ASSIMILATORY PIGMENTS CONTENT IN FERN GAMETOPHYTES AND SPOROPHYTES

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Abstract
Pteridophytes distinguishes from other land plants is that they have independent gametophyte and sporophyte generations. Half fern's lives are spent in the gametophyte stage, or haplophase, and the other half in the sporophyte stage. Fern gametophytes have no vascular system, like bryophytes, and live on substrate surfaces as small individual plants, but their sporophytes have a vascular system enabling more vertical growth than gametophytes, resulting in a large herbaceous plant form. Many species are able to change the composition of their photosynthetic apparatus to optimize photosynthesis for the light environment in which they are growing. Measuremenst performed at fern gametophytes (Polypodium vulgare, Asplenium trichomanes and Cyptopteris fragilis) obtaines in vitro and in fern sporophytes (ten species) from the natural site showed that content of chlorophylls is both qualitatively and quantitatively similar to that of higher plants Chlorophyll content was much higher in sporophytes, which is in agreement with their higher photosynthetic rates. The highest amount of chlorophyll values was determined to species of Asplenium, and the lower value was in Lycopodium clavatum.

Keywords: gametophyte, sporophyte generations, assimilatory pigments.

1. INTRODUCTION

Pteridophytes are evolutionally, in a pivotal position between bryophytes and seed plants (Pryer et al., 2001). A characteristic that distinguishes pteridophytes from other land plants is that they have independent gametophyte and sporophyte generations (Haufler, 1997). Fern gametophytes have no vascular system, like bryophytes, and live on substrate surfaces as small individual plants, but their sporophytes have a vascular system enabling more vertical growth than gametophytes, resulting in a large herbaceous plant form (Wada, 2007). The origin of the plant vascular system must therefore have arisen during the evolution of primitive ferns (Kenrick, 2000). Half fern's lives are spent in the gametophyte stage, or haplophase, and the other half in the sporophyte stage. In conjunction with these differences, a variety of physiological phenomena must have been established and developed during evolution of the fern (Dyer, 1979; Raghavan, 1989; Wada and Kadota, 1989; Banks, 1999). Many authors studied the alternation of generations from a physiological viewpoint (Sakamaki and Ino, 1999).

2. MATERIAL AND METHOD

Measurements were performed at fern gametophytes obtained in vitro and in fern sporophytes from the natural site.

In vitro gametophytes of *Polypodium vulgare, Asplenium trichomanes* and *Cystopteris fragilis* were used. The culture medium was a modified M&S (1962), with ½ macronutrients, 10 g l^{-1} sucrose, 6 g l^{-1} agar, pH - 5.8 to 6. Cultures kept in a growth chamber received light from cool-white fluorescent lamp at a photosynthetic photon flux density of 40 µmol m^{-2} s^{-1} and a day/night cycle of 14/10 h. Temperature was 24 ^{o}C during the day and 22 ^{o}C at night. Adult sporophytes of ten species of fern were collected from the Valley Valsan.

Determination of the quantity of assimilatory pigments was performed by spectrophotometric method, using Holm's formulas. Graphical representation of results and statistical interpretation were performed using SPSS 16.0 for Windows.

3. RESULTS AND DISCUSSIONS

It is generally stated that, in the Pteridophytes, the content of chlorophylls is both qualitatively and quantitatively similar to that of higher plants (Wolf, 1958). Gametophytic generation is essential in the fern life cycle, however, very little is known about its ecology and physiology (Greer et al., 1999, Johnson et al., 2000, Watkins et al., 2007). The gametophytes of three fern species obtained in vitro haf a chlorophyll content of 0,997 – 1,712 mg g^{-1} f.w. and a chlorophyll *a:b* ratio of 1,03 – 1,19. The highest chlorophyll content was registered in the *Asplenium trichomanes* (figure 1, 2). The chlorophyll *a*:*b* ratio in *Trichomanes speciosum* was 1,58±0,06 and 2,0±0,06 for the gametophytes and the sporophyte, respectively. The higher hhlorophyll *a*:*b* ratio seen in the sporophytes might, however, represent a degree of adaptation or acclimation in plants (Johnson et al., 2000). In ferns Valley Valsan amount of chlorophyll was determined between 1,78 and 9,58 mg g^{-1} f.w. (Figure 4, 5 Chlorophyll content was much higher in sporophytes, which is in agreement with their higher photosynthetic rates (Hagar and Freeberg, 1980). The leaves of *Teratophyllum rotundifoliatum* had a chlorophyll content of 5,8 mg g^{-1}f.w. and a chlorophyll *a:b* ratio of 1,8. Many species are able to alter the composition of their photosynthetic apparatus to optimize photosynthesis for the light environment in which they are growing (Anderson et al., 1995). Although the responses seen are complex, with variations between species, the overall process can be summarized as follows: In shade there tends to be an increase in the total amount of chlorophyll binding proteins relative to electron transport proteins and enzymes of the Calvin cycle (Yin and Johnson, 2000). Amount of chlorophyll was greater in the shade ferns than the sun ferns (Nasrulhaq-Boyce and Haji Mohamed, 1987).

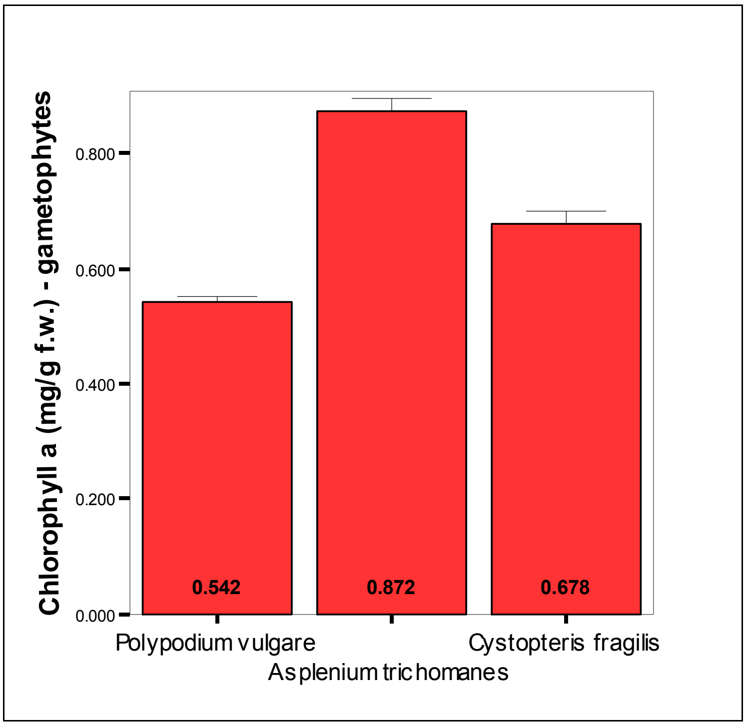

Figure 1. Chlorophyll a content in fern gametophytes

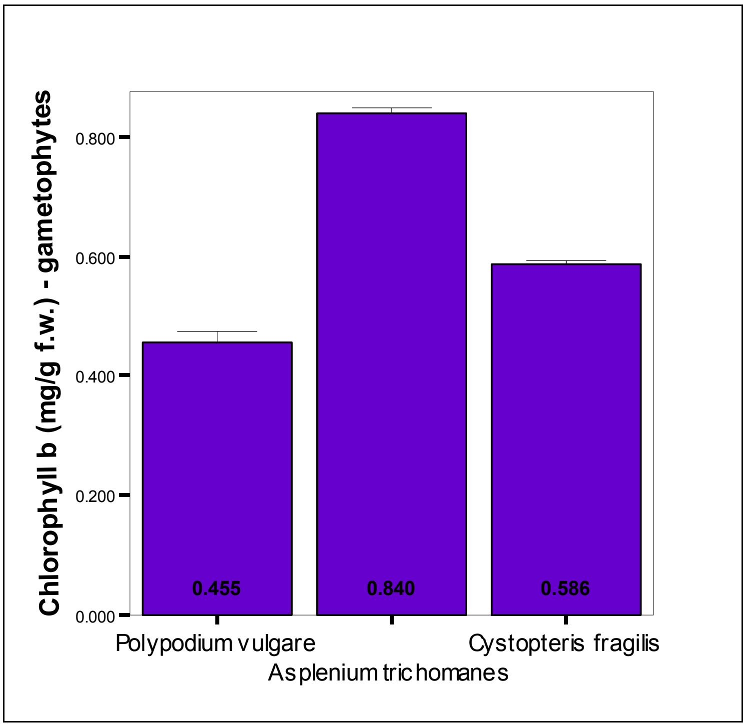

Figure 2. Chlorophyll b content in fern gametophytes

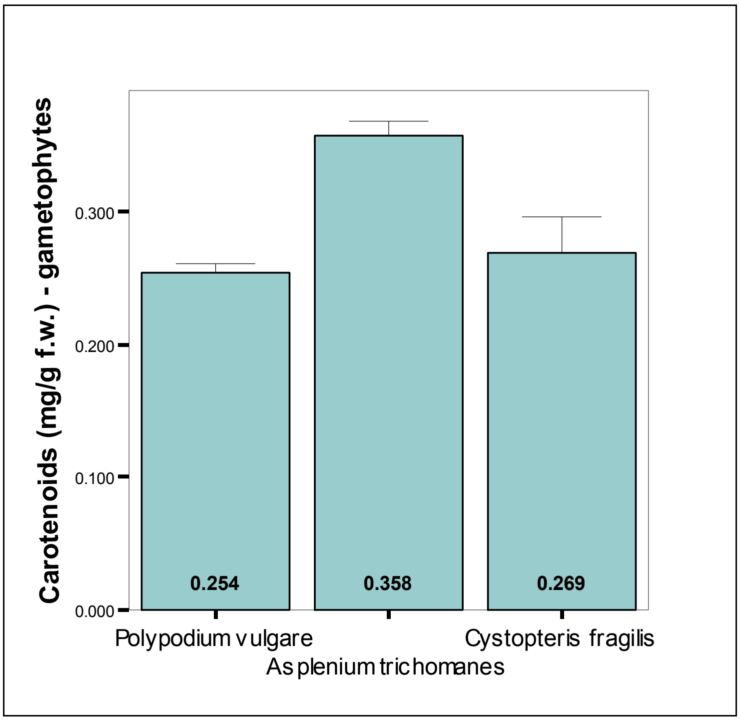

Figure 3. Carotenoids content in fern gametophytes

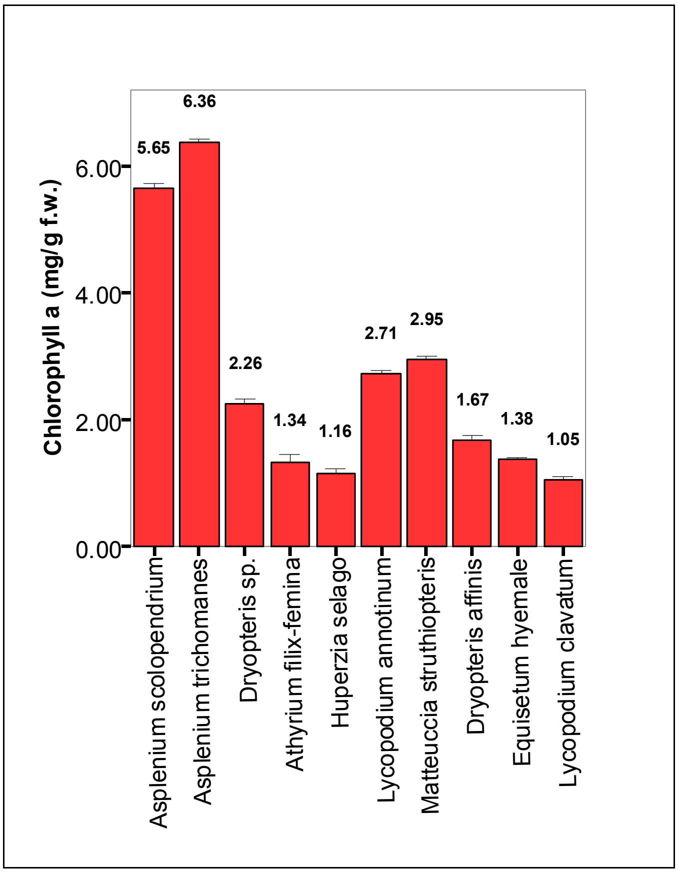

Figure 4. Chlorophyll a content in fern adult sporophytes

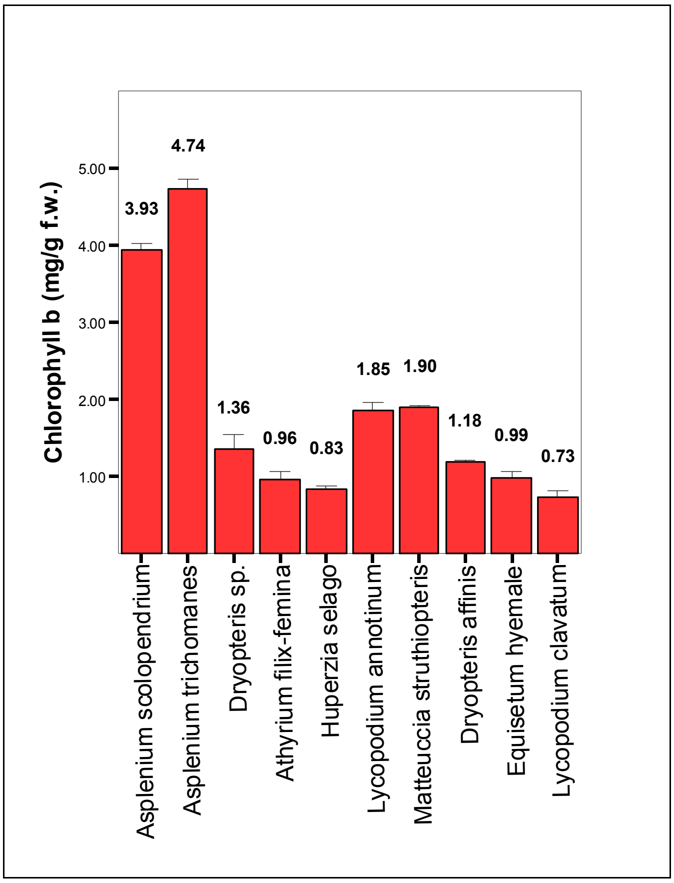

Figure 5. Chlorophyll b content in fern adult sporophytes

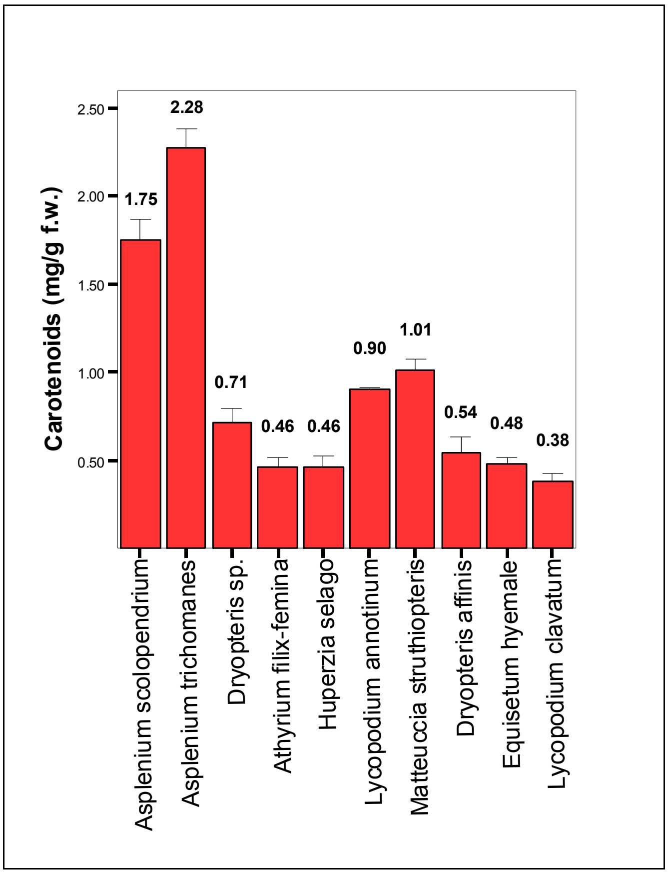

Figure 6. Carotenoids content in fern adult sporophytes

In eight Malayan ferns, Nasrulhaq-Boyce and Haji Mohamed (1987) found chlorophyll *a:b* ratios from 2,1 to 2,9, with a slightly higher mean in sun (2,70) than in shade (2,33) species. Nasrulhaq and Duckett (1991) found a ratio of 1,8 in the Malayan rainforest fern *Teratophyllum* (and 2,2 in the lycopod *Selaginella willdenowii*). The highest amount of chlorophyll values were determined to species of *Asplenium*: 9,58 mg g^{-1}f.w. in *Asplenium scolopendrium* and 11,1 mg g^{-1}f.w. in *Asplenium trichomanes.* The chlorophyll *a:b* ratio was 1,43 and 1,34, respective. The lowest ratio chlorophyll *a:b* was determined in *Asplenium trichomanes.* In sporophytes of *Lycopodium clavatum*, chlorophyll a+b was 1,78 mg g^{-1}f.w., and a ratio 1,43.

4. CONCLUSIONS

Many species are able to change the composition of their photosynthetic apparatus to optimize photosynthesis for the light environment in which they are growing. In the Pteridophytes, the content of chlorophylls is both qualitatively and quantitatively similar to that of higher plants. Sporophytes had higher chlorophyll content than gamethophytes.

5. ACKNOWLEDGEMENTS

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