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CHEMICAL COMPOSITION OF A TROPICAL FERN *CERATOPTERIS CORNUTA* (PARKERIACEAE, PTERIDOPHYTA) IN NIGERIA

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Extracts from some fern species have been found to be useful in fortifying livestock and fish feeds to enhance production especially in peasant communities. The chemical composition of *Ceratopteris cornuta* has not been documented in Nigeria. This study was thus designed to determine its suitability for use in fortifying fish feed by analysing the nutrient and anti-nutrient contents of its dimorphic fronds separately. One kg of sterile and fertile fronds of *C. cornuta* were collected, washed using distilled water and oven dried at 40 °C for about 96 hours. The dried samples were milled and analysed for proximate minerals, cyanide and oxalate analyses in triplicates. Results of the nutrient and anti-nutrient analyses show that both the sterile and the fertile fronds of *C. cornuta* can be used in aquaculture. The crude protein (4.22–5.28 g/100 g), moisture (87–91.00 g/100 g), carbohydrate (3.12–7.40 g/100 g), magnesium (23.55–194.65 mg/100 g), calcium (0.03 mg/100 g), potassium (0.17 mg/100 g), sodium (0.17 mg/100 g), silver (50.0 mg/100 g), cobalt (3.75–4.45 mg/100 g), lead (53.5–172.5 mg/100 g), copper (60.45–61.0 mg/100 g), manganese (15.65 mg/100 g), arsenium (50 mg/100 g), cadmium (3.75–4.50 mg/100 g), iron (430.00–537.45 mg/100 g) and selenium (106.83–195.45 mg/100 g) contents are considerably high. The anti-nutritional oxalate (0.86–1.38 mg/100 g) and cyanide (0.88–1.16 mg/100 g) are low and fall within the safe and acceptable limits as recommended by the World Health Organisation. Thus, extract from these fronds can be incorporated into livestocks and fish meals.

Key words: aquarium, dimorphic fronds, herbivores, nutrient composition

INTRODUCTION

Within Pteridophyta, there are many plants that are currently used in the aquarium and probably many more that could be used. Among these is *Cerato-*

pteris cornuta (P. Beauv.) Lepr. (Parkeriaceae), which has been found to be very useful in aquarium. *C. cornuta* grown as a floating plant provides surface cover to make fish feel more secure. It is suitable as a floating or underwater plant. If a leaf is allowed to float on the water surface, small plants (fernlets) form on the leaf margins. In good light *C. cornuta* grows fast and helps prevent algae by consuming large amounts of nutrients. This makes it a good starter plant in large aquarium. The roots of the floating *C. cornuta* provide good protection for young fish (Anonymous 2008*a*, *b*, Karen 1998). Lloyd (1974) recognised four species of this genus as *Ceratopteris cornuta* (which is confined to mainland Africa in distribution), *C. thalictroides*, *C. richandii* and *C. pteridoides*. The leaf protein concentrates of water fern (*Azolla africana* Desv.) and duckweed (*Spirodela polyrrhiza* L. Schleiden) could be used to fortify livestock and fish feeds to enhance production, particularly in peasant communities (Fasakin 1999). The demand for cereals as livestock feedstuffs and human consumption shows a precarious situation for both the human population and animals in Nigeria. Hence, there is a need to use cheaper feedstuffs that have shown great potential in terms of their nutrient supply as well as reduction in feeding costs (Akegbejo and Olagunju 2002). Thus, the possibilities of using *C. cornuta* in fish feed mixture through the determination of its nutrient and anti-nutrient contents are considered in this study. *C. cornuta* possesses both sterile and fertile fronds. The fronds were hence analysed separately for the purpose of comparison.

MATERIALS AND METHODS

About 1 kg each of the sterile and fertile fronds of *Ceratopteris cornuta* were collected during the rainy season of 2007, washed using distilled water and oven dried at 40 °C for about 48 hours. The dried samples were milled and analysed for proximate, minerals, cyanide and oxalate at the Central Science Laboratory and the Department of Food Science and Technology, Obafemi Awolowo University, Ile-Ife (Nigeria). All the chemical analyses were carried out in triplicates using the routine chemical analytical methods (AOAC 1995). Nitrogen content was determined by the Kjeldahl method. The crude protein content was determined by multiplying the nitrogen value by factor 6.25. The crude fibre was determined by digesting about 5.0 g of the ground sample in 1.25% sulphuric acid and 1.25% sodium hydroxide (NaOH). The ether extract content was determined by Soxhlet extraction method. About 2 g of the ground sample was put into a fat free extraction thimble and plugged lightly with cotton wool. Petroleum ether was added up to 300 ml mark and the content was boiled for 2 hours, ensuring that the ether siphon until the siphoning was no longer noticed. After draining, the extraction thimble was removed and dried. The thimble was weighed and ether extracts content determined by difference. The ash contents of the samples were obtained by digesting about 5 g ground sample in a muffle furnace at 550 °C for 1 hour. The proportional difference in weight converted to percentage is expressed as percent ash content. The moisture content was determined by drying about 10.0 g of the ground samples in the oven at 80 °C for 48 hours. The proportional difference in weight converted to percentage was expressed as percent moisture content.

The ascorbic acid was determined by extracting about 10 g of the samples in 90 ml distilled water for 1 hour. The mixture was filtered and stored at –5 °C. A standard indophenol solution was prepared and 2 ml of it was filled in a burette while the 10 ml sample filtrate was also filled in the burette. Titration was done and the titre value was used in calculating the ascorbic acid concentration.

About 0.2 g of the digested sample was used to carry out the elemental analysis of magnesium, arsenium, mercury, selenium, cadmium, manganese, chromium, copper, lead, cobalt and iron using an atomic absorption spectrophotometer (AAS). Sodium ion, potassium ion and calcium ion were estimated using flame spectrophotometer.

For cyanide determination, 100 g of sample was mixed with 90 ml of distilled water and allowed to stand for about 2–4 hours. Ten ml of 2.5% NaOH was prepared into a conical flask, the solution of the sample was distilled into NaOH in a conical flask until the level reached 150 ml. Fifty ml of distilled water was added to the distilled samples in the conical flask which was titrated against 0.02 M silver nitrate ($AgNO_3$) using 8 ml of 5% potassium iodide (KI) solution. The endpoint of the titration was light yellow. One m of 0.02 M of $AgNO_3$ equals 1.08 mg of hydrogen cyanide (HCN). The oxalate content was determined by using high pressure liquid chromatography (HPLC) method as described by Wilson *et al.* (1982).

RESULTS

Table 1 shows the result of the nutrient and anti-nutrient concentrations of the fronds of *C. cornuta.* Frond types affected the nutrient and anti-nutrient contents significantly except for crude fibre and ascorbic acid (vitamin C) contents. The crude protein content of the sterile fronds (5.28 g/100 g), ether extract (fat) (0.04 g/100 g), moisture (91.00 g/100 g) and anti-nutritional oxalate (1.38 mg/100 g) were higher compared to those of the fertile fronds. The fertile fronds in turn had higher ash content (0.45 g/100 g), carbohydrate (7.40 g/100 g) and anti-nutritional cyanide (1.16 mg/100 g) compared to those of the sterile fronds. Table 2 shows that nutrient element concentration was also significantly affected by the frond type, with the exception of calcium content, which

Table 1

Nutrient and anti-nutrient composition of *C. cornuta*

Frond type	Protein	Crude fibre	Ether extract	Ash	Moisture	CHO	Ascorbic acid	HCN	Oxalate
	g/100 g						mg/100 g		
Sterile	5.28	0.03	0.04	0.42	91.00	3.12	27.27	0.86	1.38
Fertile	4.22	0.03	0.03	0.45	87.00	7.40	27.27	1.16	0.88
$LSD_{0.05}$	0.064	NS	0.004	0.006	1.271	0.064	NS	0.025	0.110

NS = Non-significant

was the same in both fronds while zinc and chromium were not detected in either frond. Arsenium was not detected in the fertile frond but it is (50 mg/100 g) in the sterile frond. The calcium (0.03 mg/100 g), potassium (0.17 mg/100 g), magnesium (194.65 mg/100 g), silver (50.0 mg/100 g), cobalt (4.45 mg/100 g), lead (172.5 mg/100 g), copper (61.0 mg/100 g), manganese (15.65 mg/100 g), nickel (0.05 mg/100 g), cadmium (4.50 mg/100 g) and mercury (100.00 mg/100 g) of the sterile fronds were significantly higher than those of the fertile fronds. The iron (430.00 mg/100 g), sodium (0.17 mg/100 g) and selenium (195.45 mg/100 g) contents of the fertile fronds were in turn significantly higher than those of the sterile fronds.

Table 2

Nutrient elements content of *C. cornuta*

Mineral elements	Sterile fronds (mg/100 g)	Fertile fronds (mg/100 g)	$LSD_{0.05}$
Fe	430.00	537.45	0.635
Ca	0.03	0.03	NS
K	0.17	0.16	0.006
Na	0.09	0.17	0.013
Mg	194.65	23.55	0.445
As	50.00	0.00	0.710
Se	106.83	195.45	0.318
Co	4.45	3.75	0.572
Pb	172.50	53.5	0.864
Zn	N.D.	N.D.	–
Cu	61.00	60.45	0.064
Cr	N.D.	N.D.	–
Mn	15.65	0.00	0.635
Ni	0.05	0.00	0.010
Cd	4.50	3.75	0.064
Hg	100.00	25.00	0.765

NS = non-significant, N.D. = not detected

DISCUSSION

The results of this study are in disagreement with some of the reasons for underutilisation of ferns by herbivores which include host resistance factors such as texture and poor nutritional composition as reported by Moon and Pal (1949), and Soo and Fraenkel (1964). This assumption may not be well founded and may be due to less documentation of herbivory on ferns (Hendrix 1977, 1980). The results are in agreement with Biplab and Subir (2007) that a lot of herbivores consume ferns, Babayemi *et al.* (2006) that *Nephrolepis biserrata* is suitable for feeding African dwarf goats as a fodder and Oloyede *et al.* (2008) that *Nephrolepis biserrata* has high carbohydrate, protein and ascorbic acid contents. The records of herbivores damaging ferns have also been reported since Upper Triassic as shown by fossil evidence (Ash 2000). The results also showed that the oxalate and cyanide contents of the two fronds are low just as in Fasakin (1999), Oloyede *et al.* (2008) and fall within the safe and acceptable limits as recommended by the World Health Organisation (Munro and Bassir 1969). *Ceratopteris cornuta* is succulent and possesses good nutritional qualities and can therefore be useful in fish feed mixture. This is paramount, especially now that there is global food crisis, which has been partly attributed to high demand for cereals as livestock feedstuffs, human consumption and biofuel, whereas the yield is being reduced as a result of climate change. Hence, there is a need to use cheaper feedstuffs, such as *C. cornuta* that has shown great potential in terms of its nutrient supply as well as reduction in feeding costs.

The sterile frond is bigger with higher nutrient and proximate contents on the average compared to the fertile frond. However, there might not be any need to separate the fronds when preparing fish meal, since they can complement each other, unless in the case of a need to increase a particular nutrient in question which is present in higher quantity in one frond type compared to the other. Thus, extract from these fronds can be used to fortify fish or animal feeds.

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