NUTRITIONAL STATUS OF FERNS AND THEIR RELATION TO INSECT INFESTATION FROM DARJEELING FOOTHILLS AND PLAINS[1]

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[1]Accepted June 2002
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Some dietary parameters of five common fern species from the Darjeeling foothills and plains were analysed. Biomolecules like proteins, carbohydrates and lipids, as well as phenols, fibres and moisture content of mature fronds were studied to understand the basis of colonization by fern-attacking insects. High moisture content, along with high nutritive protein and carbohydrate levels of mature fronds of *Diplazium esculentum* (Retz.) Sw. and *Christella crinipes* (Hk.) Holt appeared to be important factors in determining the palatability and infestation of the fern species by insect herbivores.

Key words: Nutritional status, host fern, insect herbivory

INTRODUCTION

Ferns are apparently found to be underutilized as food plants by insect herbivores (Soo Hoo and Fraenkel 1964, Eastop 1973, Hendrix 1980, Cooper-Driver 1978). However, intensive studies on insect-fern relationships show that some fern species are palatable and well exploited by insects as food plant. Thus, the assumption that ferns are underutilized may be an artifact of inadequate sampling (Hendrix and Marquis 1983). Nevertheless, it has been adequately documented that certain chemicals (Karlson and Bode 1969, Daniel and Chandrasekar 1986), as well as physical factors (Soo Hoo and Fraenkel 1964) determine the resistance and non-palatability of ferns.

In a study on ferns from the foothills and plains of Darjeeling, it was noted that the common ferns, *Diplazium esculentum* (Retz.) Sw. and *Christella crinipes* (Hk.) Holt were the most preferred food plants. While a meagre infestation of *Lindsaea ensifolia* Sw. and *Microlepia speluncae* (L.) Moore has been recorded, no insect herbivores have so far been observed on *Dicranopteris linearis* (Brum. F.) Underus. (Mukhopadhyay and Thapa 1994). To understand the preference and colonization by insect herbivores, five common fern species were analysed for proteins, carbohydrates, lipids and fibres, moisture and total phenols.

METHODS

Nutritive carbohydrate of dry fern powder of middle-aged fronds was estimated using the techniques of Plummer (1979) and Ananthakrishnan (1990). Protein was extracted as per Draper (1976), and estimated as in Lowry *et al.* (1951). Total lipid was estimated by the standard gravimetric technique using petroleum ether as solvent. Total phenol was assayed from the ethanol extract as per Hori (1974). Moisture content was estimated by drying the fronds in an oven at 50 °C for 48 hrs. Fibre (non-extractable components) was assayed as per Rowell *et al.* (1983).

RESULTS

The biochemical analysis of the fern species revealed that although the total storage protein was highest in *Christella crinipes* and *Dicranopteris linearis*, the nutritionally higher quality protein, albumin and globulin, far exceeded in the former. Total protein in *Diplazium esculentum* followed close behind, with a fair amount of albumin and globulin. Total protein was least in *Microlepia speluncae*, and marginally higher in *Lindsaea ensifolia*. Glutelin, second amongst nutritive proteins (Slansky and Panizzi 1987), was highest in *Diplazium esculentum*, and considerably low for the other fern species. Prolamine, the poorest of storage proteins, was highest in *Dicranopteris linearis*, followed by *Lindsaea ensifolia*, where it was almost half that of the highest value. In the other fern species, the value was almost equal to that of *L. ensifolia* (Table 1).

Total carbohydrate comprised monosaccharides and oligosaccharides, and starch. They were highest in *L. ensifolia* closely followed by *Diplazium esculentum* and *Christella crinipes*. The level was comparatively low in *Microlepia speluncae* and the lowest in *Dicranopteris linearis*. The quantity of both the mono- and oligosaccharide is less than starch in all the species. Maximum starch was found in *Christella crinipes* followed by *Diplazium esculentum*. It was comparatively less in the other species (Table 1). Total lipid was highest in *Lindsaea ensifolia*, while it was lowest in *Dicranopteris linearis*. Total lipid was almost half of *Lindsaea ensifolia* in *Christella crinipes* followed by *D. esculentum* and *M. speluncae* (Table 1).

Table 1: Comparison of basic nutritional components (mg/g) of five fern species (Mean ±SE)

Fern species	Albumin + Globulin	Glutelin	Prolamine	Total Protein	Monosaccharide + Oligosaccharide	Starch	Total Carbohydrate	Total Lipid
Diplazium esculentum	96.85 ±0.66	68.09 ±0.23	19.37 ±0.05	184.32 ±0.58	96.69 ±0.64	126.9 ±0.34	223.65 ±0.90	23.03 ± 0.85
Christella crinipes	163.26 ±1.21	10.12 ±0.13	18.17 ±0.02	190.36 ±0.66	89.78 ±0.51	130.9 ±0.05	220.76 ±0.52	36.52 ±1.17
Lindsaea ensifolia	69.18 ±0.40	8.40 ±0.13	36.37 ±0.02	113.97 ±0.52	133.5 ±0.44	94.66 ±0.21	228.22 ±0.97	64.10 ±1.08
Microlepia speluncae	50.20 ±0.48	9.55 ±0.08	15.99 ±0.04	75.77 ±0.46	85.96 ±0.43	104.5 ±0.19	190.48 ±0.57	21.80 ±0.35
Dicranopteris linearis	106.04 ±0.73	3.77 ±0.03	80.38 ±0.07	190.21 ±0.71	53.83 ±0.09	90.89 ±0.14	144.73 ±0.17	7.75 ±0.24

Percentage of moisture was highest in *Diplazium esculentum*, closely followed by *Microlepia speluncae*. The moisture content of *Christella crinipes* and *Lindsaea ensifolia* was slightly reduced with an overlapping value, while *Dicranopteris linearis* had the least. Total phenol was estimated to be highest in *Lindsaea ensifolia*, followed by *Christella crinipes*, *Diplazium esculentum* and *Dicranopteris linearis*. *Microlepia speluncae* had a remarkably low phenol content. The percentage of fibre (non-extractable components) was estimated to be the highest in *Lindsaea ensifolia* and lowest in *Dicranopteris linearis*. The fibre content of *Diplazium esculentum* and *Microlepia speluncae* had intermediate and overlapping ranges (Table 2).

Observation of the fern vegetation from the foothills and plains of Darjeeling have confirmed an association of 60 insect species from the orders Lepidoptera (12), Coleoptera (19), Hemiptera (20), Hymenoptera (4), Orthoptera (2), Thysanoptera (2) and Diptera (1) (Mukhopadhyay and Thapa 1994). Of these, 16 species were regular fern feeders, suckers and miners. The fern species preferred and attacked by most of the insects was *Diplazium esculentum*, followed by *Christella crinipes*. The other species were less attacked or colonized by only a few specialized insect herbivores.

Table 2: Comparison of some dietary factors (Mean ±SE) and percentage occurrence of insect-herbivores on five fern species

Fern species	Total (mg/g)	Water (%)	Fibre (%)	Insect occurrence (%)
Diplazium esculentum	6.90 ±0.20	81.30 ±0.29	50.47 ±0.27	87.50
Christella crinipes	7.46 ±0.01	72.13 ±0.59	54.43 ±0.38	43.75
Lindsaea ensifolia	8.15 ±0.35	71.84 ±0.54	56.07 ±0.37	6.25
Microlepia speluncae	1.85 ±0.02	79.86 ±0.41	50.12 ±0.35	6.25
Dicranopteris linearis	6.68 ±0.03	57.83 ±0.60	44.39 ±0.35	0

DISCUSSION

In ferns, higher concentration of protein and nitrogen plays a significant synergistic role with other chemicals in attracting jassids and aphids (Daniel and Chandrasekhar 1986). Species like *Lindsaea ensifolia* and *Microlepia speluncae* with low levels of total protein largely remained unexploited by insects. *Dicranopteris linearis* with high total protein was possibly unpalatable because of its low carbohydrate and moisture content. A low concentration of carbohydrate has been reported to attract aphids (Daniel and Chandrasekar 1986). However, in this study, maximum insect attack was recorded on *Diplazium esculentum* and *Christella crinipes*, both with high total carbohydrates. This, however, was matched with high nutritional protein and low lipid levels.

Higher concentration of phenols may act as a repellent to insects because of their toxic effect, and this seemed true for *Lindsaea ensifolia*. This species and *Dicranopteris linearis* had the highest and the lowest fibre content respectively, but since both were underutilized, fibre content alone might not be responsible for the preference of fern as a food plant. Rowell *et al.* (1983) in their study on fern-insect fauna suggested that the chemical constituents of fern fronds, like nitrogen, phenol, tannin, and fibre, had little impact on their palatability. In the present study, a high percentage of moisture in *D. esculentum* along with enhanced protein and carbohydrate levels, might have been the deciding factors for its greater palatability (81.3%), and overexploitation by insects.

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