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NUTRIENT EVALUATION OF *NEPHROLEPIS BISERRATA* (*NEPHROLEPIDACEAE, PTERIDOPHYTA*)

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Abstract

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Studies on some fern species have revealed their suitability for use in fortifying livestock and fish feeds to enhance food production. The intake of *Nephrolepis biserrata* (Swartz) Schott by ruminants in the tropics has been reported. Thus, its nutrient compositions were determined in this study. Proximate analysis showed 6.13 % protein, 0.87 % crude fiber, 0.33 % fat, 1.88 % ash, 80 % moisture, 10.87 % carbohydrate, 20 g/100 g total solid and 4.79 mg/100 g ascorbic acid (vitamin C). The leaflet is a rich source of mineral elements (mg/100 g dry matter): chromium 6.30±0.01, iron 1182.00±0.49, manganese 100.80±0.02, copper 158.75±0.38, cobalt 0.45±0.02, cadmium 0.02±0.03, lead 68.10±0.17, magnesium 338.70±0.01, calcium 223.20±0.06, mercury 27.59±0.11, nickel 9.00±0.03, potassium 500.00±0.04 and sodium 250.00±0.05. Zinc, selenium and arsenium were not detected. Analysis of the toxicants also showed oxalate and hydrogen cyanide to be 0.575 mg/100 g and 2.16 mg/100 g respectively. The results are discussed in terms of the nutritive value as well as the public health implication of having *N. biserrata* as part of the ruminant diet.

Keywords: elemental analysis, fossils, gametophytes, herbivores, *Nephrolepis*, proximate composition, pteridophyte, toxicants.

INTRODUCTION

Nephrolepis biserrata is a member of the *Nephrolepidaceae* family (*Pteridophyta*). According to Odu & Opapeju (1986) ferns are abundant in the high rainfall belt of the southern part of Nigeria. Fossils of ferns have contributed greatly to the formation of fossil fuel, coal, oil and gas (Jones, 1987). Fasakin (1999) reported that African fairy-moss (*Azolla africana* Desv.) and duckweed (*Spirodella polyrrhiza* (L.) Scleid.) leaf protein concentrates have low cyanide, tannin and phytic contents but high protein. Therefore, extracts from them can be used to fortify livestock and fish feeds to enhance production especially in peasant communities. Due to the nutritional properties reported for the duckweed, water hyacinth and *Azolla* Lam., they are beneficial to small ruminants in the tropics (Tamang et al., 1992). The underutilization of ferns by herbivores has been attributed to host resistance factors such as texture (Soo Hoo & Fraenkel, 1964) as in *Cyclosorus afer* (Christ) Ching and *C. striatus* (Schumach) Ching; toxins (Muenscher, 1939); amino

acid deficiency (SMITH & AGIZA, 1951) and poor nutritional composition (MOON & PAL, 1949). This assumption may not be well founded and may be due to less documentation of herbivores' attacks on ferns (AUERBACK & HENDRIX, 1980; GERSON, 1979). Fossilized ferns showing damage attributed to herbivores are known from the Carboniferous (SMART & HUGHES, 1973) to the Upper Triassic (ASH, 2000).

Among the pteridophyte species used as ornamentals in commercial and residential environments there are species of the genus *Nephrolepis* Schott. It is a highly distinctive genus characterized by abundant leaflets usually with entire margin and hydathodes in the upper surface of the pinnae and long linear sori on the margins. *N. biserrata* (Swartz) Schott is an evergreen perennial herb that forms congested colonies in very wet soils, along the edges of streams or marshy land and are sometimes on surface of lakes and stagnant water (BABAYEMI et al., 2006). They are commonly seen growing on the roadsides, in the open space, in the forest and wet savanna ecological zones. In Osun State of Nigeria, in terms of distribution, *N. biserrata* is represented in the wild as terrestrial, aquatic growing on river banks and as epiphytic growing on the palm trees. At Obafemi Awolowo University, Ile-Ife, it is being cultivated as an ornamental plant. Its common name is "Giant Sword Fern" and in Yoruba language it is called "Omu". The fronds of *N. biserrata* reach 2.5 m in height; the pinnae reach 23 cm long and 2 cm wide. There are reddish to light brown hair like scales on the stipes. The margins are finely double-toothed, lamina is densely pubescent, apex is acute or acumminate. The costa, i.e. mid-rib has dense, erect or rarely glabrous hair on the upper surface. The indusia are circular to horseshoe shaped (LANGELAND, 2001). According to USDA (2007) *N. biserrata* is native to the following continents of the world: Africa, Asia, South and North America.

BABAYEMI et al. (2006) based on their work on the intake of this plant by ruminants in the tropics reported that *N. biserrata* has high nutritive potential. This work, therefore, evaluated the nutritional and antinutritional compositions of *N. biserrata* leaflets.

MATERIALS AND METHODS

The fern fronds were collected from the garden of the Laboratory of the College of Health Sciences Obafemi Awolowo University, Ile-Ife and identified at the Department of Botany Obafemi Awolowo University, Ile-Ife, using herbarium specimens as *Nephrolepis biserrata* (Swartz) Schott (*Nephrolepidaceae*). About 1 kg of mature leaflets of *N. biserrata* was washed with distilled water and dried at 40 °C for analytical processes done in triplicates as follows:

Proximate analysis was done using fresh leaflets for fat, crude protein, carbohydrate, ash, crude fibre and moisture content as well as ascorbic acid (Vitamin C). These were carried out using the methods described in AOAC (1990).

Determination of hydrogen cyanide and oxalate was performed by the method described in AOAC (1990). Elemental analysis was performed using Atomic Absorption Spectrophotometer (AAS) (AOAC, 1990). 0.2 g of the digested sample was used to carry out the elemental analysis of As, Hg, Se, Cd, Mn, Cr, Cu, Pb, Co, Ni, Zn, Mg and Fe while Na^+, K^+ and Ca^{++} were estimated with 0.2 g of the digested sample using flame spectrophotometer.

RESULTS

Nutrient composition in *Nephrolepis biserrata* was determined. Proximate analysis revealed that leaves of this plant contain at average 6.13 % protein, 0.87 % crude fiber, 0.33 % fat, 1.88 % ash, 80 % moisture, 10.87 % carbohydrate, 20 g/100 g total solid and 4.79 mg/100 g ascorbic acid (vitamin C) (Table 1). The leaflet is a rich source of mineral elements (mg/100 g of dry matter): chromium 6.30±0.01, iron 1182.00±0.49, manganese 100.80±0.02, copper 158.75±0.38, cobalt 0.45±0.02, cadmium 0.02±0.03, lead 68.10±0.17, magnesium 338.70±0.01, calcium 223.20±0.06, mercury 27.59±0.11, nickel 9.00±0.03, potassium 500.00±0.04 and sodium 250.00±0.05 (Table 2). Zinc, selenium and arsenium were not detected.

Table 1.

Composition of fresh leaflets of *Nephrolepis biserrata*

Protein (%)	Crude fibre (%)	Fat (%)	Ash (%)	Moisture (%)	Carbohyd-rates (%)	Total solid (g/100g)	Vitamin C (mg/100g)
6.13	0.87	0.33	1.80	80.00	10.87	20.00	4.79

Table 2.

Mineral content of the leaflets of *Nephrolepis biserrata*. Abbreviations: SD – standard deviation; ND – not detected

Mineral elements	Content (mg/100g)	SD
Cr	6.30	± 0.01
Fe	1128.00	± 0.49
Mn	100.80	± 0.02
Cu	158.75	± 0.38
Co	0.45	± 0.04
Zn	ND	ND
Se	ND	ND
Cd	0.02	± 0.01
Pb	68.10	± 0.17
As	ND	ND
Mg	338.7	± 0.01
Ca	223.2	± 0.06
Hg	27.59	± 0.11
Ni	9.00	± 0.03
K	500.00	± 0.02
Na	250.00	± 0.03

Table 3.

Level of some toxicants in the leaflets of *Nephrolepis biserrata*

Toxic substances	Content (mg/100 g)
Hydrogen cyanide	2.16
Oxalate	0.75

Analysis of the toxic compounds in leaflets of *Nephrolepis biserrata* revealed that the main toxicants are oxalate and hydrogen cyanide. Their mean content in fresh leaflets was 0.575 mg/100 g and 2.16 mg/100 g, respectively (Table 3).

DISCUSSION

The high moisture content may be due to *Nephrolepis biserrata* habitat and high water requirements for surviving. The plant can serve as a rich source of carbohydrates in the diet. Meanwhile, *N. biserrata* contains considerable amount of ascorbic acid (vitamin C), which is highly valuable to the animals. The mineral composition (Table 2) showed that leaflets of *N. biserrata* is a rich source of sodium, potassium, iron and also contains reasonable amount of other bulk and trace elements. These minerals play very important role in metabolic activities (Enechi, 2001). The oxalate and cyanide contents of the plant are low and fall within the safe and acceptable limits as recommended by World Health Organization, (Munro & Bassir, 1969). Ruminants are more susceptible to cyanide toxicity than non-ruminants. Hydrogen cyanide, when absorbed, is rapidly detoxified in the liver by the enzyme rhodanese which converts cyanide to thiocynate. Excess cyanide ion inhibits the cytochrome oxidase, thus, stopping ATP formation and the body suffers energy deprivation. The lethal dose of hydrogen cyanide for cattle and sheep (ruminants) is 2.0 to 4.0 mg per kg body weight. Therefore, *N. biserrata* pose no toxicity problem. The studies by Babayemi et al. (2006) also showed that it is useful as fodder for feeding West African dwarf goats. The result of this study is similar to the findings of Eisner (1997), Biplab et al. (2007) where it was revealed that a lot of herbivores consume ferns and of Dahlan et al. (1993) that ferns generally have high crude protein content.

CONCLUSIONS

In conclusion, the present study shows that the leaflets of *N. biserrata* is a good source of carbohydrate, protein, minerals such as sodium, potassium, calcium and iron as well as ascorbic acid. This investigation revealed that herbivores feed successfully on ferns. This study also revealed that the oxalate and cyanide contents of the fern are low and they are not likely to pose any health hazard especially at the level at which the fern is usually used in the ruminant diet.

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DVIEILIO INKSTPAPARČIO (*NEPHROLEPIS BISERRATA*) (*NEPHROLEPIDACEAE, PTERIDOPHYTA*) PAŠARINĖS VERTĖS TYRIMAS

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Santrauka

Paparčiai yra maistingi augalai, tačiau kaip pašariniai jie nepakankamai vertinami. Dvieilis inskt-papartis (*Nephrolepis biserrata*) Nigerijoje plačiai paplitęs augalas. Dažniausiai auga praardytame dirvožemyje, ypač pakelėse, tačiau neretai įsikuria vandens telkinių pakrantėse ar ant medžių kaip epifitas. Atlikus pagrindinių maisto medžiagų ir nuodingų junginių sudėtį dvieilių inkstpaparčių lapuose nustatyta, kad jie yra vertingi pašariniai augalai. Jų lapuose susikaupia iki 6,13 % baltymų ir 4,79 mg/100 g askorbo rūgšties.