is of great importance in medicine because it is used in hypercholesterolaemia, hyperglycaemia, antioxidant, anti-cancer, anti-inflammatory and body loss. Steroidal saponins are used as contraceptive and precursors for sex hormones while glycosidal saponins are cardiotonic (Eghareva and Kunle, 2010; Okwu, 2006, Evans, 2002; Sieigler, 1998).Phytate has therapeutic uses as phytonutrient, providing an antioxidant effect. It has a strong binding affinity to important minerals such as calcium, magnesium, iron and zinc; and as such it becomes insoluble precipitate and will be nonabsorbed in the intestine. The mineral binding properties of phytate prevent colon cancer by reducing oxidative stress in the intestinal tract (Osagie, 1998).Ascorbic acid is an antioxidant which helps to protect the body against cancer and other generative diseases such as arthritis and type II diabetes mellitus. It also strengthens the body’s immune system (Egwaikhide and Gimba, 2007). Ascorbic acid is a reductone sugar acid with antioxidant properties. The water soluble compounds of sodium, potassium and calcium salts of ascorbic acid are commonly used as antioxidant food additives but these can not protect fats from oxidation except the fat soluble ester of ascorbic acid with long chain fatty acids (ascorbyl palmitate or ascorbyl stearate) is used.

Conclusion

Fireweed has a very high nutrient, mineral and antioxidant potential and it can serve as potent nutritious food supplements to improve the health status of its consumers as a result of high phytochemical and crude fibre contents for sustainable healthy living. Methanol and water are suitable solvents for the extraction of phytochemicals from fireweed. The antioxidant and antimicrobial activities of methanol and water extracts of this plant can be further investigated on edible oils and microorganism infested materials respectively.

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