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NUTRITIVE VALUE OF RIPARIAN COMMON REED BIOMASS FOR RUMINANTS

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ABSTRACT

The extensive reedbeds, especially *Phragmites australis,* that spread around the perimeter of the lake Mikri Prespa, a Ramsar protected lake in the northwest of Greece, serves beneficially for several human activities and wildlife needs. Nevertheless, the apparent overgrowth and removal of this vegetation is often problematic and imposes difficulties in management and increases costs. Recent research is focusing into the use of *P. australis* as an alternative or complementary feed for ruminants. The aim of the present study was to evaluate the nutritive value of *P. australis* biomass derived from the riparian vegetation as a potential animal feed. Biomass samples were collected from six different sites of the Mikri Prespa lake in two different time periods (i.e. early August and late October 2020). The samples were analyzed for macro- and trace elements, total protein, NDF, fat and nitrogen-free extracts. Location and sampling date had a significant effect on all macronutrient concentrations with significant reductions in the second sampling period. For the trace elements zinc, copper and boron higher concentrations were observed in August, while the concentration of iron increased significantly in October. Dry matter and NDF content of *P. australis* was particularly high, 67.08% and 46.3% respectively; while protein content was rather moderate (8.38%, August sampling) to low (5.06%, October sampling). The results show that the nutritive value of *P. australis* is comparable to feeds widely used in ruminant nutrition such as wheat straw or marc, indicating a potential use as an alternative or complementary coarse feed with appropriate administration or treatment.

Keywords: *Reed beds, P. australis, Quality characteristics, Ruminant nutrition.*

INTRODUCTION

The riparian areas of Lake Mikri Prespa are surrounded by extensive reedbeds that spread almost all around the perimeter of the lake. Although reedbeds, especially *Phragmites australis*, are beneficial for many human activities as well as wildlife needs (Cronk and Fennessy, 2001), the apparent overgrowth of vegetation that predominates in some aquatic habitats is often considered a potential threat for some ecosystems. For this reason, different methods have been applied worldwide to manage the overgrowth of *P. australis* either individually or in combination, including removal of aboveground biomass by cutting, grazing, or burning (Marks *et al.,* 1994; Hazelton *et al.,* 2014; Volesky *et al.,* 2016).

In recent years the reed has been widely used as feed for buffaloes, cows, sheep, goats and donkeys in many different countries (*Al*-Sodany *et al.,* 2012). Its high content of fiber, nitrogen, potassium and manganese among others makes it particularly important (Kadi *et al.,* 2012). The nutritional value of about 13.31 kilos of reed is equivalent to that of one kilo of oats (Köbbing *et al.,* 2013) while according to the guide of nutritional requirements of dairy cows it has a similar nutritional value to sorghum (NRC 2001). Although it has a lower nutritional value than other forage plants, it is cheap and easily available in some parts of the world while large animals can consume *in situ* shoots up to 50-75 cm tall.

In the Prespa area, farmers use the reed from the lake vegetation as animal feed mainly in the summer months or until mid-autumn, but so far there is no study on the chemical composition and quality of the fodder. The aim of the present study was to evaluate the quality characteristics of reed biomass that can be used as animal feed which results from the management of lakeside vegetation in different areas of Lake Mikri Prespa. The ultimate goal of the study was to contribute to the development of lakeside vegetation management strategies for sustainable use of *P. australis* reed.

MATERIALS AND METHODS

Plant material and experimentation

Lakeside phytomass samples were collected from six different areas [Karyes (KAR), Mikrolimni (MIK), Mikros Kampos (MKA), Opaya (OPA), Slatina Lemou (SLL) and Slatina Plateos (SLP)]. These areas were selected as management was implemented in them for the restoration and maintenance of wet meadows. To study the effect of different cutting times, samples were taken in two different seasons: early August and late October 2020. The samples collected were four per region and date and contained mainly *P. australis* reed. Biomass was cut for each sample from an area of approximately 2 x 2 m that had not been previously grazed. The reed plants were cut over 40 cm in order for the samples to be representative of the plant biomass that the animals would utilize by grazing.

Sample analysis

The samples after being properly processed (drying, grinding, etc.) were analyzed for macro and micronutrients. Sub-samples were placed in a furnace at 515 °C for 5 hours. The ash was dissolved in 3 ml of 6 N HCL and distilled water until it reached a volume of 50 ml. Concentrations of P, K, Ca, Mg, Fe and Zn were determined by the method of inductively coupled plasma-ICP spectrophotometer (Allen, 1976). The concentration of N was determined by the Kjeldahl method and that of B according to the method of azomethine-H (Wolf, 1974). Macronutrient concentrations were expressed in % dry weight while trace elements in mg/kg or ppm dry weight. Total protein (P = N x 6.25) was determined by the Kjeldahl method in a nitrogen analyzer by Gerhardt, total fibrous substances (NDF) according to Weende using a Fibertech apparatus, fat by the Soxhlet method using a Foss apparatus and on the basis of the percentage contents of the analyzed sample in total nitrogenous substances, fats, fibrous substances, the nitrogen-free extracts (NFE) was determined.

Statistical analysis

The statistical analysis of the results was performed with Analysis of Variance (ANOVA) with two factors (location and date of sampling) while comparison of means was conducted by Least Significant Difference (LSD) at significance level $p < 0.05$.

RESULTS AND DISCUSSION

The analysis of variance of various parameters of the reedbed vegetation that were measured in six different locations of Lake Mikri Prespa showed a significant effect of the location on the concentrations of macronutrients N, P and K and trace elements B and Fe (data not shown). Also, the location significantly affected the concentrations of most quality characteristics such as proteins, fat, fibrous substances (NDF), ash and NFE. The sampling date factor had a statistically significant effect on all concentrations of macronutrients and trace elements except the concentration of boron, while from the qualitative characteristics the percentages of ash and NFE did not differ statistically significant between the two sampling dates.

Table 1. Concentrations of macronutrients in reed (*Phragmites australis*) samples collected in two sampling dates (S1, August 2020 and S2, October 2020) at six locations of the lake Mikri Prespa.

Location	**N%***		**P%**		**K%**		**Ca%**		**Mg%**	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
KAR	1,81a	1,03a	0,19a	0,10a	0,71c	0,52a	0,62a	0,33a	0,27a	0,15a
MIK	1,22b	0,68a	0,15abc	0,10a	0,86bc	0,35ab	0,59a	0,30a	0,18a	0,11a
MKA	1,35ab	0,75a	0,12c	0,11a	1,34a	0,52a	0,99a	0,47a	0,23a	0,14a
OPA	1,08b	1,01a	0,19a	0,10a	1,07ab	0,26b	0,47a	0,41a	0,17a	0,13a
SLL	1,18b	0,69a	0,14b	0,09a	1,12ab	0,33ab	0,68a	0,31a	0,21a	0,15a
SLP	1,40ab	0,71a	0,18ab	0,08a	0,93bc	0,29b	0,63a	0,52a	0,19a	0,17a

*means in the same column followed by the same letter are not significantly different (t-test, P<0,05).

Nitrogen concentration differed statistically significant between the different sites in the August sampling with the KAR area having the highest percentage of 1,81% and the OPA location the lowest with 1,08% (Table 1). In the October sampling, no statistically significant difference was observed between sites in nitrogen concentration. In phosphorus levels there were differences between the different locations in the August sampling with the KAR and OPA areas having the highest percentage of 0,19% and the MKA region having the lowest with 0,12%. In the October sampling, no statistically significant difference was observed between sites in P concentration. The area of MIK had the highest concentration of potassium on both sampling dates with 1,34% and 0,52% while the lowest levels showed the samples from KAR with 0,71% in August and from the area of OPA with 0,26% in October. Between the two sampling dates the K concentration decreased from 27% to 75% in the different locations. Calcium and magnesium concentrations did not differ statistically between the different sampling sites on both dates (Table 1). In August the concentration of Ca ranged from 0,47-0,99% and of Mg from 0,17-0,27% while in October they decreased significantly in all areas from 0,30-0,52% and from 0,11-0,17% respectively. The concentrations of most trace elements differed statistically between the two sampling dates with the exception of boron (data not shown). Higher concentrations were observed in August, mainly for the trace elements zinc, copper and boron, while the concentration of iron increased significantly in October. The concentrations of the macronutrients and trace elements found in this study were similar to concentrations found in *P. australis* samples in other studies (Van der Werff, *et al.,* 1987; Baran *et al.,* 2002; Toumpeli *et al.,* 2013; Carson *et al.,* 2018) depending on the stage of development and the sampling season. After August, the macro and trace elements concentration in the aboveground part decreases significantly, as our results showed, while they increase in the underground part, especially N in the rhizomes, due to the internal displacement in the plant during the winter months (Van der Linden, 1980).

The dry matter percentage did not differ between the different sampling sites on both dates but increased significantly from 53-95% in October (data not shown). The protein concentration in the August sampling ranged from 6,74% (OPA) to 11.33% (KAR) (Table 2) while in the October sampling there were significant reductions of up to 50% in the protein concentration in almost all sampling areas. Fibrous substances in the August sampling ranged from 29,48% (MKA) to 36,83% (SLP) while in the October sampling there were increases from 15-37% in their concentration at all locations with concentrations varying between regions with levels from 39,18% up to 46,13% in the SLL area. The fat concentration in the August sampling differed statistically significant between the sampling locations and ranged from 0,98% (KAR) to 1,91% (MKA). In the October sampling there were also significant differences with the majority of concentrations falling by up to 46% with the exception of samples from the MIK area where a very small increase was observed. The NFE differed significantly between sites in the first sampling and ranged from 45,5% in the SLP area to 52,92% in the MKA area samples, while in the October sampling the concentrations decreased from 3-19% depending on the area.

Table 2. Concentration (%) of quality characteristics in *P. australis* samples collected in two sampling dates (S1, August 2020 and S2, October 2020) at six locations of the lake Mikri Prespa.

Location	**NDF%**		**Proteins%**		**Fat%**		**Ash%**		**NFE%**	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
KAR	34,80a	42,42ab	11,33a	6,43a	0,98c	0,75bc	6,90b	6,91c	45,99b	43,50ab
MIK	32,14ab	39,18b	7,65b	4,28a	1,12bc	1,15a	9,32a	10,52a	49,77ab	44,88a
MKA	29,48b	40,35ab	8,43ab	4,66a	1,91a	1,07ab	7,27b	6,99c	52,92a	46,94a
OPA	34,84a	41,79ab	6,74b	6,29a	1,00bc	0,54c	7,05b	6,90c	50,38ab	44,49a
SLL	35,27a	46,13a	7,39b	4,30a	1,50abc	0,85abc	7,84ab	9,74ab	47,98ab	38,99b
SLP	36,83a	42,19ab	8,78ab	4,43a	1,66ab	1,06ab	7,23b	8,27bc	45,50b	44,06a

*means in the same column followed by the same letter are not significantly different (t-test, P<0,05).

The location factor significantly affected most of the quality characteristics and this may be due to the different soil composition around Lake Mikri Prespa but also to the different levels of nutrient runoff from neighboring bean crops (Kosmas *et al.*, 1997). The results of the present study showed that *P. australis* could be considered as a fibrous feed due to its high content of dry matter and fibrous substances. Indeed, at the stage of maturity, as shown by the October sampling, the dry matter and the concentration of fibrous substances reached 67,08% (data not shown) and 46,3% respectively (Table 2) percentages which are comparable to the most fibrous feed, such as is wheat straw or marc (Maertens *et al.*, 2002). The high fiber content of *P. australis* during flowering may have an inhibitory effect on food intake as the high fiber content increases chewing time (Mertens, 1994). *P.*

australis could be an alternative feed as a source of fibrous substances in ruminant diets, however it is doubtful whether it may be the only coarse feed in the diet (Kadi *et al.,* 2012; Monllor *et al.,* 2020). In a recent study Mokhtarpour and Jahantigh (2018) showed that *P. australis* can't meet the nutritional requirements of sheep even if it is enriched with urea. The protein content of *P. australis* is close to that reported by Kadi *et al.,* (2012). It is not characterized as particularly high and is rather considered moderate, 8,38% in the August sampling, to a low of 5,06% in the October sampling (Table 2). However, it is higher than that of some fibrous feeds used in the diet of ruminants such as e.g. the wheat straw. The results of the present study and other studies show that reed could be an alternative coarse feed with the appropriate administration or treatment. Its low digestibility also makes it imperative to add energy for a better nutritional balance, especially in large animals, in case *P. australis* will be the only food source for long periods of time (Volesky *et al.,* 2016).
Direct grazing is a proven successful practice for the use of *P. australis*. Reedbeds provide large amounts of grazing material, which can be used for grazing mainly by large ruminants or even provided to them as winter feed. The grazing of *P. australis* by cattle such as the buffalo, in practice has proven to be a highly successful and efficient practice for feeding buffaloes but also for controlling the growth of the reed and the conservation of biodiversity, both in the Prespa area and in other wetlands (Kazoglou *et al.,* 2001). In addition, grazing brings other benefits to the wetland through the recycling of nutrients into the soil, while the pressed reeds allow the wetlands to flood freely. In the present study, the mean percentage of fibrous substances in all locations at the August sampling was 33,9%, a percentage which is comparable to the percentage of maize fibrous substances at the milky stage (Zaralis *et al.,* 2014). Considering also the concentration of *P. australis* in sugars (NFE), it makes it an alternative coarse feed to silage. Indeed, recent studies show that *P. australis* can be successfully silaged and administered to ruminants (El-Talty *et al.,* 2015; Monllor *et al.,* 2020). Administration of *P. australis*-based silage to lambs did not adversely affect their growth leading to the expected meat yield (El-Talty *et al.,* 2015). In a goat silage food preference study, reed silage was the least preferred of the other silage, possibly due to its higher fiber content (Volesky *et al.,* 2016).

CONCLUSION

The present study confirms the possible use of *P. australis* from the riparian areas of Lake Mikri Prespa as a high quality coarse feed, especially when direct grazing or cutting is done at an earlier stage of development. Further research on the use of lakeside vegetation for silage production and an extensive study on its effects on the diet of small and large ruminants would be in the right direction.

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