SPECTROMAITRISE
CAPACITÉS

METABOLOMICS

Metabolomics consists in studying metabolic changes which happen in different biological matrices following an external disturbance (medicinal treatment, diet alteration, etc.). This is achieved by establishing a metabolic profile of the studied matrix.

For fifteen years, and according to the full expansion of this application field, the achievement of metabolomic studies requires the use of analytical techniques that are always more efficient, sensitive and reproducible in order to analyze different sample cohorts and to answer biological issues. As Nuclear Magnetic Resonance (NMR) matches these different criteria, it is a technique of choice to perform metabolomic analyses.

These can be requested in particular via the CORSAIRE platform (https://www.pf-corsaire.org/), dependent on Biogenouest and to which SPECTROMAITRISE is affiliated. CORSAIRE brings together a strong academic expertise and technical skills in metabolomics, fluxomics and lipidomics from several western France laboratories.

Corsaire
plate-forme de métabolomique du Grand Ouest

Which expertise is proposed by SPECTROMAITRISE?

- Metabolomic or lipidomic workflow, including a potential sample preparation (e.g. metabolite extraction), a profiling of biological matrices by one dimension (1D) and/or two dimensions (2D) NMR (targeted or untargeted analyses), a possible identification of biomarkers, the achievement of statistical analyses such as PCA and PLS-DA
- Targeted quantification of major metabolites in biological samples

What are the innovative and differentiating methodologies used or proposed by SPECTROMAITRISE?

- Fast 2D NMR. During the last decade, many developments have significantly reduced the experimental duration of 2D NMR. Therefore, these fast 2D NMR methods are particularly adapted to lipidomic and metabolomic studies in order to perform targeted or untargeted analysis of a sample cohort
- Equipment dedicated to metabolomic and lipidomic analyses: Bruker 700 MHz spectrometer equipped with a cryogenically cooled probe and a refrigerated high capacity auto-sampler (SampleJet)
- ^{1}H NMR with high accuracy and trueness (~1%)

To which matrices can the SPECTROMAITRISE expertise be applied?

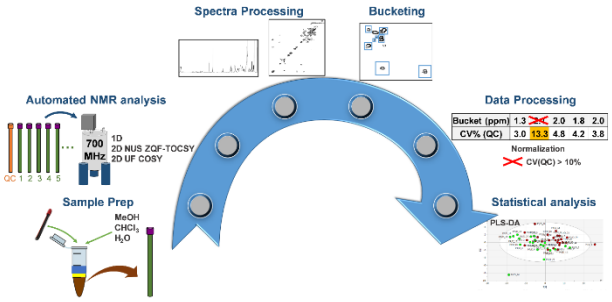
- Metabolic or lipidomic extracts obtained from animal (e.g. muscles, tissues, cells) or vegetable (e.g. fruits, plants) matrices, bacteria, etc.
- Biofluids: urine, blood, plasma, culture supernatants, etc.

Examples of recent applications

A multidimensional ^{1}H NMR lipidomics fingerprinting workflow to address chemical food safety issues,

J. Marchand *et al.*, *Metabolomics*, 2018, 14:60

This article demonstrates the potential of 1D and 2D NMR to realize lipidomic analyses. In particular, a lipidomics workflow has been developed on serum extracts from pigs in the context of food chemical safety. This workflow enabled the discrimination of two groups of animals, a control one and a group which was doped with a β-agonist. This molecule promotes leaner meat with more proteins but its use is forbidden in Europe.



Workflow for high-throughput lipidomics by 1D and 2D ^{1}H NMR

Multidimensional NMR approaches towards highly resolved, sensitive and high-throughput quantitative metabolomics,

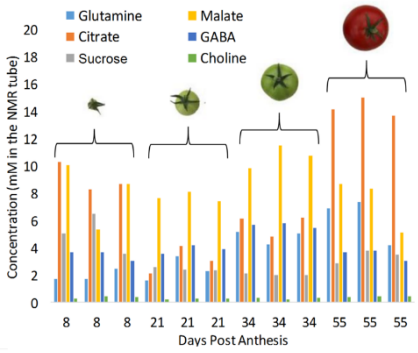
J. Marchand *et al.*, *Current Opinion in Biotechnology*, 2017, 43, 49-55

In this article, we describe the recent improvements which make it possible to consider 2D NMR as a privileged tool to perform quantitative metabolomic analyses. In particular, the various strategies which lead to the reduction of experimental duration are listed (Non Uniform Sampling or NUS, ultrafast NMR, etc.).

Absolute quantification of metabolites in tomato fruit extracts by fast 2D NMR,

T. Jézéquel *et al.*, *Metabolomics*, 2015, 11, 1231-1242

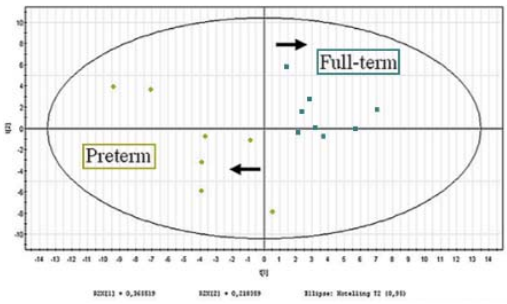
This article demonstrates that quantitative NMR metabolomics is a powerful tool to access valuable information on plant metabolism. More particularly, the use of fast COSY experiments allows the acquisition of 2D NMR spectra in five minutes on tomato extracts at different stages of development. Moreover, eight major metabolites can be quantified with a trueness of a few percent.



Quantification of glucose at different development stages in polar extracts of tomato fruits by a fast 2D NMR strategy (collaboration with C. Deborde and A. Moing, INRA Bordeaux)

^{1}H-NMR based metabolomics profiling of maternal and umbilical cord blood indicates altered maternal- fœtal nutrient exchange in preterm infants,

I. Tea *et al.*, *Plos One*, 2012, 7, 1



Foetal growth is determined by nutriment availability which is dependent on placental transport and foetal metabolism. In relation to premature birth, a metabolomic analysis by 1D ^{1}H NMR of cord blood was carried out in order to underline metabolic changes associated with the prematurity of neonates. A metabolic signature of mothers who gave birth to preterm infants was identified by associated these measurements with statistical analyses.

PLS-DA score plot resulting from the analysis of arterial umbilical cord plasma –The discrimination between groups reveals metabolic variations related to the term of delivery

Plant metabolism as studied by NMR spectroscopy (Collaboration with MetaboHub – Bordeaux Metabolome Platform),

C. Deborde *et al.*, *Progress in Nuclear Magnetic Resonance Spectroscopy*, 2017, 102-103, 61-97

The study of plant metabolism impacts a broad range of fields such as phytochemistry or animal nutrition. Its complexity is especially due to a huge variety of existing mechanisms as well as to different concentration ranges of metabolites which have to be analyzed. This article illustrates how these different experimental approaches developed by NMR have led to a clear and real progress in the understanding of different types of metabolisms.