

Using BATMAN Software to Analyze Metabolic Changes in Type 1 Diabetes-Susceptible Rats

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Introduction

Rats with the LEW.1WR1 genotype have been shown to be susceptible to developing Type 1 Diabetes¹ and are used to understand metabolic changes in connection with diabetes. This project monitors the concentration of metabolites in LEW.1WR1 and control rats at different timepoints in their lifetimes. The Bayesian AuTomed Metabolite Analyser for Nuclear Magnetic Resonance (NMR) spectra (BATMAN) software package uses Bayesian statistical modeling to analyze NMR spectra, resulting in relative concentration profiles for the samples².

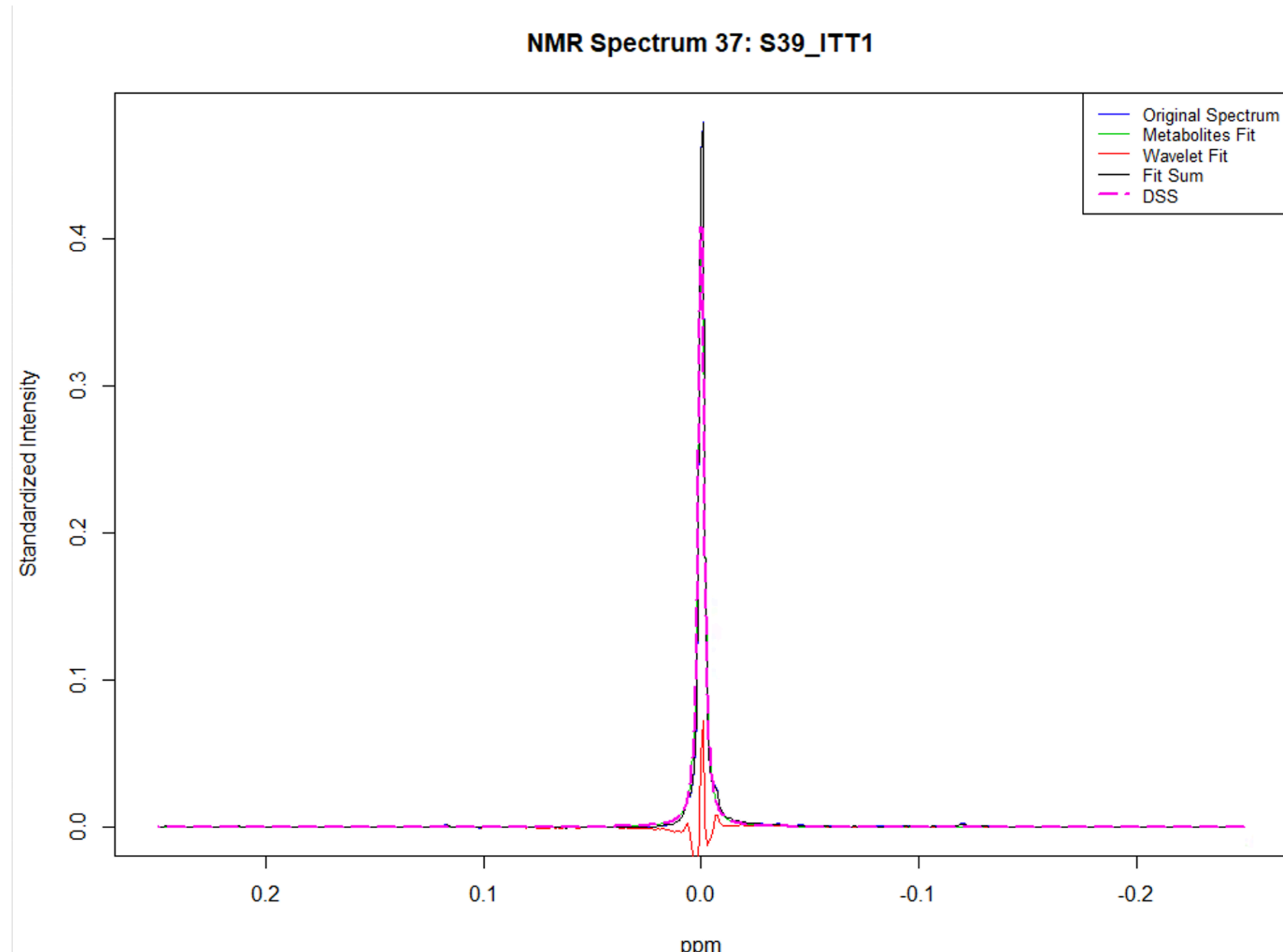


Figure 1. DSS peak fitting. The DSS peak is standardized across all spectra at 0.0 ppm with a concentration of 1 mM. A proper fit of this peak is very important as it is the reference standard for all other concentrations.

Impact

Further work, including comparison of concentrations of specific metabolites over the lifespan of the different groups of rats, is expected to reveal the metabolic changes that the diabetes-susceptible rats go through versus the control.

Results

A standard operating procedure for analyzing the large amounts of spectra was developed:

- Setting of the peak width parameter using the standard DSS peak at 0 ppm (as shown in Fig. 1),
- Setting of the general chemical shift change parameter (rdelta) using the DSS peak, and
- Setting of the specific rdelta values for various peaks that have a large variability in chemical shift values (as shown in Fig. 2 with the citric acid peak at approximately 2.7 ppm).

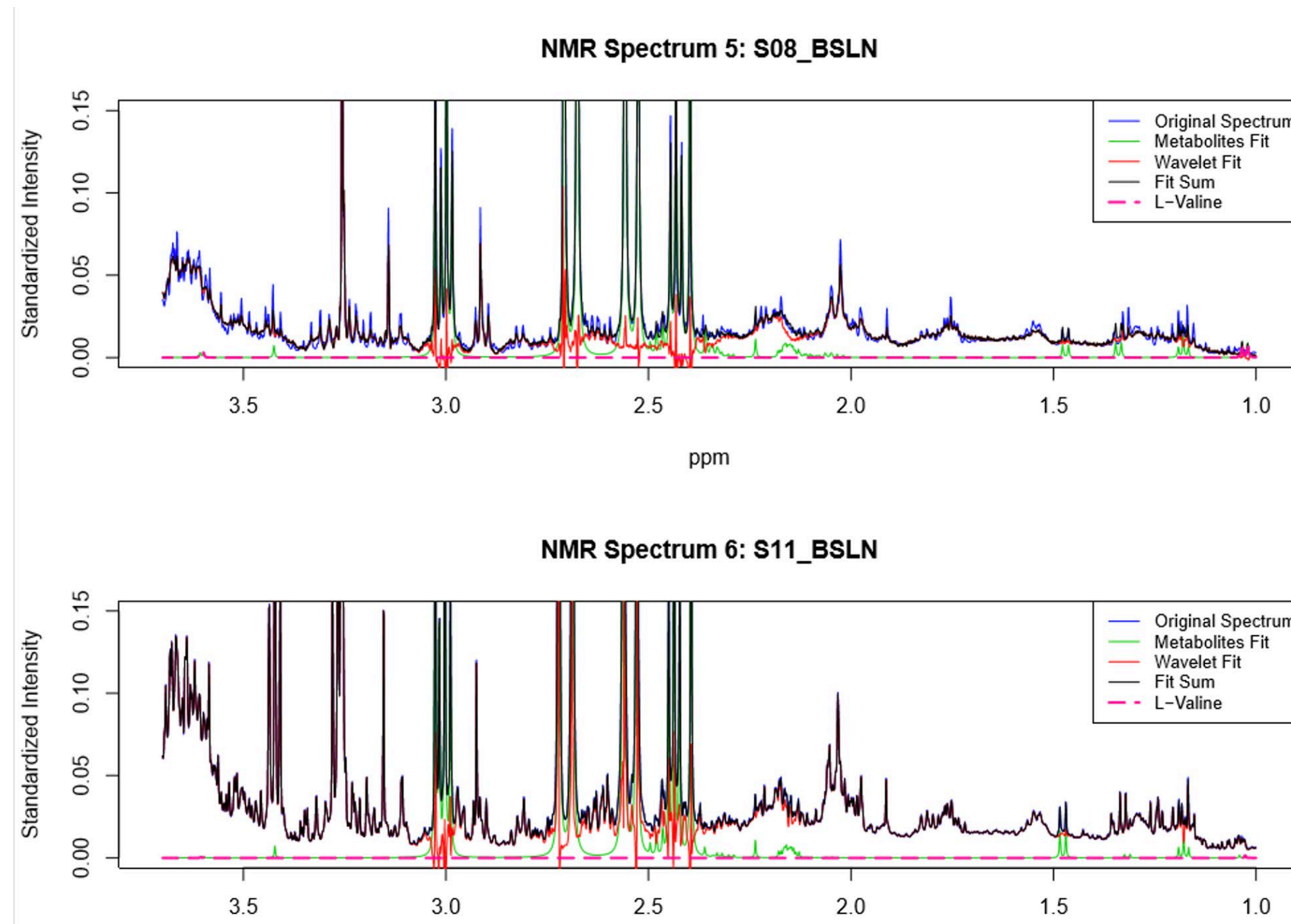


Figure 2. Metabolite peak fitting. Fitting of the many metabolites of interest required changing several of the available parameters to achieve a proper fit that would yield relative concentration values that could be compared with the DSS values to give a true concentration.

References

1. Mordes, J. P.; Guberski, D. L.; Leif, J. H.; Woda, B. A.; Flanagan, J. F.; Greiner, D. L.; Kislauskis, E. H.; Tirabassi, R. S. LEW.1WR1 Rats Develop Autoimmune Diabetes Spontaneously and in Response to Environmental Perturbation. *Diabetes* **2005**, *54* (9), 2727–2733. <https://doi.org/10.2337/diabetes.54.9.2727>.
2. Hao, J.; Liebeke, M.; Astle, W.; De Iorio, M.; Bundy, J. G.; Ebbels, T. M. D. Bayesian Deconvolution and Quantification of Metabolites in Complex 1D NMR Spectra Using BATMAN. *Nat. Protoc.* **2014**, *9* (6), 1416–1427.

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