Pipecolate and taurine, rat urinary biomarkers for lysine and threonine deficiency

Dalila Azzout-Marniche, Joanna Moro, Gaëtan Roisné-Hamelin, Nadezda Khodorova, Douglas N Rutledge, Jean-Charles Martin, Pierre Barbillon, Daniel Tomé, Claire Gaudichon, Catherine Tardivel, et al.

Pipecolate and taurine, rat urinary biomarkers for lysine and threonine deficiency

D. Azzout-Marniche[a], G. Roisné-Hamelin[a], J. Moro[a], N. Khodorova[a], D N. Rutledge[b], JC. Martin[c], P. Barbillon[e], D. Tomé[a], C. Gaudichon[a], C. Tardivel[c], D. Jouan-Rimbaud Bouveresse[a*]

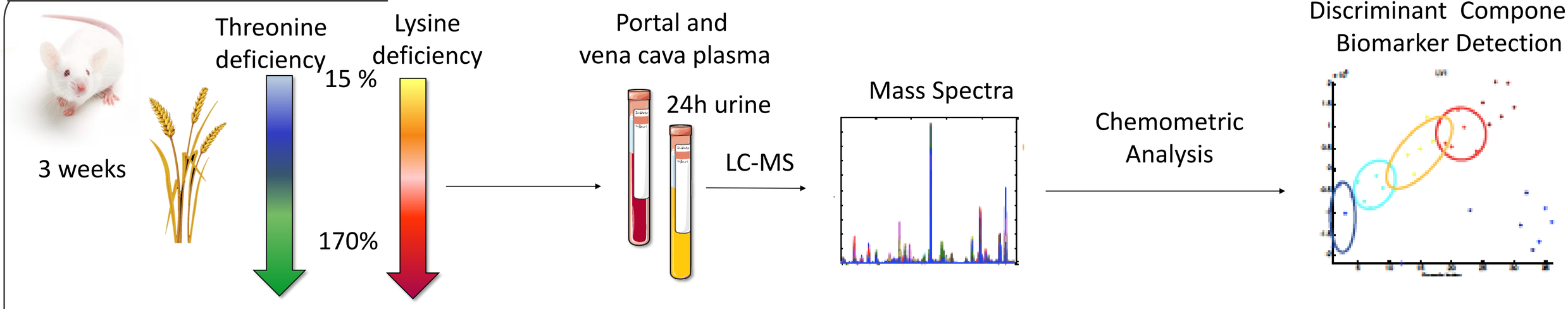
[a]Université Paris-Saclay, AgroParisTech, INRAE, UMR PNCA, 91120, Palaiseau, France.
[b]AgroParisTech, Université Paris-Saclay, INRAE, UMR SayFood, 91300, Massy, France.
[c]Aix Marseille Université, INSERM, INRAE, C2VN, Marseille, France.
[e]Université Paris-Saclay, AgroParisTech, INRAE, UMR MIA Paris-Saclay, 91120, Palaiseau, France.

Introduction

The quality of dietary protein sources became a particularly sensitive issue in the current debates on a rebalancing between animal and plant food sources. The ability of a protein to meet the nutritional requirements of essential amino acids (EAA) is the basis for assessing the quality of protein.

The objective of this study was to develop metabolomic approaches to identify specific biomarkers for an EAA deficiency, such as lysine and threonine.

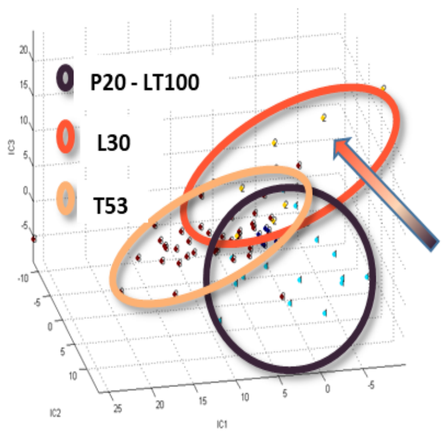
Materiel and Methods



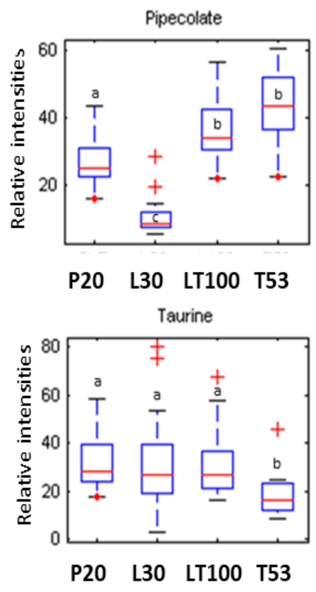
Experiment 1: 24 rats were fed during 3 weeks a gluten diet (L30, T53 or LT100) or a control diet (P20). L30 diet: gluten diet deficient in lysine but supplemented in threonine to cover 100% of its requirement; T53 diet: gluten diet deficient in threonine but supplemented in lysine to cover 100% of its requirement; LT100 diet: gluten diet supplemented in lysine and threonine to cover 100% of their requirements.
Experiments 2 and 3: 64 rats were fed during 3 weeks different levels of Lysine (L) or Threonine (T) deficient diets: 15, 25, 40, 60, 75, 100 or 170% of the theoretical threonine requirement necessary for growing rats comparatively to the control diet (P20) (n=8 by group).

Results

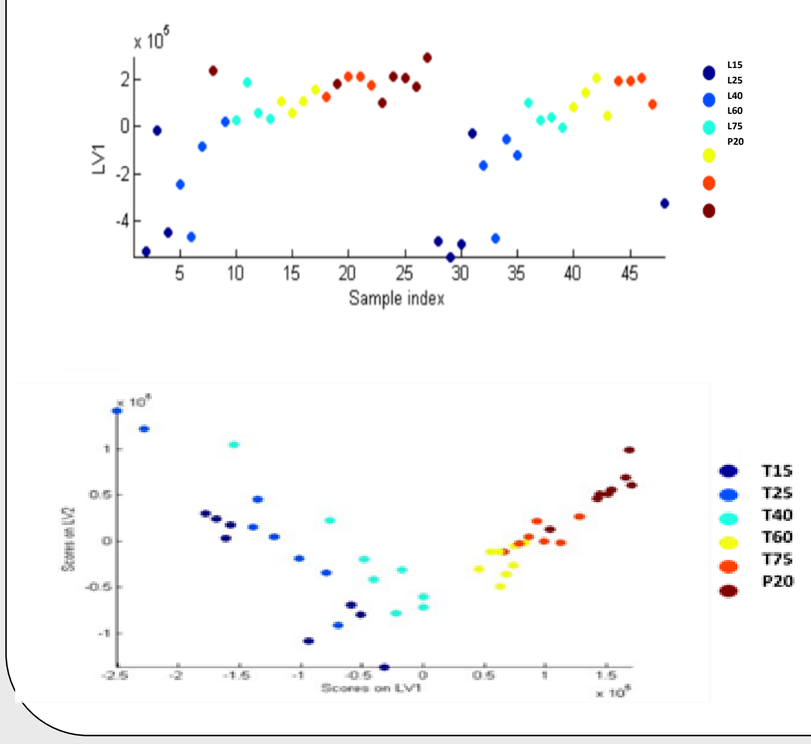
IC-DA analysis for the LC-MS data



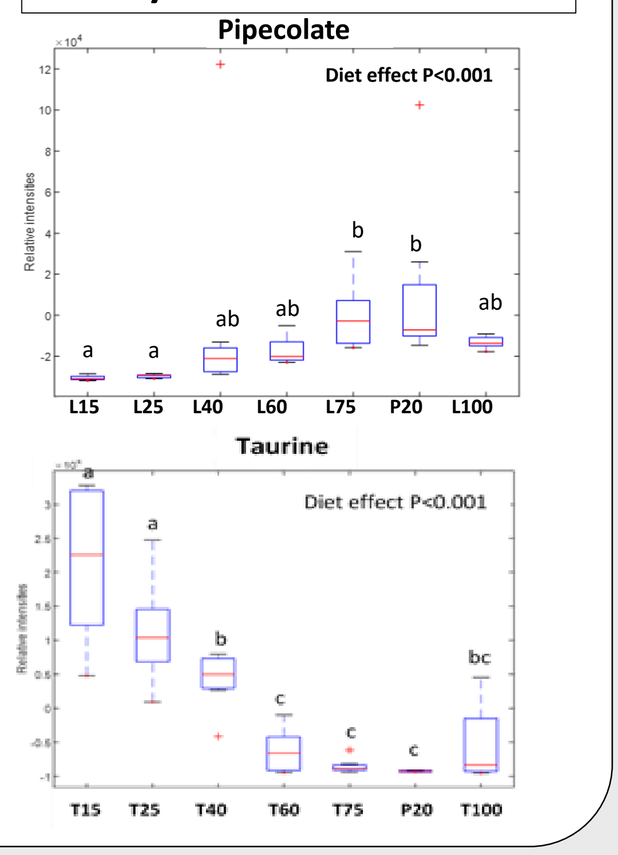
Urinary biomarkers variation



PLS analysis for the LC-MS data



Urinary biomarkers variation



- With non-targeted metabolomics (Experiment 1) and targeted metabolomics approaches (Experiments 2 and 3), two biomarkers were identified: pipecolate and taurine.
- Pipecolate is lower for low lysine diets (Experiments 1 and 2), but not for low threonine diets.
- Taurine is the second biomarker found in two experiments on protein/AA deficiency. Interestingly, taurine does not present the same variation between these two experiments but it discriminates between the groups and differentiates the threonine deficient diets from the control diets.

Conclusion

We identified two biomarkers specific to EAA deficiency in rats: pipecolate for lysine and taurine for threonine. Additional experiments are needed to clarify the effect of threonine on taurine excretion in urine. These two biomarkers, which can predict the state of sufficiency in lysine or threonine in rats in experimentally controlled conditions, are promising. Their measurement in the urine could make it possible to know the AA status of an individual, and thus to detect a possible state of deficiency.

J. Moro, G. Roisné-Hamelin, N. Khodorova, D.N. Rutledge, J.-C. Martin, P. Barbillon, D. Tomé, C. Gaudichon, C. Tardivel, D. Jouan-Rimbaud Bouveresse, D. Azzout-Marniche. Pipecolate and taurine, rat urinary biomarkers for lysine and threonine deficiencies respectively; The Journal of Nutrition ***153 (9)*** *(2023), 2571-2584, https://doi.org/10.1016/j.tjnut.2023.06.039*