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Carbon, nitrogen, and biogenic silica concentrations in papyrus in the Okavango Delta, Botswana

The Okavango Delta is southern Africa's greatest wetland. Research on the Delta is limited, especially on the chemical processes governing its environment. This study provides new knowledge on nutrient concentrations on the Okavango Delta by analysing samples of papyrus (Fig. 1), one of the main aquatic plants in the area.

The samples were harvested in three sites in the permanently flooded swamp of the Okavango Delta and divided into the different organs of papyrus: umbel, culm, scales, roots, and rhizome. Papyrus grows mainly rooted on the peat forming the levées of the Okavango River. Therefore, the samples were collected on the channel margin as well as in the backswamp. Moreover, the Delta is characterized by an annual flood event that starts in the highlands of Angola and reaching the end of the Delta in about six months. Consequently, samples were collected both during high flood periods and during recession times.

Total nitrogen, total organic carbon, and biogenic silica concentrations in papyrus were measured and analysed. Two methods were used in this project. To measure nitrogen and carbon, a high temperature combustion analysis was done. To measure biogenic silica, a wet chemical digestion was performed, during which the samples' matrices are decomposed into aqueous solutions, ideal to be introduced into a wet chemistry analyzer.

Figure 1. The aquatic plant *Cyperus papyrus.*

Results

Total nitrogen concentrations were found to be highest in umbels, rhizomes, and roots. Umbels are the inflorescences of papyrus and are very important photosynthetic organs. Rhizomes are subterranean modifications of the plant's stem, which act as a storage. Roots have been found to be colonized by bacteria which fixate the atmospheric nitrogen making it available for organisms. All these characters are linked to high nitrogen concentrations. Moreover, young papyrus was found to have a higher concentration of total nitrogen than old papyrus. The main explanation for this is that juvenile plants are more productive than mature ones, meaning that they grow faster.
Total organic carbon was found to be around 40%. Lastly, biogenic silica improves plant shoot rigidity and disease resistance. The highest concentration of biogenic silica was found in mature papyrus. This is due to the fact that biogenic silica is accumulated into the plant throughout its life. Biogenic silica is not uniformly distributed in the different organs of papyrus: more biogenic silica is found in organs mostly affected by water loss.

To summarise, nitrogen is a fundamental nutrient for papyrus growth and productivity, that explains why the highest nitrogen concentrations are in juvenile plants. Carbon makes up ~40% of papyrus biomass. Biogenic silica is very important for plants in general and it is accumulated throughout the plant life, accounting for the highest concentrations in mature papyrus.

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