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The Impact of Vegetation Type On Denitrification Activity in the Tributary Sediments, the Santa Fe River, FL

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Abstract

A woody plant has a perennial stem above ground which is covered by a layer of thickened bark and adapted to survive from one year to the next; as a result, the stem supports the continued vegetative growth above ground for several years. However, herbaceous vegetation type has low carbon and lignin contents, resulting in easily being decomposed. Therefore, it can be expected that the difference of vegetation type can drive the rate of litter decomposition, which can influence the level of available carbon to denitrifiers. In order to explain the impact of different vegetation type on the supply of organic carbon to denitrifiers, the cellulase and phenolic oxidase enzyme activities as an index of decomposition rate were measured with tributary sediment and litters. Our results showed that the tributary sediment surrounded by woody vegetation had lower cellulase activities in litters and sediments than those of the tributary sediment surrounded by herbaceous vegetation type. In case of phenol oxidase, the change of activity was observed in the sediments; however the difference was little significant. Potential denitrification activity in the tributary sediment surrounded by herbaceous vegetation was higher than that of woody vegetation system. Therefore, the difference vegetation type can determine the relative content of liable carbon per total carbon, which could drive the denitrification activity in tributary sediments.

Objectives

•To investigate how different vegetation types affect the extracellular enzyme activities and supply of labile carbon in tributary sediments
•To investigate if the level of available carbon content can influence the denitrification activity in tributary sediment
•To see if there are positive relationships among vegetation types, extracellular enzyme activities and denitrification activity in tributary sediments

Hypotheses

Woody Vegetation

Woody →High lignin
→Cellulase ↓
→Decomposition↓
Available carbon ↓
Activity of Heterotrophs ↓
Denitrification ↓

Herbaceous Vegetation

Herbaceous →Low lignin
→ Cellulase ↑
→Decomposition ↑
Available carbon ↑
Activity of Heterotrophs ↑
Denitrification ↑

•Different types of vegetations will affect extracellular enzyme activities associated with organic matter decomposition, determining the denitrification activity.

Sites & Methods

Site Description

Tributary 2 up (T2 UP) and down streams (T2 DOWN) in Santa Fe Beef Research Unit (SFRBU), Santa Fe River watershed, northern Alachua County, FL (Fig 1).

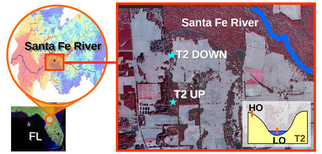

Fig. 1 Santa Fe River Watershed and Study Sites (★)

•T2 UP: Input of N fertilizer from nursery & woody vegetation.
•T2 DOWN: Input of N fertilizer from headwater and input of organic N from diary manure & herbaceous vegetation.
•The edge and uphill sediments of each site contain high organic matter (HO) and the center sediments of each site have sandy soils (LO)

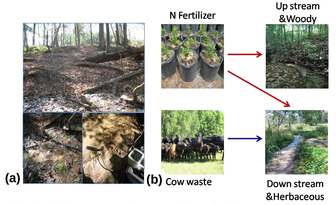

Fig.2. Tributary sediments (a) and different vegetation type (b)

Experimental Methods

•The surface of sediment and litters were collected with spades for Oct 2007, Jan, April and July 2008.
• Biogeochemical properties, extracellular enzyme activities and potential denitrification activity were determined in tributary sediments and litters.

Result 1

Table 1. Biogeochemical Properties in the sediments of Tributary 2 up and down for Oct 2007, Jan, April and July 2008 (n=12).

	Tributary 2 UP		Tributary 2 DOWN	
	Woody vegetation		Herbaceous vegetation	
(mg·kg dry soil^{-1})	Low organic matter	High organic matter	Low organic matter	High organic matter
pH	5.2 (±0.5)	4.6 (±0.6)	5.8 (±0.4)	6.2 (±0.2)
NO_3^--N	1.6 (±0.6)	1.9 (±1.3)	1.8 (±0.4)	0.5 (±0.2)
NH_4^+-N	5.2 (±0.1)	16.8 (±9.3)	6.1(±2.6)	18.5(±7.3)
Organic N	6.3(±4.4)	10.7 (1.7)	6.7 (±3.2)	1.7 (±0.8)
Microbiomass N	13.5 (±9.5)	85.6 (±29.6)	19.6 (±15.3)	37.4 (±32.8)
Total N	0.4 (±0.3)	2.6 (±0.7)	0.4 (±0.3)	1.2 (±0.4)
Extractable OC	45 (±24)	131 (±35)	52 (±20)	78 (±37)
Microbiomass C	339 (±218)	1224 (±302)	296 (±103)	563 (±199)
Total C	36 (±24)	480 (±150)	50(±25)	200(±48)
TC:TN	9	18	11	16
Extractable OC:TC (mg OC·kg TC^{-1})	*	2723	*	4000

•Microbiomass C, Extractable OC and Total C were higher in upstream sediments; however, the relative ratio of Extractable OC to Total C was higher in down stream sediments, indicating that the down stream system had higher relative availability of carbon content per total carbon.

Table 2. Cellulase (Cello) and phenol oxidase (PO) enzyme activities in the sediments and litters of Tributary 2 up and down system and Potential denitrification activities (PD) in tributary sediments for Oct 2007, Jan, April and July 2008 (n=12).

		Tributary 2 UP		Tributary 2 DOWN	
		Woody vegetation		Herbaceous vegetation	
		Low organic matter	High organic matter	Low organic matter	High organic matter
Cello	Sediment	0.1 (±0)	8.7(±6.5)	0.9 (±1.3)	19.4(±17.5)
(mM substrate·g soil^{-1}hr^{-1})	Litter	*	35.6(±14.6)	*	69.0(±0)
PO	Sediment	0.2 (±0.1)	1.3 (±0.6)	0.4 (±0.3)	2.8 (±1.7)
(nM substrate·g soil^{-1}hr^{-1})	Litter	*	13.2 (±5.2)	*	9.7 (±0)
PD (ug N_2·g soil^{-1}·day^{-1})	Sediment	1.2 (±0.6)	12.4 (±3.4)	3.1 (±3.0)	38.7 (±16.4)

•Cellulase and phenol oxidase enzyme activities in litter were higher than those of sediments.

•Higher cellulase enzyme activities in sediments and litters had higher potential denitrification activity at T2 down stream sediments.

Result 2

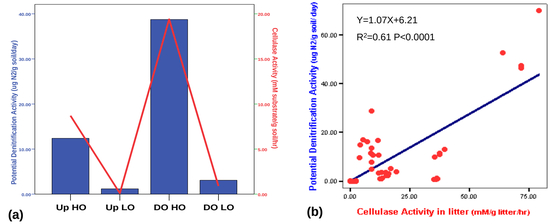

Fig 3. Cellulase enzyme activities and potential denitrification activities in sediments (a) and the relationship between cellulase enzyme activity in litter and denitrification activity of Tributary 2 sediment (b) for Oct 2007, Jan, April to July 2008 (n=12).

•Cellulase enzyme and potential denitrification activities of sediments in the down stream surrounded by herbaceous vegetation were higher than those of up stream sediments impacted by woody vegetation type.

•The positive correlation between cellulase enzyme activity of litter and potential denitrification activity in sediment was observed.

Conclusions

•No significance differences of biogeochemical properties between up and down stream sediments in T2 were not observed except for the relative availability of carbon content per total carbon.

•The tributary sediment surrounded by herbaceous vegetation type had higher cellulase enzyme and potential denitrification activities in T2 down stream system.

•Herbaceous vegetation could be easily decomposed and supply more labile carbon to denitrifiers, enhancing the activity.

Future Study

•To see if there are any relationships between the litter decomposition rate and extracellular enzyme activities and how the litter quality determined by different vegetation type affect the denitrification rate through changing the decomposition rate .