

Fructan, sugar and starch concentrations in North American grass

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Introduction

Researchers must have accurate, precise quantification of fructan, sugar and starch (NSC) concentrations in grass in order to generate realistic models for clinical induction of laminitis. Previously, data on carbohydrate levels in grass have been generated under artificial conditions in growth chambers (Chatterton, 1989) or other countries with different climates and grass species not common in North American pastures (Longland, 2006). Because growing conditions and species have a profound influence on NSC concentration in grass, these data have little relevance to horses at pasture in North America.

There are few studies quantifying NSC in grass under field conditions. Usually fructan and sugars are quantified together as Water Soluble Carbohydrates (WSC). This analytical method makes it impossible to discern which fraction causes laminitis.

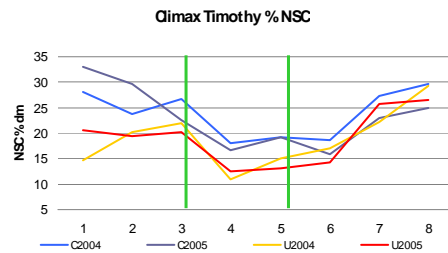
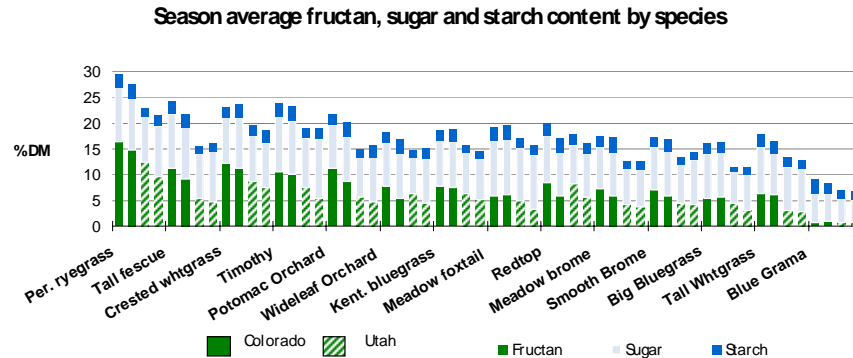
Materials and methods

24 selections of grass were planted in randomized blocks with four replications in Colorado and Utah. After a full year for establishment, samples were cut by hand 8X per growing season for 2 consecutive years at each site. The Colorado site is at 7,600 ft altitude, with cold, sunny growing conditions that should create a worst case scenario for high NSC in grass. Average temperature was 4 °C warmer in Utah.



Spring sampling at the Colorado site.

Samples were frozen immediately at -20°C and shipped by freezer truck to the USDA Forage and Rangeland Research Lab, where they were freeze dried and analyzed for fructan, sugar and starch. Samples were analyzed using a Megazyme procedure modified with an acid hydrolysis to better quantify the type of fructan found in grass. Sugars, oligosaccharides, and starch were quantified separately.



Typical pattern of total NSC concentration over 2 growing seasons at 2 sites. C = Colorado, U = Utah. Harvest 1- 3 = spring, 4- 6 = summer, and 7- 8 = fall. Vertical green lines represent hay removal, and fertilization with nitrogen. NSC average over all species was 4.5% higher at the colder CO site than in UT.

Maximum NSC concentrations

	Fructan	Sugar	Starch
<i>Per. ryegrass</i>	22	11	2.7
<i>Timothy</i>	11	13	3.5
<i>Kentucky bluegrass</i>	14	15	4
<i>Orchard grass</i>	17	14	4
<i>Tall fescue</i>	14	15	4
<i>Meadow brome</i>	11	13	5
<i>Blue grama</i>	1	8	3
<i>Big bluegrass</i>	7	12	4
<i>Indian ricegrass</i>	1	13	4

Highest concentration measured of each NSC fraction throughout the season at various sample dates.

Conclusions

Highest NSC concentrations occurred from green up in early May until nights were no longer freezing in early June. When hay was cut and plots were fertilized, NSC concentration in subsequent regrowth during optimum conditions was 30-50% of the concentrations found during spring. After onset of freezing nights in fall, NSC increased again until sampling ended in early Nov. The period of very high NSC in this region lasted approximately one month in spring and again in fall.

A realistic maximum concentration for pasture grass in the intermountain region of North America is 15% dm fructan, 15% dm sugar and 4% dm starch. If a 500 kg horse were to eat 3% of bodyweight in grass per day (dm basis) total intake would be 2.25 kg fructan, 2.25 kg sugar and 0.6 kg starch per day. This corresponds to dosage of 4.5 g/kg BW fructan, 4.5 g/kg BW sugar, and 1 g/kg BW starch spread over the course of a day, every day for up to a month in spring and again in fall.

This study found lower fructan and higher sugar concentrations than previously reported in the United Kingdom, where perennial ryegrass is common (Longland, 2006). Per. ryegrass was highest in fructan in this study, with a mean concentration of 22% dm one year in late fall at the CO site. This grass is only persistent in marine climates with mild winters such as the PNW region of North America and not grown in the intermountain region. As growing conditions and common grass varieties differ in North America from the United Kingdom, it should be expected that NSC concentrations and ratios of various fractions will differ as well.

Literature cited

Longland A, and Byrd B. Pasture Nonstructural Carbohydrates and Equine Laminitis. J Nutr 2006;136:2099S-2102S.
Chatterton NJ, Harrison PA, Bennett JH, Asay KH. Carbohydrate partitioning in 185 accessions of graminiae grown under warm and cool temperatures. J Plant Physiol 1989;143:169-79.

The lowest in NSC are unimproved species native to the area

Acknowledgments

Thanks is given for funding by the Animal Health Foundation, Pacific, MO for the Colorado site.

For further information

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More information on this and related projects can be obtained at www.safergrass.org

