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Microbial Amino Sugars in some Canadian agricultural soils

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Introduction

- Amino sugars are an important component of soil organic matter, with concentrations in soil up to 40 times greater than the concentration of living microbial biomass (Liang and Balser, 2011, Nature Reviews Microbiology, doi:10.1038/nrmicro2386-c1). In addition, amino sugars are potentially useful for tracking changes in microbe composition through time due to their various origins and slower turnover rates relative to living microbial biomass. Hence, the concentration and composition of amino sugars are important determinants of the amount, quality, and characteristics of soil organic matter.
- The objectives of this presentation are to: (i) examine the variations in the concentrations of amino sugars in soils collected from various sites, including Agassiz in BC, Lethbridge in AB, Woodslee and Ottawa in ON and Québec city in QC; (ii) examine the effect of fertilization (organic or chemical), relative to non-fertilized control, on the concentrations of amino sugars in soils.

Materials & Methods

1. Soil samples (0-15 cm): 276 soil samples were used including sample from various field experiments cross Canada, including (Figure 1):
   - 80 samples (one soil type) from Agassiz, BC
   - 60 samples (two types of soil) from Québec City (QC)
   - 56 samples (one soil type) from Lethbridge, AB
   - 50 samples (one soil type) from Woodslee, ON, and
   - 30 samples (one soil type) from Ottawa, ON
2. Amino sugar analysis was performed according to Zhang and Amelung (1996, Soil Biol. Biochem. 28:1201-1206).
3. The effects of fertilizer and organic amendment on amino sugar concentrations were illustrated by three treatments for each site.
4. Hot-water dissolved organic carbon (DOC): extract from 1:10 (soil:water) soil suspension for 60 min (80 °C).
   - Measure the concentrations of TOC in aliquots of the hot water extracts using a TOC Analyzer (TOC-L, Shimadzu, Japan).
   - Collect MIR spectra of each extract using Tensor 37 (Bruker, Germany).

Results & discussion

Table 1. **Concentrations of total nitrogen (N), soil organic carbon (SOC), glucosamine (GluN), galactosamine (GlaN), muramic acid (MurA), and total amino sugars (AS).**

All samples	Total N	SOC	GluN	GlaN	MurA	Total ASs
N=276	g/kg soil		mg/kg soil			
Mean	3.3	43.4	1346	719	190	2270
Min	0.9	10.3	485	188	0	700
Max	12.4	220.4	4034	2051	1426	6746
N=80	Agassiz, BC					
Mean	3.3	42.2	1561	891	207	2636
Min	1.7	25.3	874	431	44	1501
Max	5.8	63.3	2388	1674	348	4226
N=60	Québec City, QC					
Mean	2.2	34.8	1262	746	73	2159
Min	1.0	15.9	485	367	0	1121
Max	3.6	63.8	2098	1793	223	4972
N=56	Lethbridge, AB					
Mean	6.1	78.5	1634	716	539	2901
Min	1.8	19.8	716	188	136	1213
Max	12.4	220.4	4034	2051	1426	6746
N=50	Woodslee, ON					
Mean	2.4	28.1	947	527	-	1482
Min	2.0	24.3	660	263	-	923
Max	3.1	34.4	1520	1020	-	2541
N=30	Ottawa, ON					
Mean	2.2	24.0	1073	538	-	1652
Min	0.9	10.3	498	202	-	700
Max	4.4	50.8	1740	968	-	2781

1. Total ASs varied from 700 to 6746 mg kg^{-1} and GluN was present in the highest concentrations (485–4034 mg kg^{-1}), followed by GalN at intermediate concentrations (188–2051 mg kg^{-1}) whereas MurA had the lowest concentrations (0-190 mg kg^{-1}) amongst all samples (Table 1).
2. The highest AS concentrations occurred in the samples from Lethbridge (AB) and Agassiz (BC) and the lowest AS concentrations were found in the samples from Woodslee and Ottawa (ON). The AS concentrations for the soils from Québec (QC) were in the between.
3. Although Québec soils had a lower total AS concentration relative to Lethbridge soils, the former had a different pattern in individual amino sugar concentrations (lower averages in GluN and MurA but higher GalN), compared with the latter.
4. The average of GluN:GalN ratio was 1.87, varying from 1.70 to 2.00, for all the soils except for the soils from Lethbridge (AB) which had the highest GluN:GalN ratio of 2.28. The Lethbridge soils also showed highest MurA concentrations, followed by the Agassiz soils, and the sandy soil from Québec. However, no MurA was detected from two Ontario soils (Woodslee and Ottawa) and the clay loam soil from Québec City, QC.

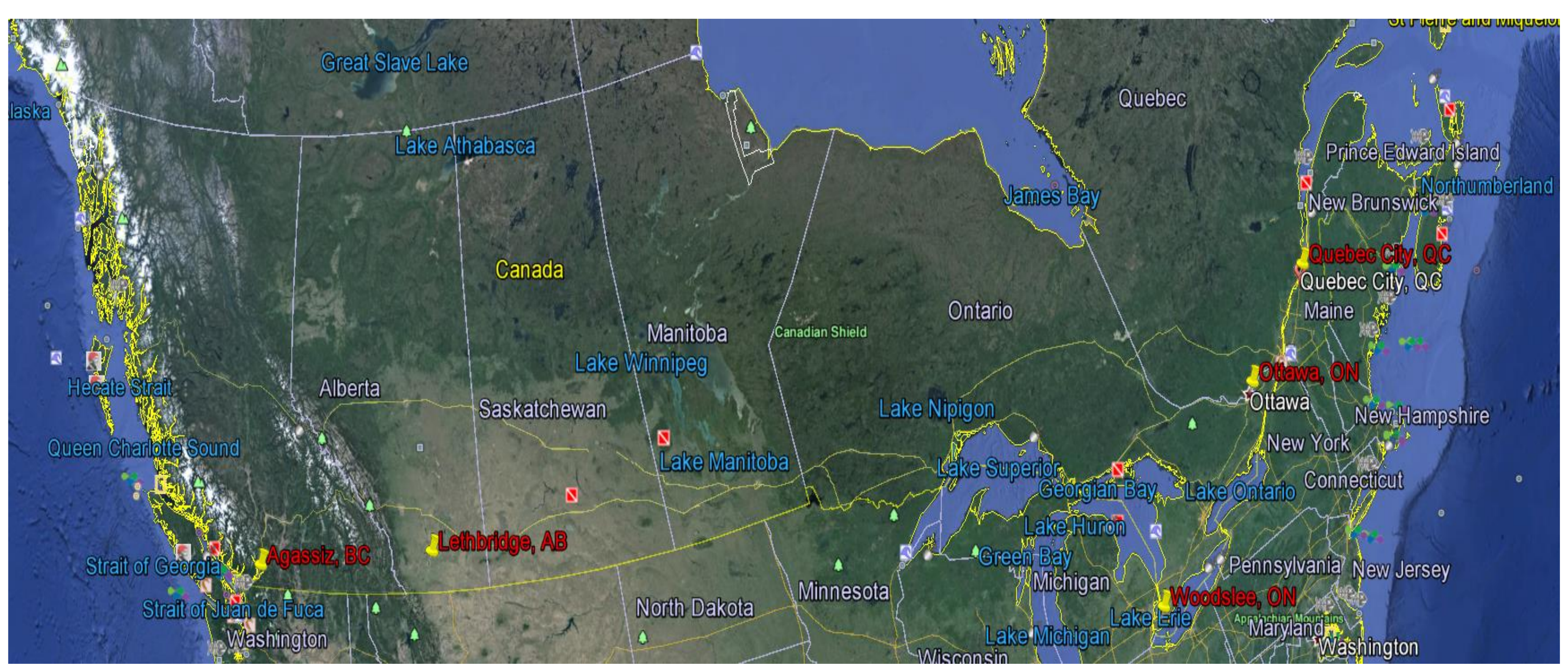

Figure 1. **Snipping diagram of sampling sites from Google map.**

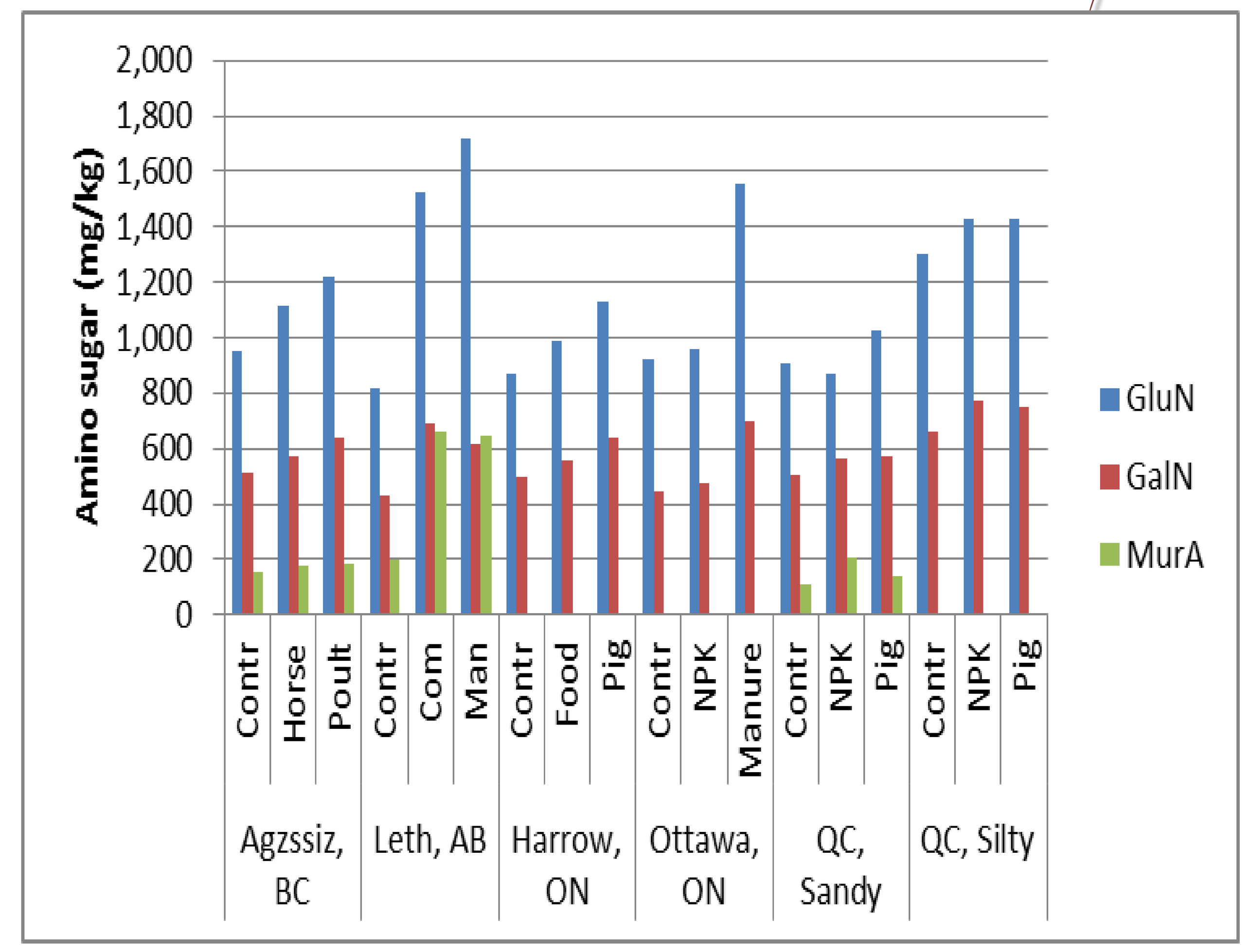

Figure 2. **The effects of fertilizer and organic amendment addition on amino sugar concentrations were illustrated only by three treatments in each site.**

1. Both inorganic fertilizer and organic amendment increase individual amino sugar concentrations (Figure 2). However, the influence was generally lower for chemical fertilizer than organic amendments.
2. The influences of organic amendments also vary with the types of amendments.

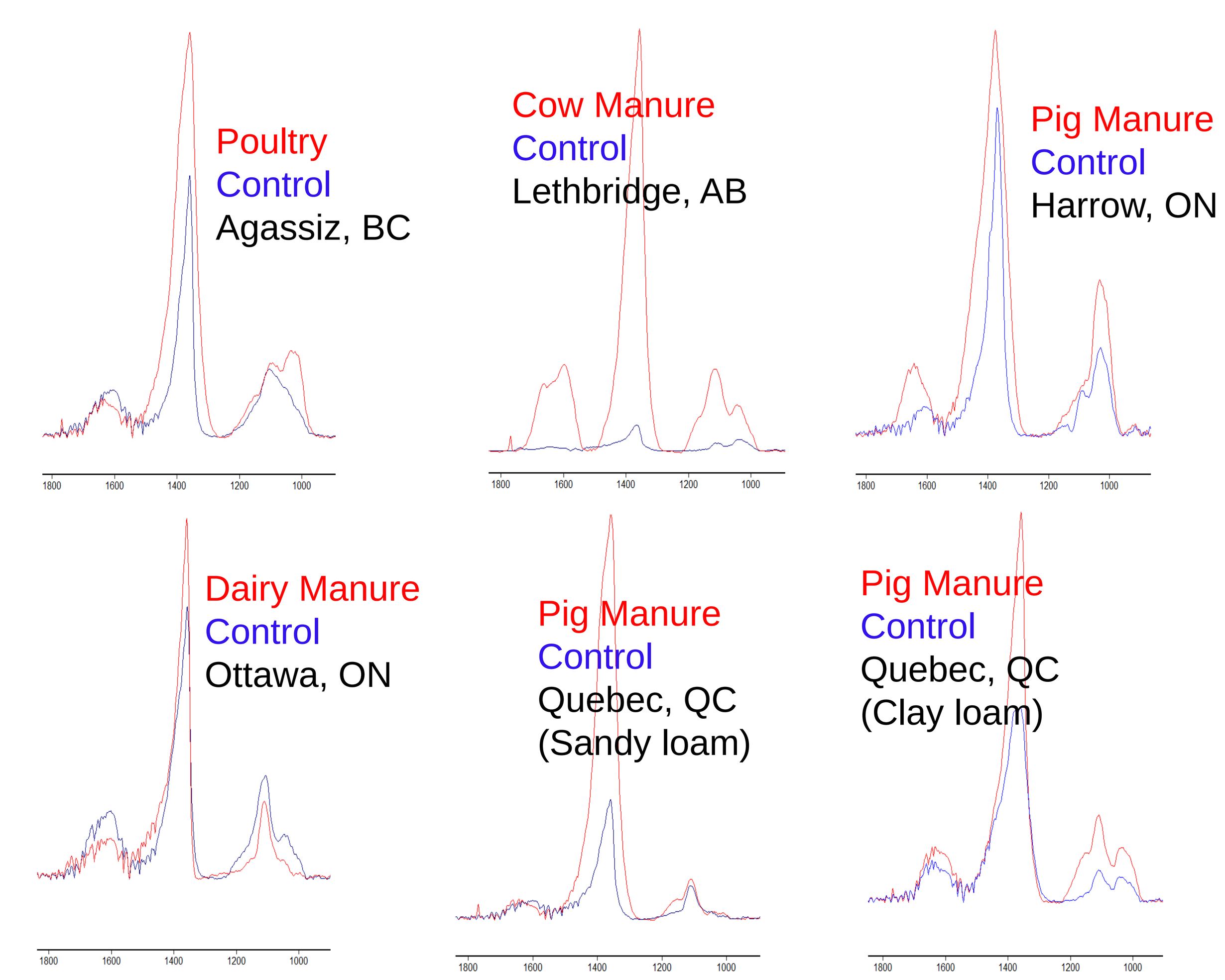

Figure 3. **Mid infrared (MIR) spectra (800-1800 cm^{-1}) of hot water extracted dissolved organic carbon from the a control and a mended soils of each site.**

There are big differences in the peak positions and intensities of the MIR absorption bands between the control and amended soils (Figure 3). The differences not only occur in —OH functional group region (800-1200 cm^{-1}), but also in aromatic/carboxylic (—COOH) functional groups region (1200-1800 cm^{-1}). In general, these differences give us a chance to link the MIR spectral information to soil amino sugars in future.

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