



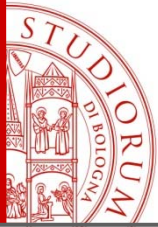
WORKSHOP MEETING

Importance of nutrition and environment on birth weight, muscle growth, health and survival of the neonate - 4th - 5th May 2017 – Cork

1NMR characterization of colostrum in pure breed sows and its influences on piglets' performance

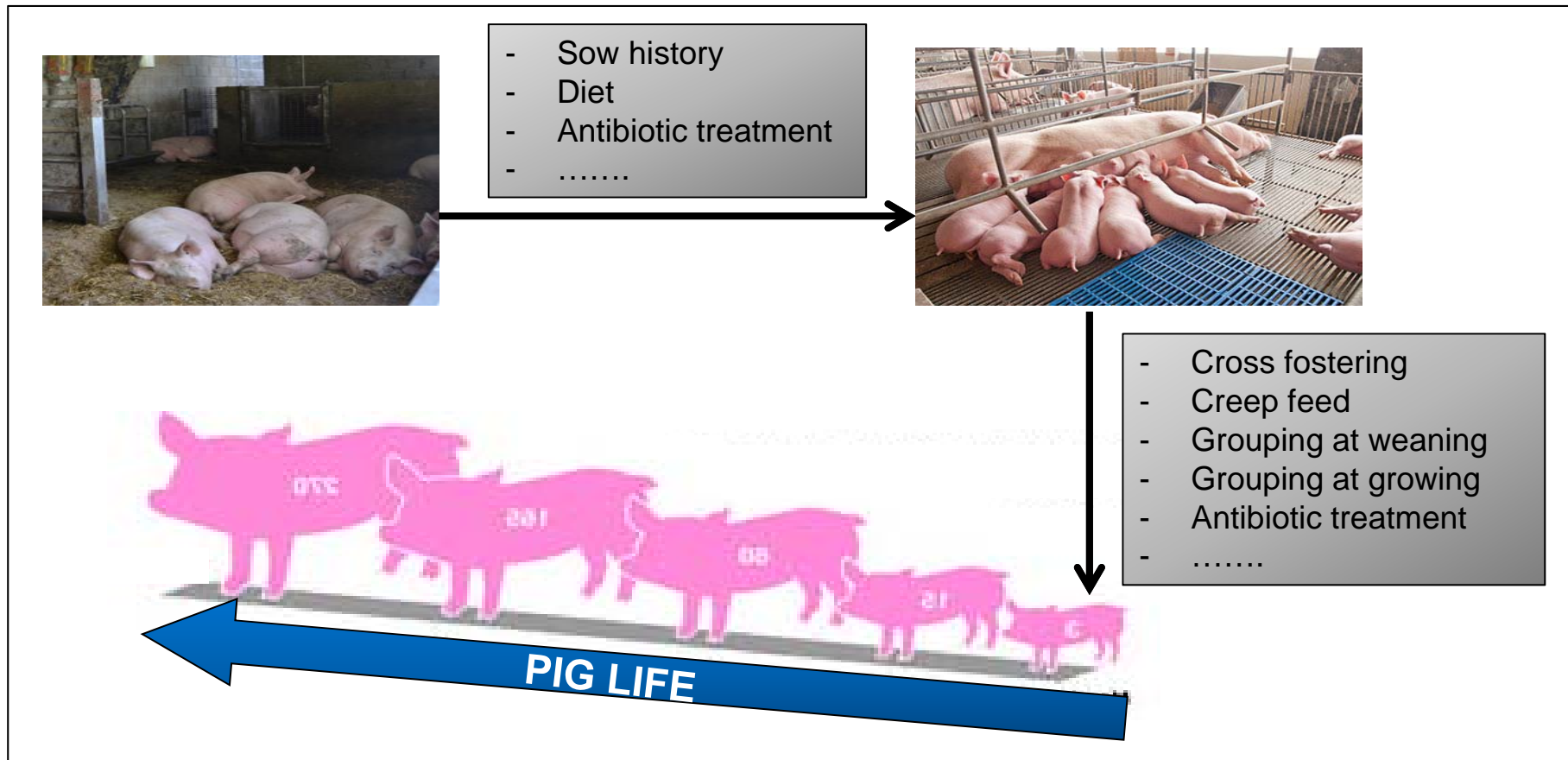
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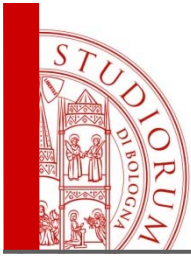


Background

The continuity concept

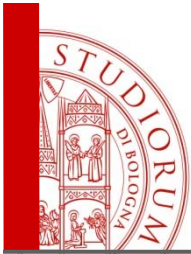


The pre-weaning litter environment has been proven to affect the pigs development and performances during later life



AIMS

- to analyse the colostrum composition in sows belonging to three pure breeds
- to test the associations between the identified metabolites, and the survival and growth rates of piglets



Animals and Sampling

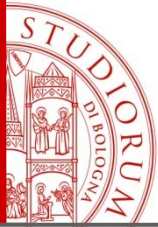
Colostrum samples were collected from 58 farrowing:
31 Large White; 15 Landrace; 12 Duroc



- Farrowing was not inducted
- Sows were not treated with antibiotics and medical products during gestation

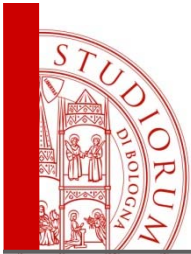
- All sows belong to a pure breed: Large White (LW), Landrace (L) or Duroc (D)
- All sows were raised in the same farm
- All sows received the same diet

Colostrum were gathered after the birth of the first piglet and before the parturition of the last, across all teats, quickly frozen at -20°C and then stored at -80°C until the samples preparation for NMR analysis



Data recorded

Parameter	Description
The farrowing parity	Parity order from 1 to 3 = 1; Parity order > 4 = 2
The parturition season	1= 1/12 - 28/02; 2= 01/03 - 31/05; 3= 1/06 - 31/08; 4= 01/09 - 30/11
The number of piglets alive	At birth, day3, at weaning (day28)
The litter body weight (LBW)	At birth, at day 3
The litter weight gain (BWG)	From birth to day 3
Occurrence of diarrhoea in piglets from day 0 to weaning	1= presence of diarrhoea events; 0= absence of diarrhoea event



Analysis work flow

58 colostrum samples



centrifuged in a 10kDa cut-off membrane.

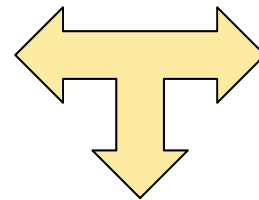


The eluted was analysed using H-NMR spectroscopy



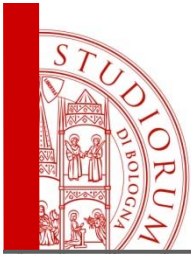
Spectra and data analysis

Analyse through a NMR-based metabolomics approach the colostrum compounds

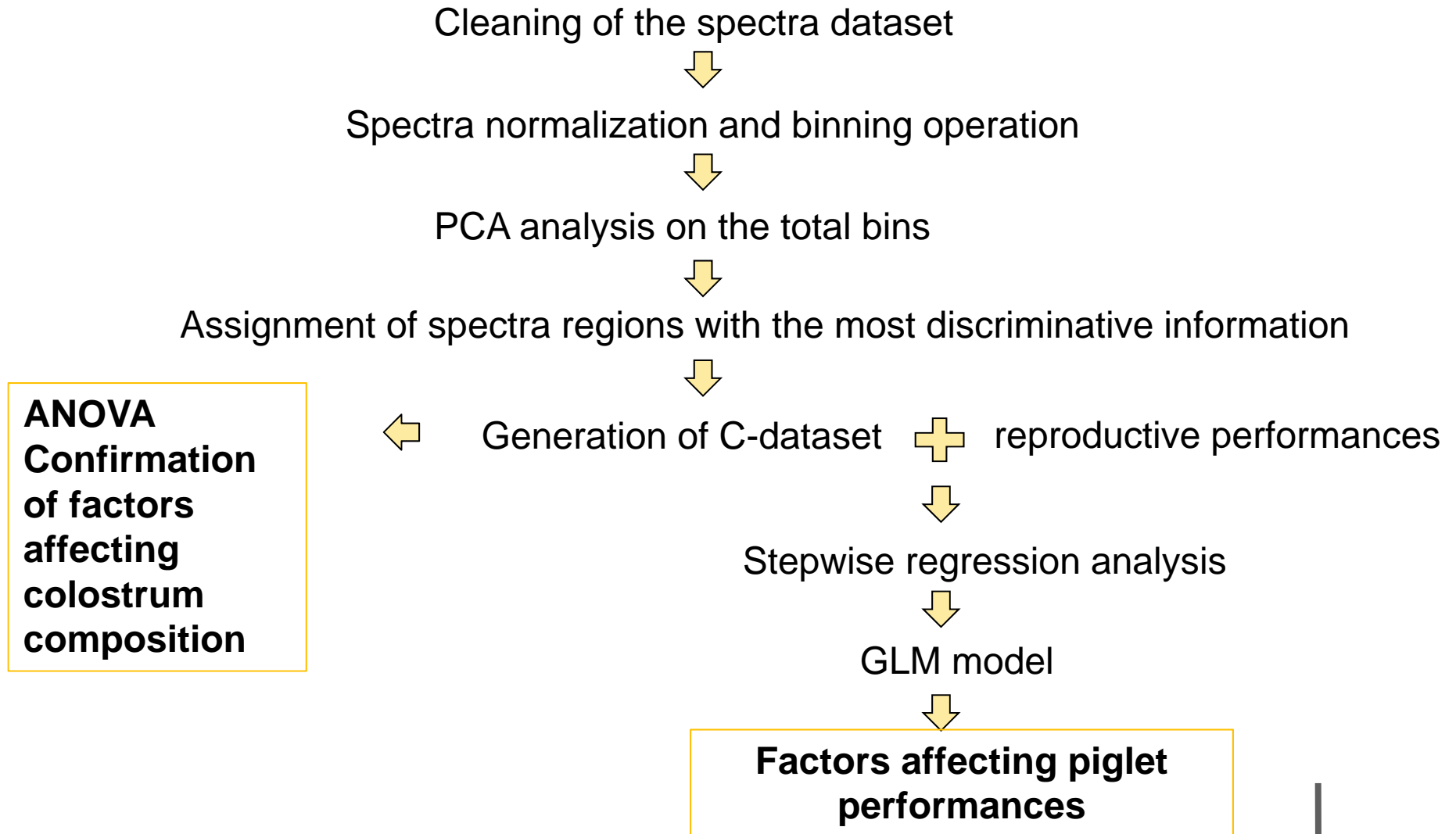


Evaluate which factors mostly affect the colostrum composition

Test the associations between the identified metabolites, the sow maternal attitude, and the piglets' survival and growth rates



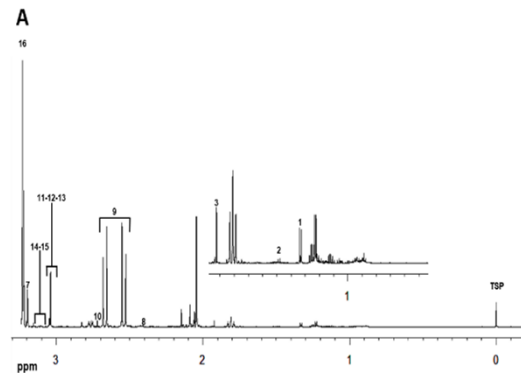
Colostrum data analysis



Results

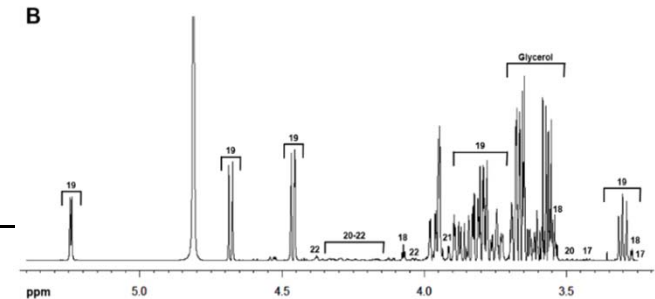
Typical $^1\text{H-NMR}$ spectrum of aqueous extract of colostrum

Number	Compound
1	Lactate
2	Alanine
3	Acetate
7	O-Acetylcholine
8	Succinate
9	Citrate
10	Dimethylamine
11-12-13	Creatine, Creatine phosphate, Creatinine
14	cis-Aconitate
15	Choline



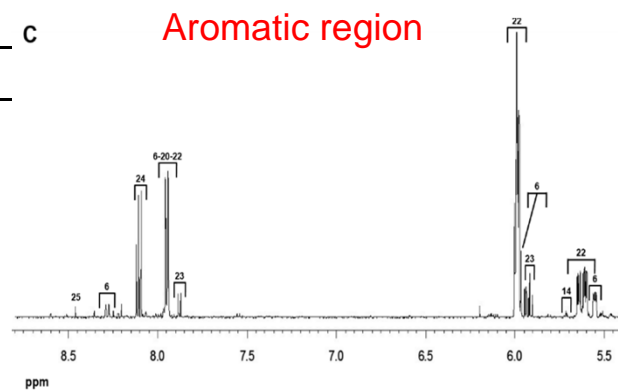
Number	Compound
17	Myo-Inositol
18	Taurine
19	Lactose
20	UDP-glucose
21	Glycolate
22	UDP-Galactose

Carbohydrate or midfield region



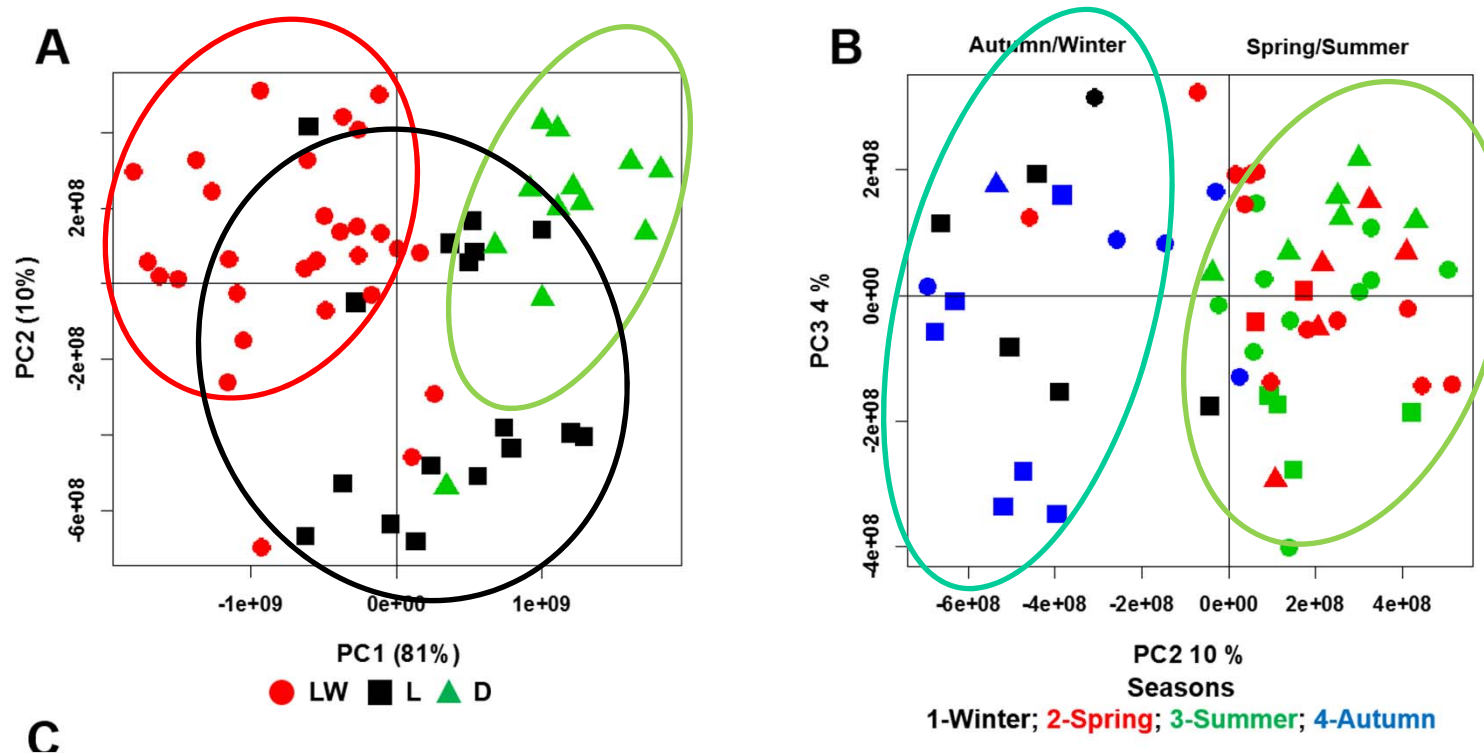
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Number	Compound
6	UDP-N-Acetylglucosamine
14	cis-Aconitate
20	UDP-glucose
22	UDP-Galactose
23	Uridine
25	UMP



Results

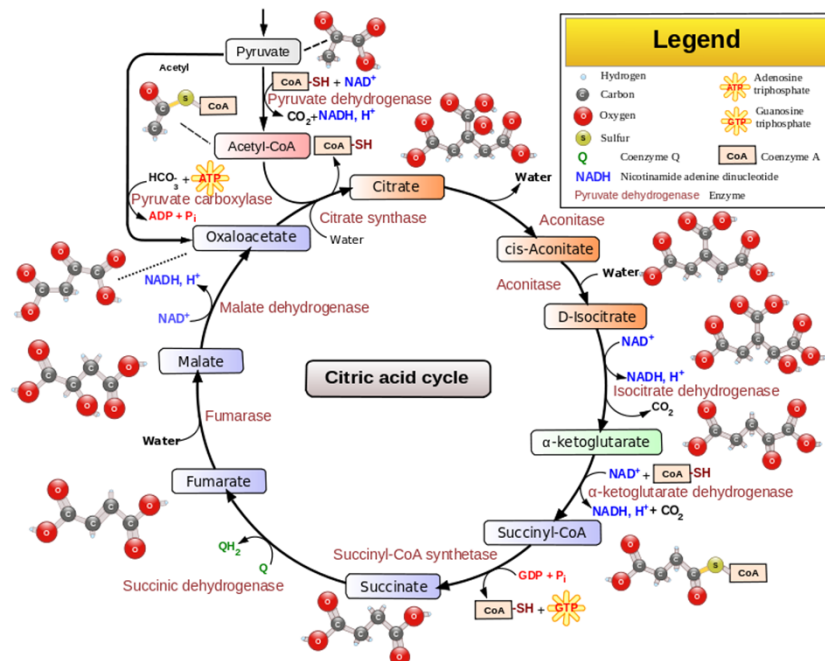
PCA score plot*



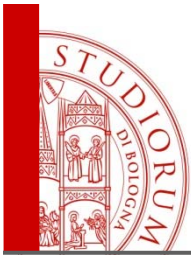
*Obtained using the whole spectrum (Bins)

Results - GLM

Metabolite	Breed			P	Season				P
	D	L	LW		1	2	3	4	
Citrate	209	301	257	<0.0005	246	286	265	228	0.024
Succinate	2.21	3.26	3.50	<0.0001	2.59	3.26	3.55	2.55	0.002
Cis-Aconitate	1.41	1.93	1.74	0.064	1.10	2.14	2.28	1.26	<0.0001



Involved in the Krebs cycle

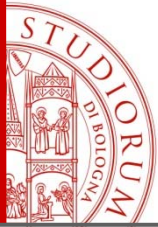


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Cis-Aconitate	1.41	1.93	1.74	0.064	1.10	2.14	2.28	1.26	<0.0001
Acetate	9.57	11.17	9.90	0.486	13.59	7.55	5.95	13.77	<0.0001

Milk Citrate is synthesized from glucose and acetate in the mammary gland. The increase of citrate thus indicate not only the onset of synthesis and secretion of this substrate but of copious secretion as well.

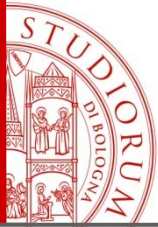
M. Peaker & J. L. Linzell. 1975. Nature Vol. 253



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Acetate	9.57	11.17	9.90	0.486	13.59	7.55	5.95	13.77	<0.0001
Creatine	39.8	59.9	58.7	<0.0005	40.9	59.0	64.7	46.6	<0.0005
Creatine Phosphate	3.40	7.99	8.01	0.001	1.90	8.50	10.78	4.69	<0.0001
Creatinine	13.6	16.7	16.5	0.119	19.9	11.8	11.6	19.2	<0.0001
Dimethylamine	2.86	4.44	4.51	0.043	2.30	5.19	5.39	2.85	0.001
O-Acetylcholine	77.1	196.9	156.6	<0.0001	101.7	148.4	171.7	152.3	0.067

The activation of the Creatinine pathway, could be a signal of the high cell turnover

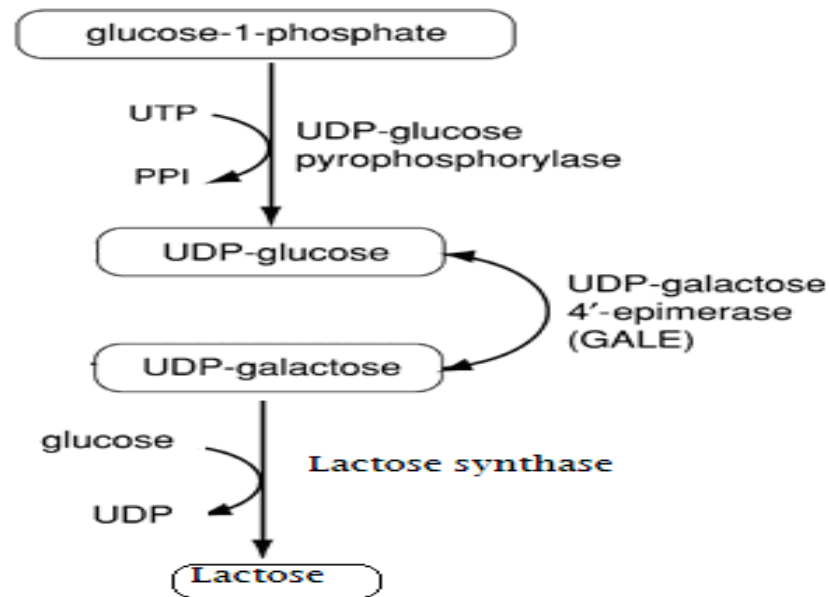


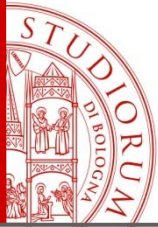
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Acetate	9.57	11.17	9.90	0.486	13.59	7.55	5.95	13.77	<0.0001
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Results

	Breed			P	Season				P
	D	L	LW		1	2	3	4	
UDP-N-Acetilglucosamine	22.4	34.4	33.9	0.001	26.2	33.4	33.8	27.4	0.07
Lactose	458	579	811	<0.0001	535	644	667	619	0.149
UDP-Glucose	6.07	9.78	6.23	<0.0001	6.08	7.30	8.09	7.97	0.189
UDP-Galactose	32.6	74.0	42.5	<0.0001	39.3	54.2	61.4	44.0	0.007





Results of the stepwise regression analysis

Variables	Coefficient	SE coefficient	F value	P-value
Model for Body weight gain from birth to day 3 ($R^2 = 0.4286$)				
Acetate	0.10433	0.03348	9.71	0.0029
Average piglet's weight at birth	0.00846	0.00164	26.63	<.0001
Model for the Number of piglets dead per litter at day 3 ($R^2 = 0.2304$)				
Dimethylamine	0.33082	0.08318	15.82	0.0002
Taurine	-0.11423	0.04432	6.64	0.0127
Model for the Number of weaned piglets ($R^2 = 0.4343$)				
Cis- Aconitate	-0.90181	0.37157	5.89	0.0185
The number of alive piglets at birth	0.58395	0.09863	35.05	<.0001

Results

Significant variables affecting piglets survival and growth rate

Variables	Coefficient	SE	P-value
GLM for BWG ¹			
Acetate ²	0.104	0.033	0.003
Average piglet's weight at birth	0.008	0.002	<.0001
GLM for Number of dead piglets at day 3			
Dimethylamine ²	0.296	0.084	0.001
Taurine ²	-0.100	0.044	0.027
GLM for Number of weaned pigs			
Breed:	Mean	0.46	0.021
LW ³	9.92		
L ⁴	10.59		
D ⁵	8.31		
Variables	Coefficient	SE	P-value
Cis-Aconitate ²	-0.952	0.354	0.010

Acetate is linked *de novo* synthesis of lipids and glucose and adipogenesis stimulation

Taurine: development of central nervous system and other tissues
Dimethylamine: irritative and barrier-disrupting properties

Cis-aconitate is an intermediate compound synthesized by several enteric bacteria

¹BWG stands for litter Body Weight Gain from birth to day 3 of life. ²Metabolites concentrations were considered in area arbitrary unit. ³LW stands for Large White. ⁴L stands for Landrace. ⁵D stands for Duroc.



Conclusion

- This study demonstrates that colostrum metabolome is greatly affected by **breed** and Duroc sows showed a colostrum compositions unlike Large White and Landrace
- Different temperatures occurring during the year affect sows' metabolism and the colostrum composition
- **Acetate** and **Taurine** showed their positive effects on piglets' performances and survival rate, while **Dimethylamine** and **Cis-aconitate** exerted a negative influence on new-borns capacity to survive

THANK YOU FOR YOUR ATTENTION!

Contacts:

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