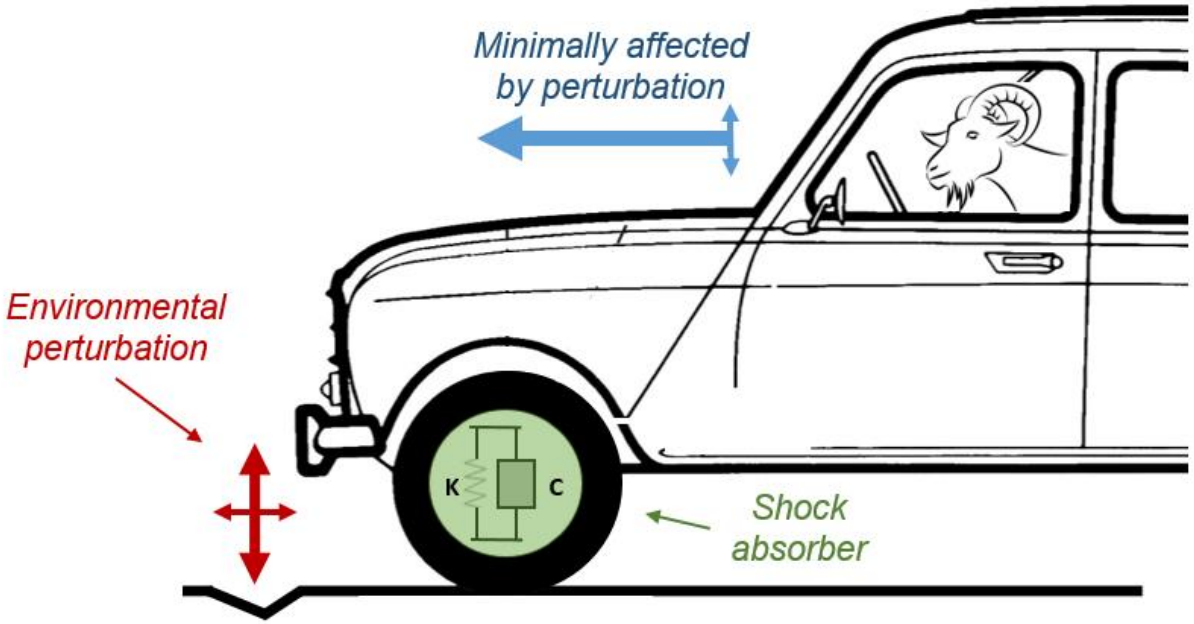
PHD fundings: 50% SMARTER (UE H2020) + 50% RESILAIT (APISGENE)

Toward genetic selection for resilience based on milk metabolites

Marie Ithurbide - Rachel RUPP - Nicolas FRIGGENS

What is resilience?



Refers to short term perturbations

Time related process

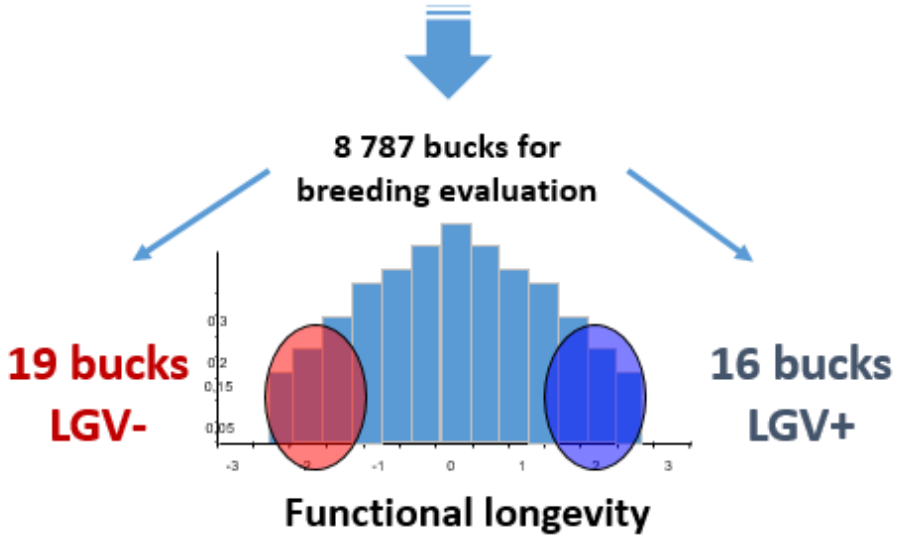
Interconnected pathways

Hypothesis

There is a diversity of metabolic strategies to respond to an underfeeding challenge, and these strategies are part of the heritable resilience mechanism in the dairy goat

Comparison of the two longevity goat lines

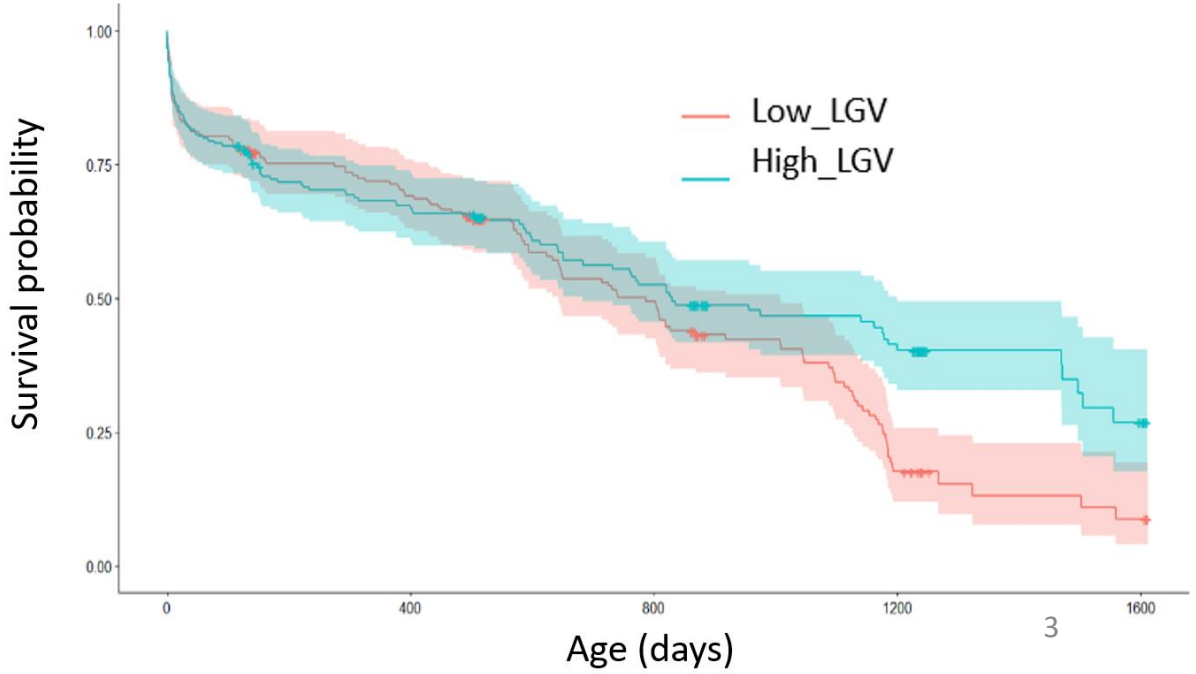
Ithurbide et al. 2022, JDS



	2017	2018	2019	2020	2021	Total
Low_LGV	48	46	39	40	39	212
High_LGV	45	45	42	68	28	228
Total	93	91	81	108	67	440

High_LGV

- Better survival
- Heavier during early lactation
- Lower milk fat-to-protein ratio
- Lower Somatic Cell Score



Metabolic response to underfeeding challenge

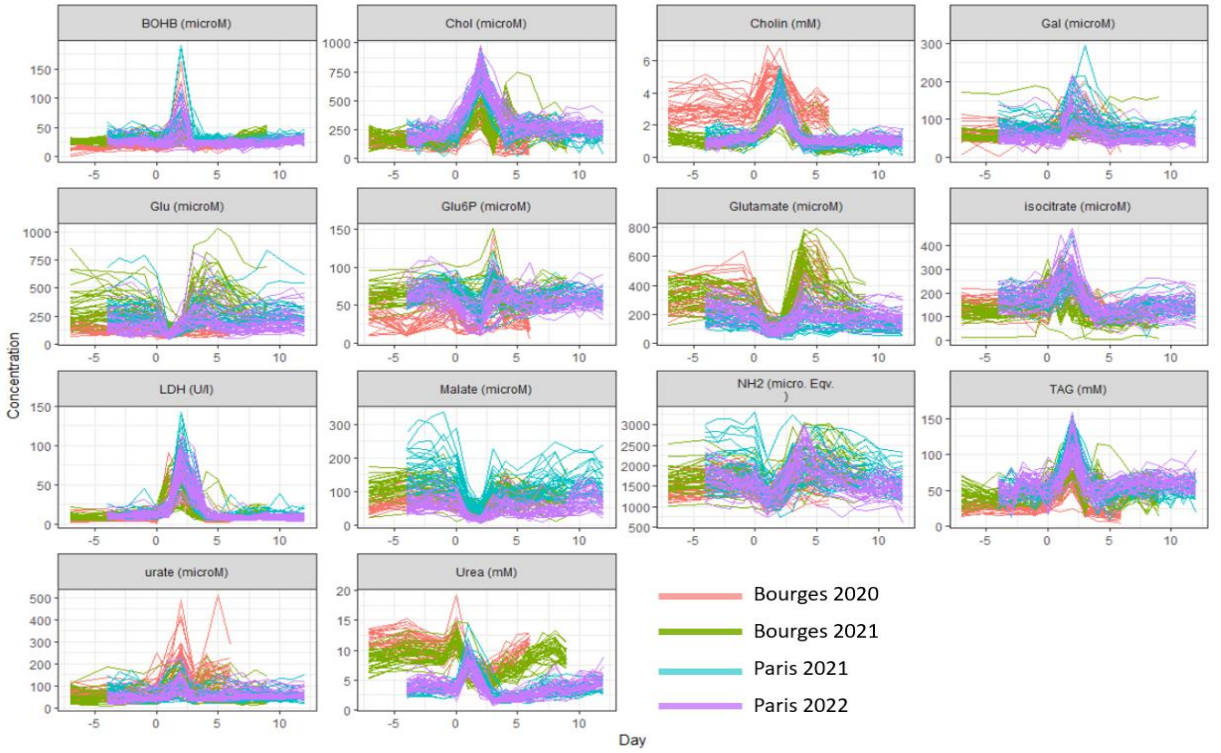
Underfeeding challenges

- Early lactation primiparous goats
- Two days on straw

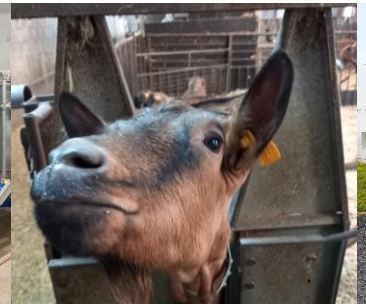
Measures

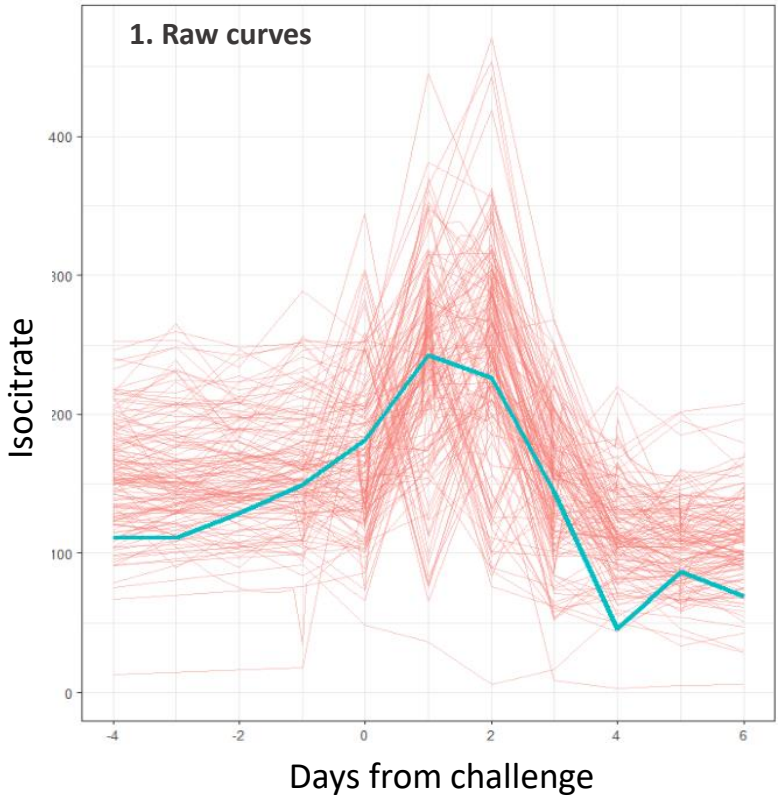
- 14 milk metabolites
- Production, Fat content, Protein content, SCS
- From day -7 to day +6

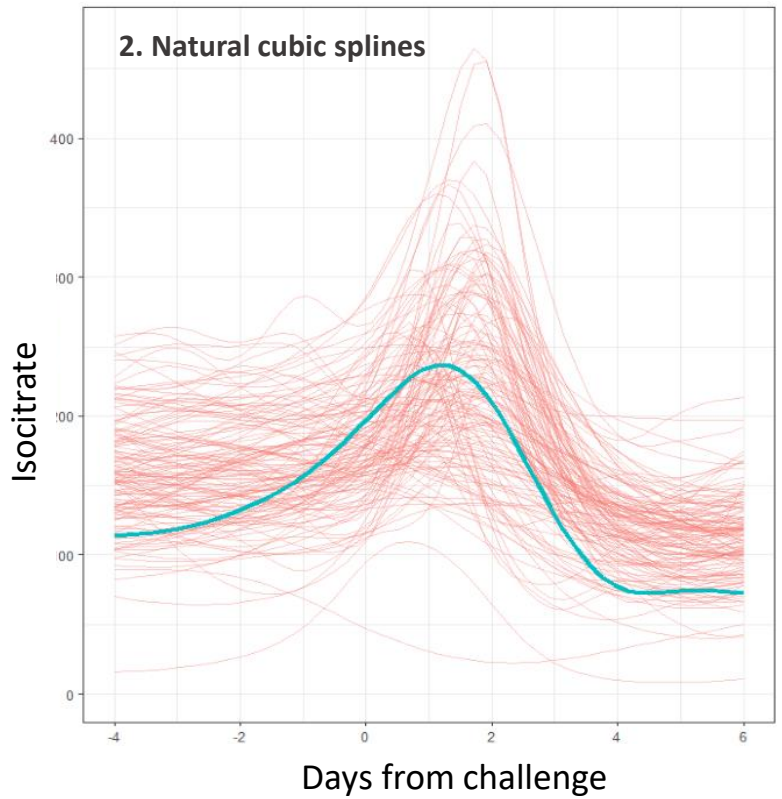
	Year of the underfeeding challenge / INRAE facility				
	2020 P3R Bourges	2021 P3R Bourges	2021 Paris	2022 Paris	Total
Low_LGV	15	14	17	14	60
High_LGV	18	22	17	21	78
Total	33	36	34	35	138

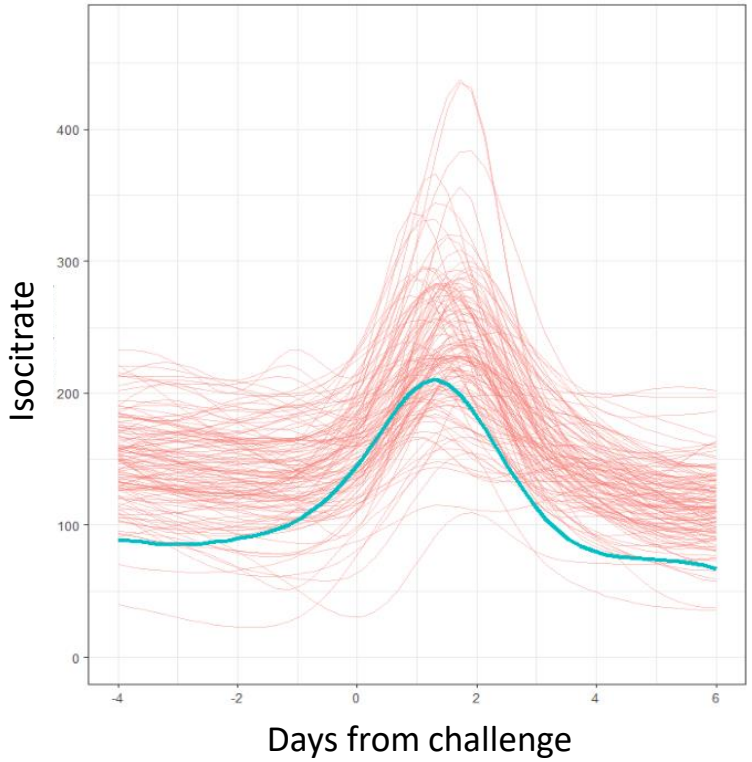


INRAE experimental facility of Bourges

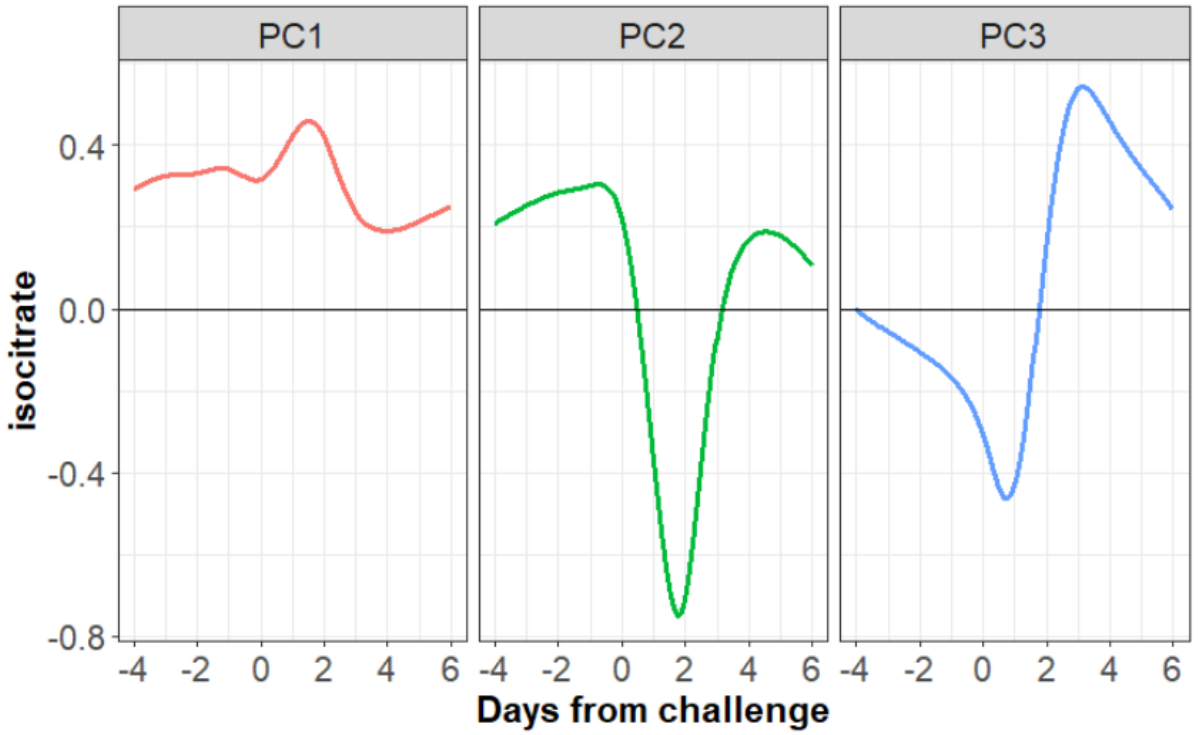




1. Raw curves
Isocitrate
Days from challenge

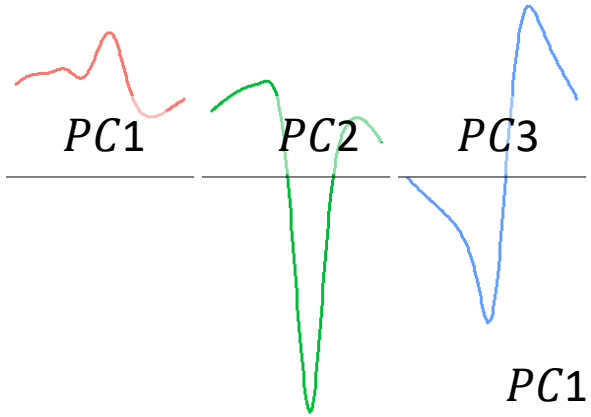

2. Natural cubic splines
Isocitrate
Days from challenge

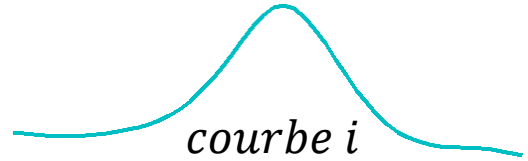


Calculation of the functional principal components

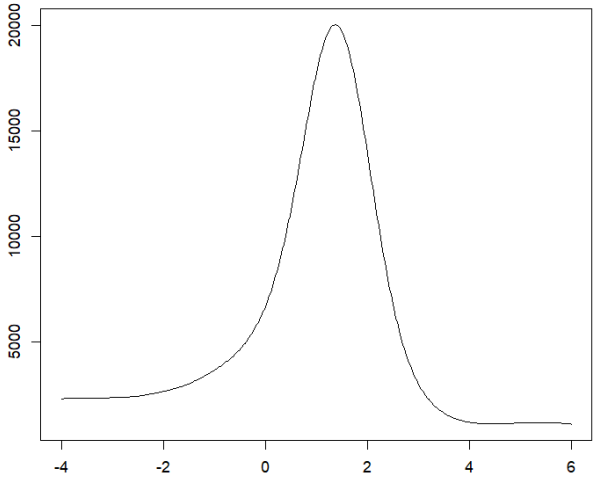


Like a classical PCA, the linear principal component decomposition explains as much of the variation as possible

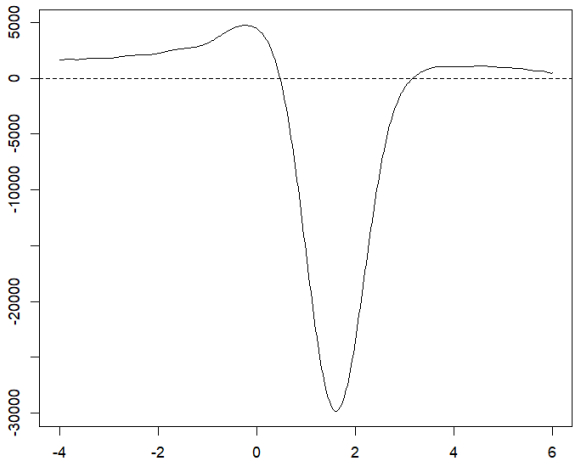




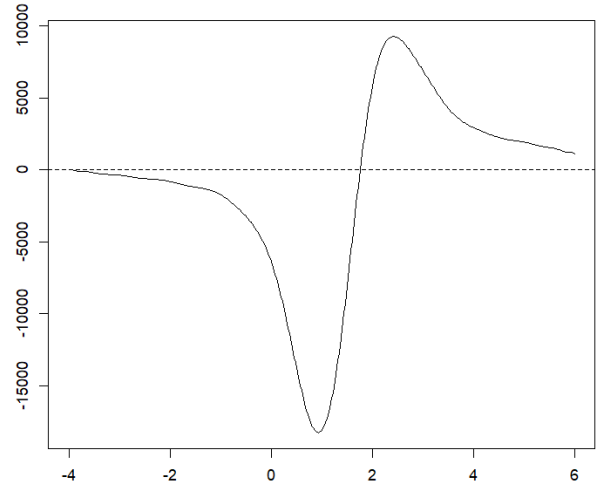
$PC1 * courbe\ i$



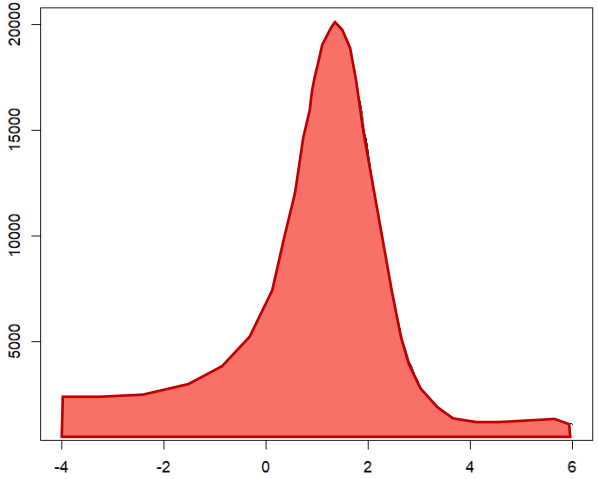
$PC2 * courbe\ i$



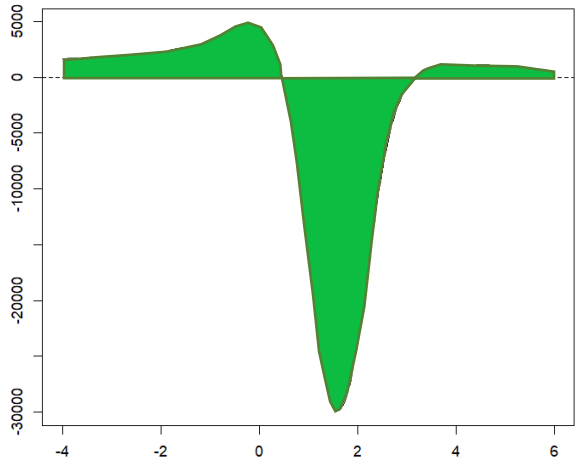
$PC3 * courbe\ i$



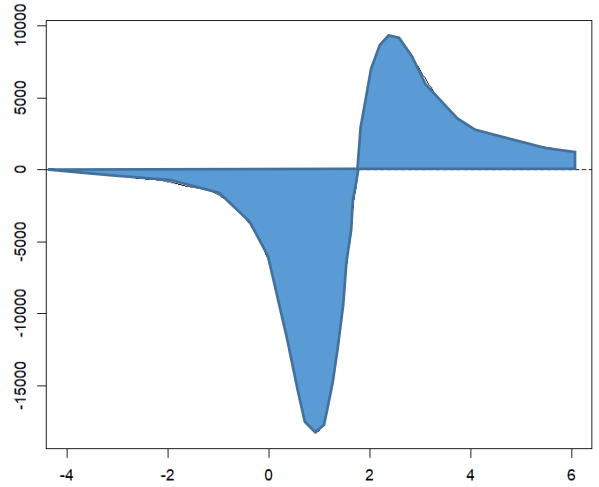
$$\int_{-4}^{6} PC1 * courbe\ i$$

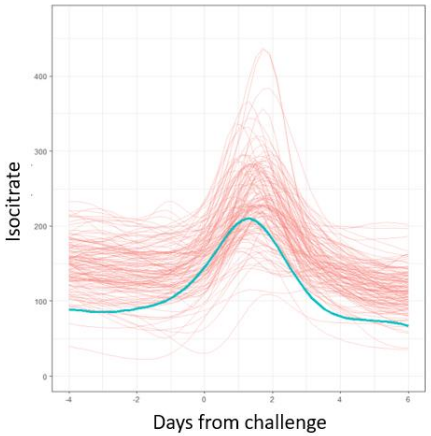


$$\int_{-4}^{6} P21 * courbe\ i$$



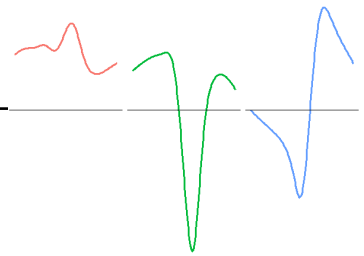
$$\int_{-4}^{6} P21 * courbe\ i$$

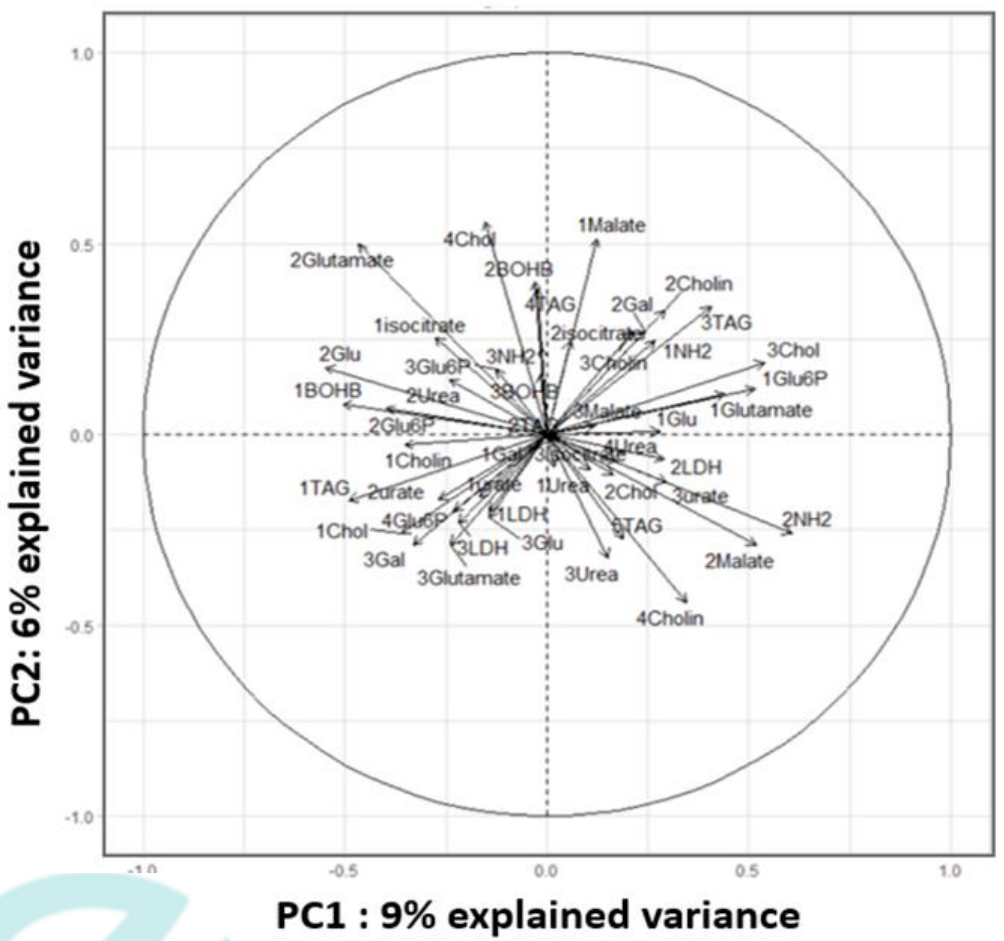


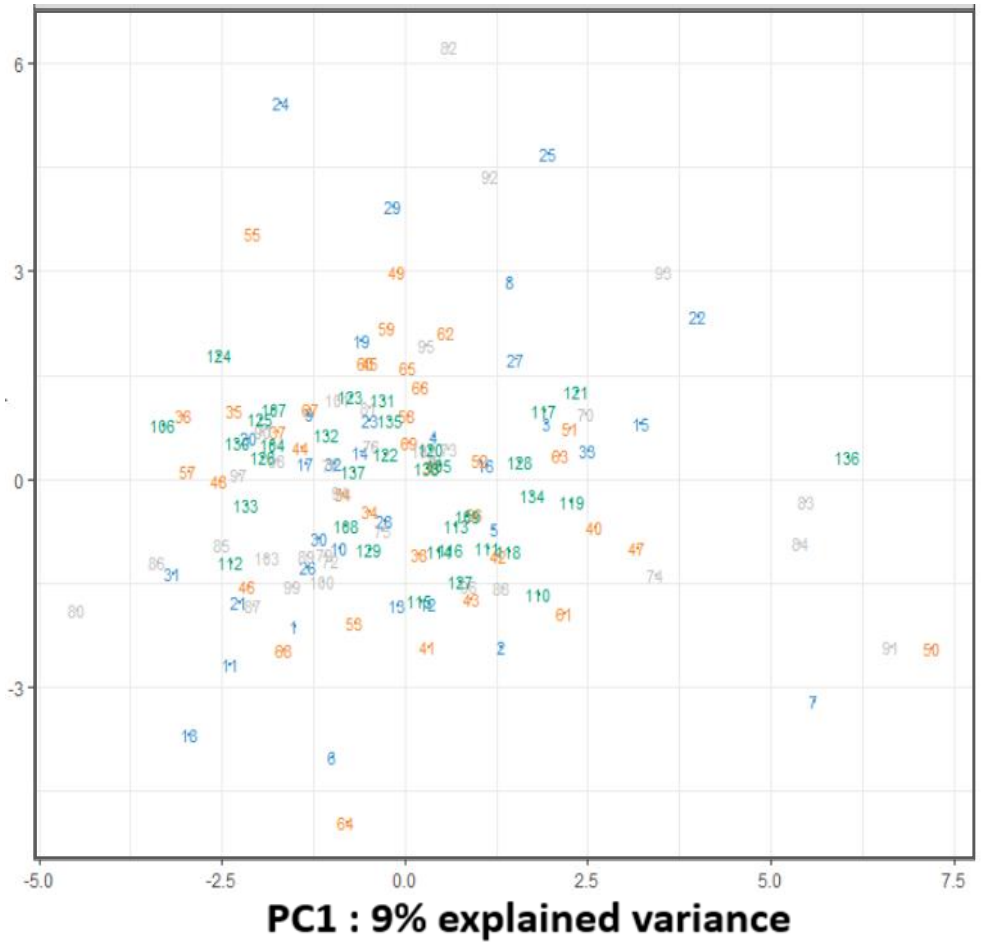


Individual functional PC scores

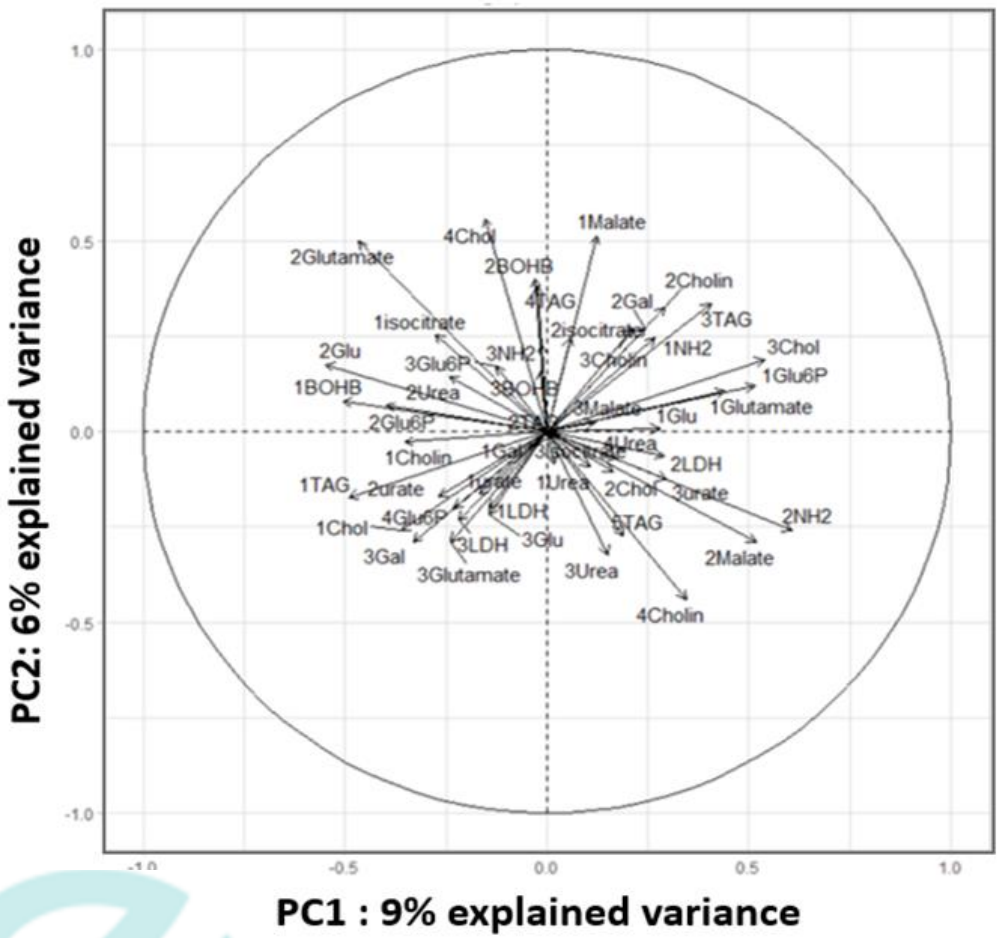
1isocitrate	2isocitrate	3isocitrate
-129.5	-30.6	-58.3

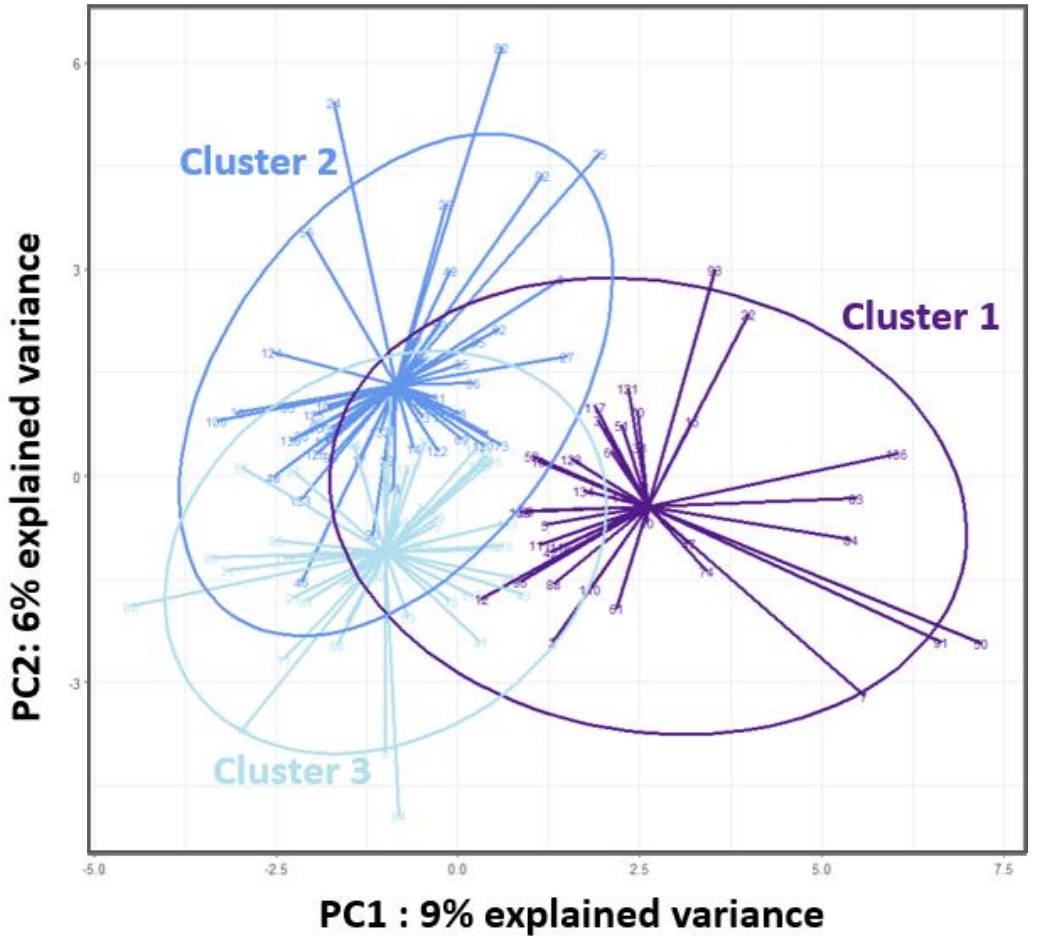




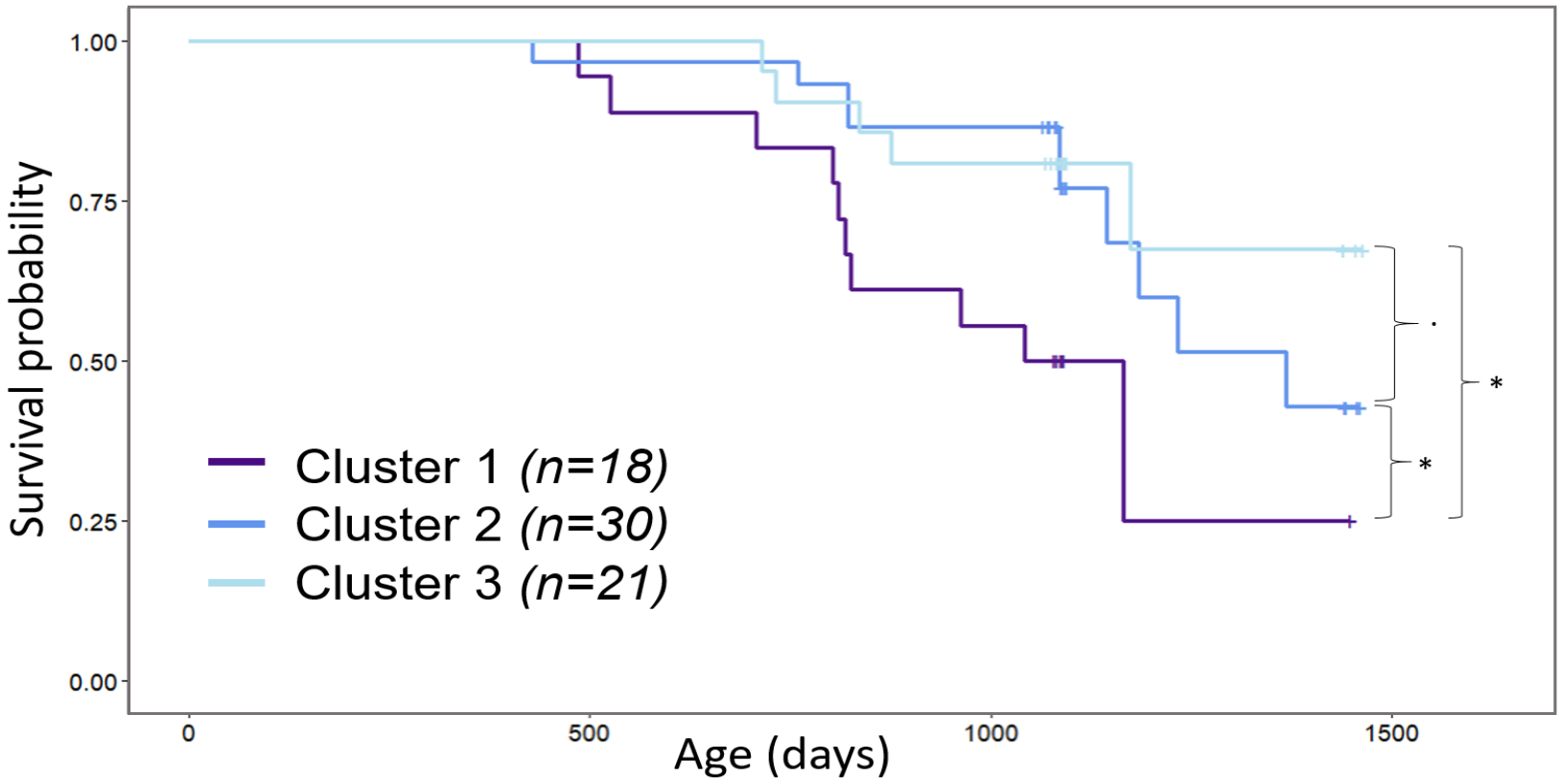


- *Bourges 2020*
- *Bourges 2021*
- *Paris 2021*
- *Paris 2022*





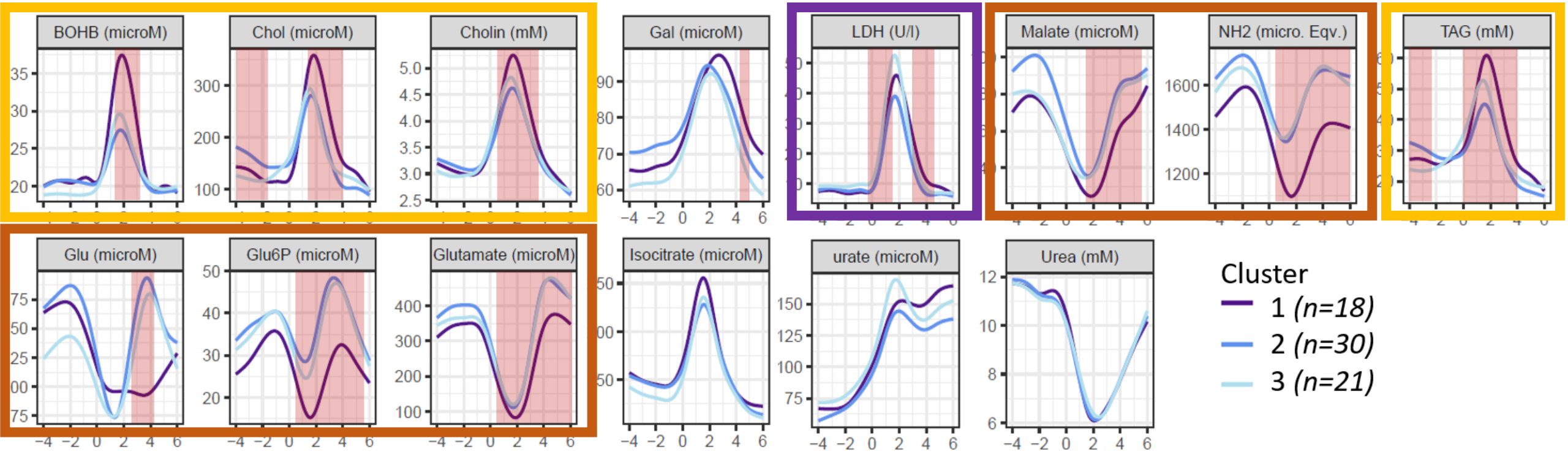
Cluster
- 1 *(n=18)*
- 2 *(n=30)*
- 3 *(n=21)*


Survival probability
1.00
0.75
0.50
0.25
0.00
0
500
1000
1500
Age (days)
Cluster 1 (n=18)
Cluster 2 (n=30)
Cluster 3 (n=21)
.
*
*

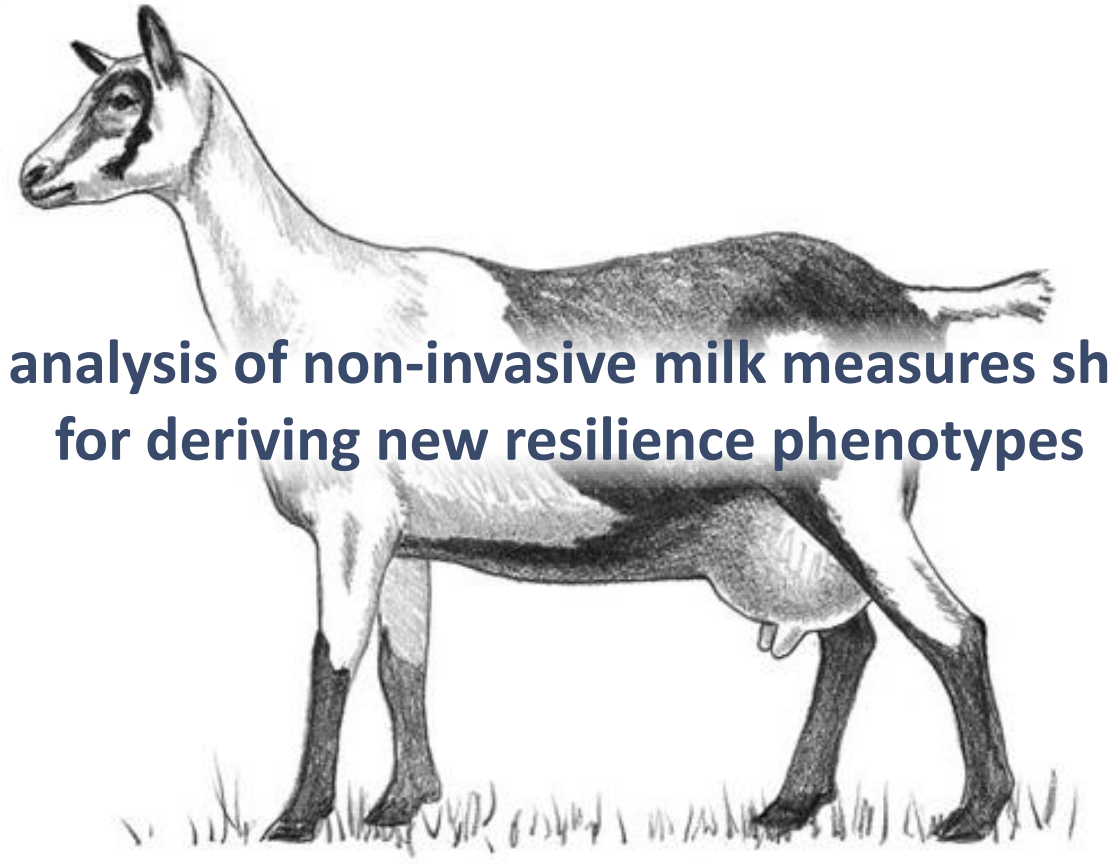
p<0.01

Cluster 1

- Higher body fat mobilisation during challenge
- Sharper decrease and slower increase of the milk sugars and protein related metabolites
- Inflammatory indicator remains longer

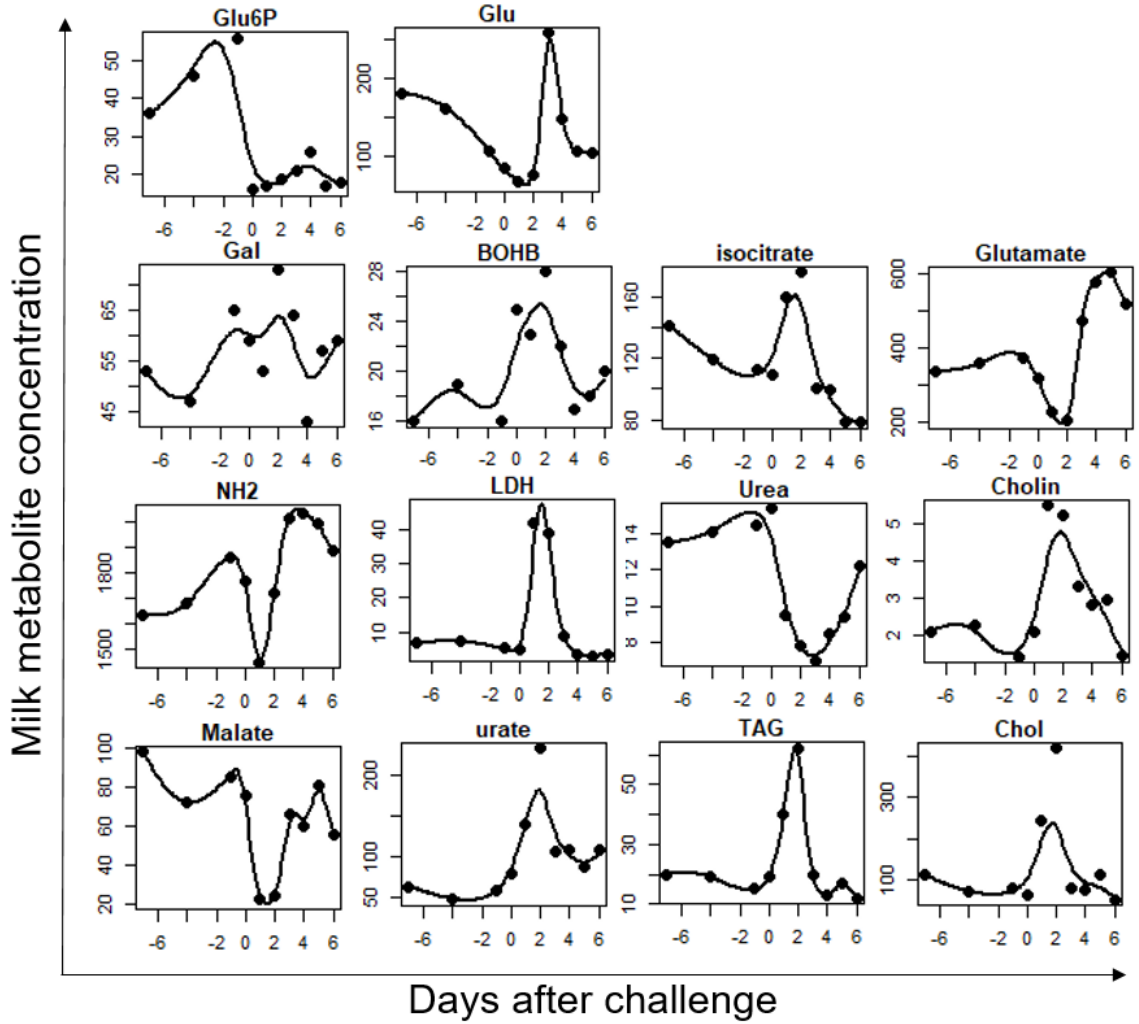


- A powerful statistical approach for exploratory characterization of multivariate longitudinal data
- A type of metabolic response to dietary challenge, characterized by high lipomobilization, high milk glucose depletion and high inflammatory response, associated with poor survival
- Several milk metabolites profiles seem heritable



Multivariate analysis of non-invasive milk measures shows potential for deriving new resilience phenotypes

Milk metabolite curves modelling



Unsupervised clustering