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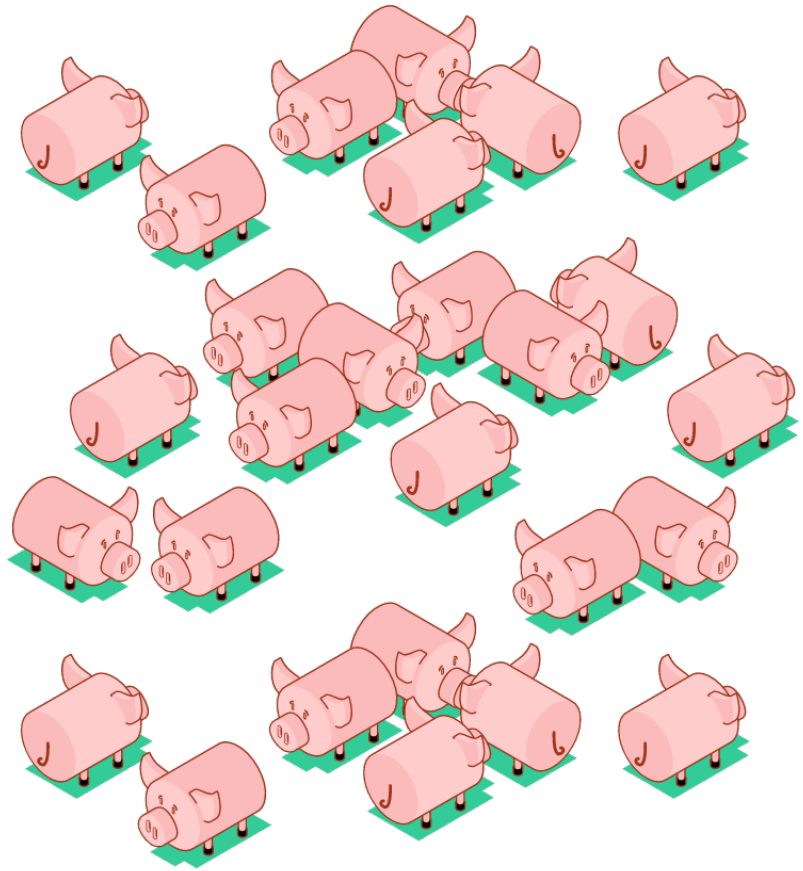


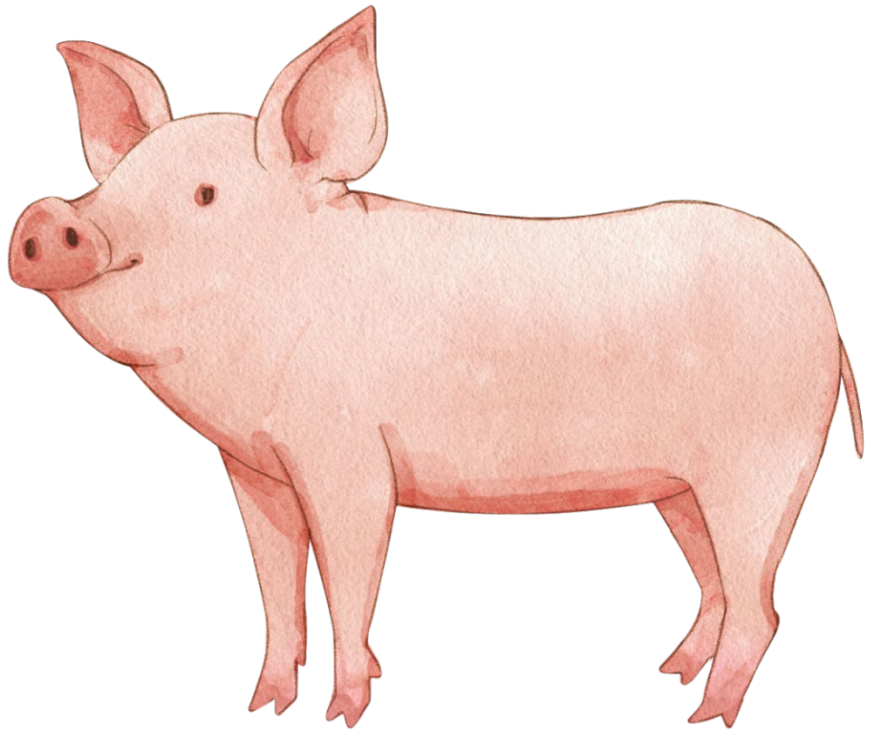
Impact of replacing diet soybean with spirulina on blood metabolic profile of heavy pigs

A. Toscano, D. Giannuzzi, G. Don, S. Schiavon, L. Gallo

EAAP · EVT · FEZ · EUROPA · 2024 · FLORENCE · ITALY 75th

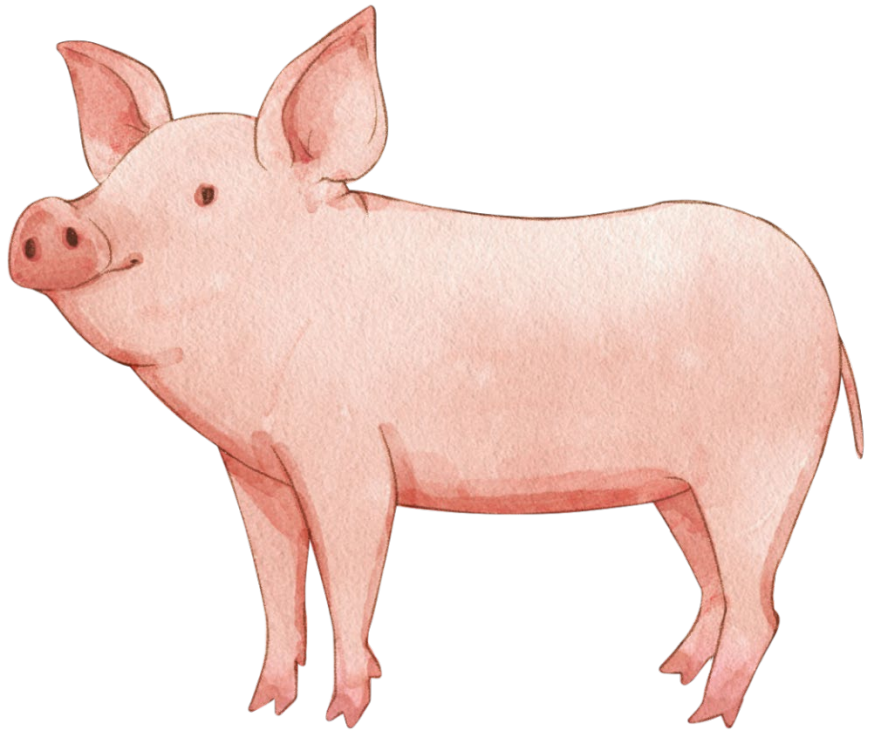
Università degli Studi di Padova
DAFNAE Dipartimento di Agronomia, Alimenti, Risorse naturali, Animali e Ambiente
Ph.D. COURSE ANIMAL & FOOD SCIENCE UNIVERSITY OF PADOVA

Protein represents the most **costly** nutrient in diet formulations



Protein represents the most **costly** nutrient in diet formulations

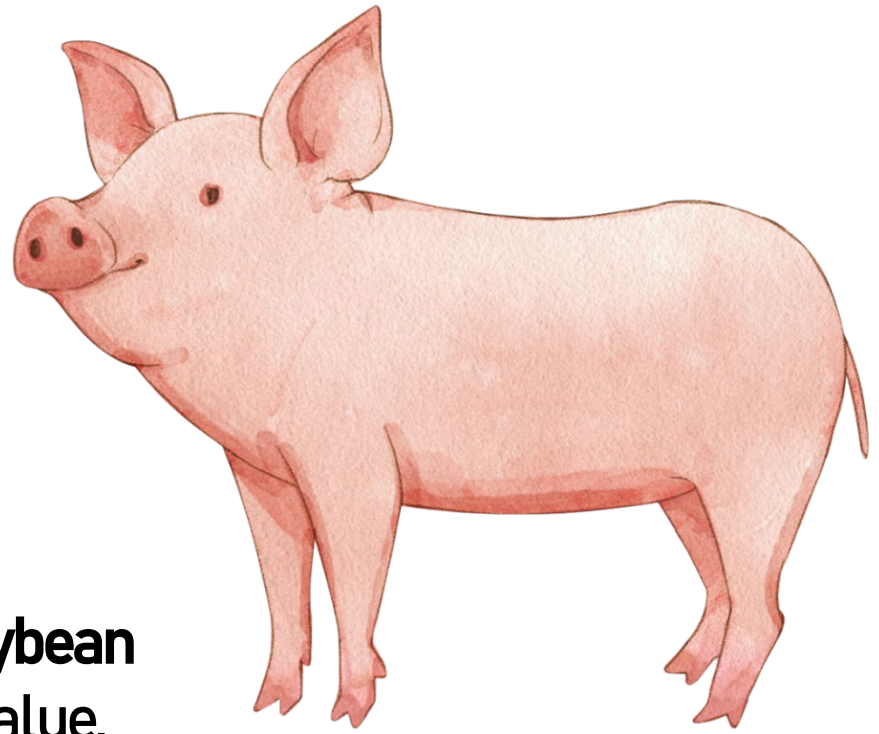
Soybean meal is the preferred protein source for monogastric animals like pigs due to its **quality** and **availability**, but its production has **sustainability concerns**.



Protein represents the most **costly** nutrient in diet formulations

Soybean meal is the preferred protein source for monogastric animals like pigs due to its **quality** and **availability**, but its production has **sustainability concerns**.

There's a growing need for **sustainable alternatives to soybean** meal in animal feed, which should match its nutritional value, efficiency, and maintain animal health.



Algae, specifically **Arthrospira platensis** (AP), is a **promising alternative** due to its high protein content, well-balanced amino acid profile, and good digestibility.

Limited research exists on the effects of high levels of AP on the **metabolic and nutritional status** of growing pigs.

Comprehensive analysis of the **blood metabolic profiles** of pigs fed **varying levels of SP** as a soybean meal substitute, aiming to assess its **impact on health** and feasibility as a **feed ingredient**.

ANIMAL DATA AND FEEDING STRATEGY

88 pigs (Goland C21 x Camborough 43) balanced for sex

4 feeding strategies:

CTR = control group, fed a **conventional diet** used for dry-cured ham production

SP33 = **33%** of soybean meal replaced by ***A. platensis*** **nucleus**

SP66 = **66%** of soybean meal replaced by ***A. platensis*** **nucleus**

SP100 = **100%** of soybean meal replaced by ***A. platensis*** **nucleus**

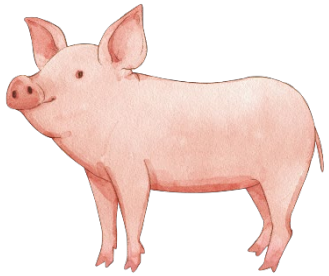
BLOOD SAMPLES COLLECTION

Collected from the jugular vein using vacuum tubes

T0

Acclimatisation period
(91 d of age, 47.9 as mean weight)

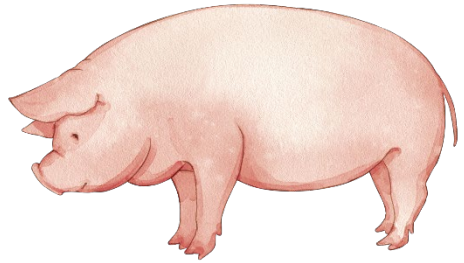
N = 88



T1

At slaughterhouse
(238 d of age, 174.5 kg as mean weight)

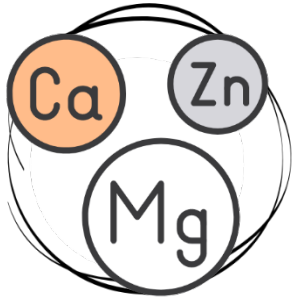
N = 86



HEMATOCHEMICAL PARAMETERS

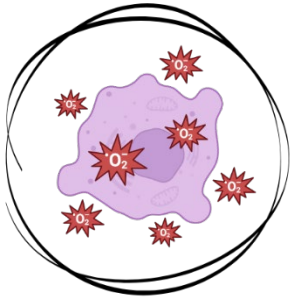
ENERGY-RELATED METABOLITES
(glucose, cholesterol, urea...)

INFLAMMATION
(globuline, haptoglobine...)



MINERALS

LIVER FUNCTION
(albumin, LDH...)



OXIDATIVE STRESS
(ROM, OXY...)

Analyzed by IZSVe

STATISTICAL ANALYSIS

PROC Mixed (sampling time were analysed separately)

$$y_{ijkl} = \mu + sex_i + feeding\ strategy_j + (sex \times feeding\ strategy)_{ij} + pen(feeding\ strategy)_{k:j} + e_{ijkl}$$

- y_{ijklm} was the observed trait;
- μ was the overall intercept of the model;
- sex_i was the fixed effect of the i^{th} treatment (i : 1 = gilts, 2 = barrows);
- $feeding\ strategy_j$ was the fixed effect of the j^{th} diet (j = 1, ..., 4);
- $(sex \times feeding\ strategy)_{ij}$ was the interaction effect between sex and diet;
- pen_l was the random effect of the l^{th} pen (l = 1,...,8) within the feeding $strategy_j$;
- e_{ijkl} was the random residual.

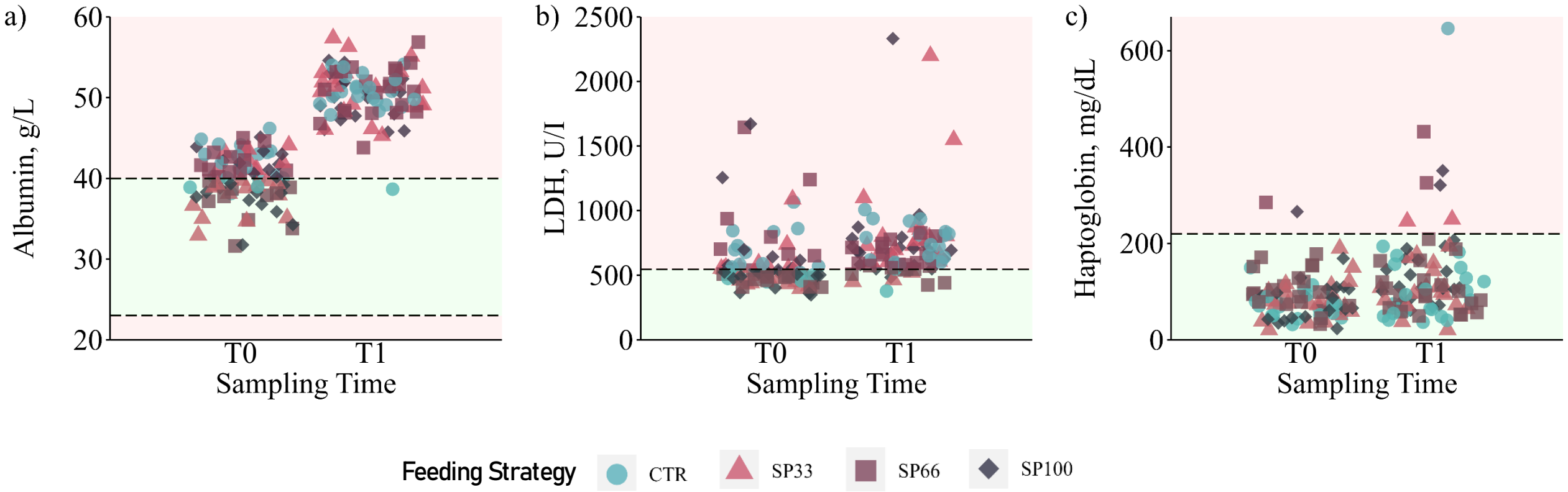
DESCRIPTIVE STATISTICS*

Trait:	No.	Mean	Std Dev	MIN	MAX
Initial BW, kg	85	52.4	4.2	40.5	64.5
Final BW, kg	85	174.9	6.37	157.5	187
Average Daily Gain (ADG), g/d	85	888	40	790	978
Feed Intake, g/d	85	2622	57	2362	2699
Gain:Feed	85	0.339	0.015	0.304	0.378

Mean values comparable to the ones obtained from pig reared for dry-cured ham production

*Results presented by Gallo et al. in session 5

PHYSIOLOGICAL THRESHOLD



BLOOD METABOLITES

FEEDING STRATEGIES EFFECT – T0

Item	Feeding Strategy				*P*-value
	CTR	SP33	SP66	SP100	
Energy-related metabolites					
Glucose, mmol/L	5.54	5.90	5.63	5.64	0.875
Cholesterol, mmol/L	2.29	2.16	2.15	2.20	0.797
Creatinin, µmol/L	92.7	94.2	93.8	98.4	0.476
CK, U/L	2227	1040	2253	1786	0.390
CK, log	3.16	2.89	3.05	2.98	0.363
TG, mmol/L	0.497	0.407	0.503	0.441	0.492
TG, log	-0.339	-0.407	-0.317	-0.378	0.317
Urea, mmol/L	3.97	3.71	3.82	3.57	0.881
Liver function					
Albumin, g/L	41.7	39.0	39.8	39.4	0.360
ALP, U/L	221	206	200	204	0.437
ALT, U/L	51.4	46.3	50.6	50.8	0.706
AST, U/L	45.4	33.8	47.7	38.7	0.334
AST, log	1.62	1.51	1.59	1.55	0.511
GGT, U/L	39.5	35.0	36.3	33.0	0.437
LDH, U/L	615	538	619	601	0.703
LDH, log	2.77	2.72	2.76	2.74	0.626

Item	Feeding Strategy				*P*-value
	CTR	SP33	SP66	SP100	
Inflammation					
Globuline, g/L	23.0	24.1	23.5	23.6	0.932
PROTt, g/L	64.6	63.1	63.3	63.0	0.469
Haptoglobin, mg/dL	74.3	81.1	113	87.8	0.560
Haptoglobin, log	1.84	1.86	2.00	1.87	0.536
Oxidative stress metabolites					
ROM, U/Carr	660	621	689	673	0.156
OXY, µmol HClO/mL	289	279	280	272	0.130
Minerals					
Ca, mmol/L	2.68	2.75	2.81	2.84	0.484
Cl, mmol/L	97.7	98.9	99.2	98.8	0.393
Fe, µg/dL	117	117	95.0	107	0.834
K, mmol/L	5.92	5.83	5.43	5.25	0.108
Mg, mmol/L	0.910	0.903	0.920	0.886	0.793
Na, mmol/L	142	142	144	143	0.262
P, mmol/L	3.13	2.91	2.91	2.73	0.561

No significant difference!

BLOOD METABOLITES

FEEDING STRATEGIES EFFECT – T1

Item	Feeding Strategy				*P*-value
	CTR	SP33	SP66	SP100	
Energy-related metabolites					
Glucose, mmol/L	5.83	5.43	6.45	5.55	0.140
Cholesterol, mmol/L	2.64	2.75	2.81	2.80	0.347
Creatinin, µmol/L	156	162	161	167	0.636
CK, U/L	1964	1982	1945	1996	0.718
CK, log	3.29	3.30	3.29	3.30	0.720
TG, mmol/L	0.509	0.557	0.454	0.487	0.330
TG, log	-0.314	-0.278	-0.355	-0.327	0.373
Urea, mmol/L	4.38	4.53	4.26	4.27	0.858
Liver function					
Albumin, g/L	50.5	50.9	50.8	50.0	0.869
ALP, U/L	132	133	146	117	0.773
ALT, U/L	64.4	62.4	66.1	58.2	0.350
AST, U/L	68.7	78.8	59.1	69.3	0.337
AST, log	1.83	1.85	1.75	1.81	0.287
GGT, U/L	39.6	39.5	40.5	39.2	0.979
LDH, U/L	718	822	613	795	0.220
LDH, log	2.85	2.88	2.78	2.87	0.172

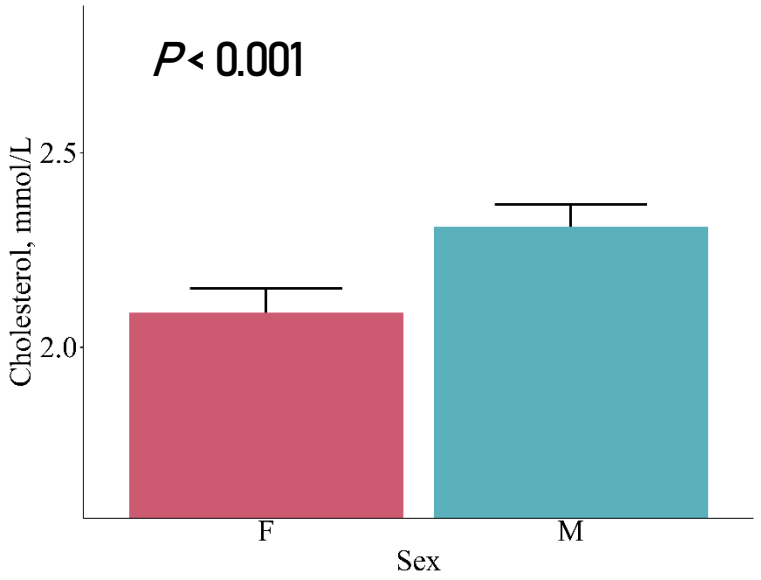
Item	Feeding Strategy				*P*-value
	CTR	SP33	SP66	SP100	
Inflammation					
Globuline, g/L	24.0	22.3	23.3	24.1	0.804
PROTt, g/L	74.5	73.3	74.1	74.0	0.879
Haptoglobin, mg/dL	122	118	129	152	0.808
Haptoglobin, log	1.98	2.01	2.03	2.13	0.570
Oxidative stress metabolites					
ROM, U/Carr	1039	1027	1111	1037	0.344
OXY, µmol HClO/mL	337	342	339	340	0.837
Minerals					
Ca, mmol/L	2.75	2.76	2.78	2.77	0.906
Cl, mmol/L	98.9	98.1	99.8	98.6	0.119
Fe, µg/dL	131	127	140	143	0.663
K, mmol/L	7.93	8.16	8.52	8.74	0.239
Mg, mmol/L	1.10	1.15	1.14	1.17	0.346
Na, mmol/L	147	145	147	145	0.227
P, mmol/L	3.30	3.22	3.30	3.37	0.530

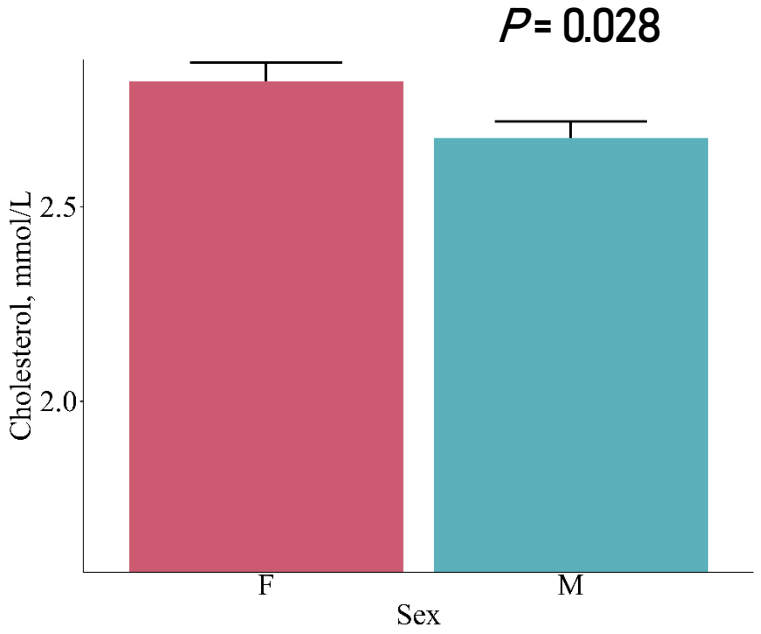
No significant difference!

ENERGY-RELATED METABOLITES

SEX EFFECT - CHOLESTEROL

T0



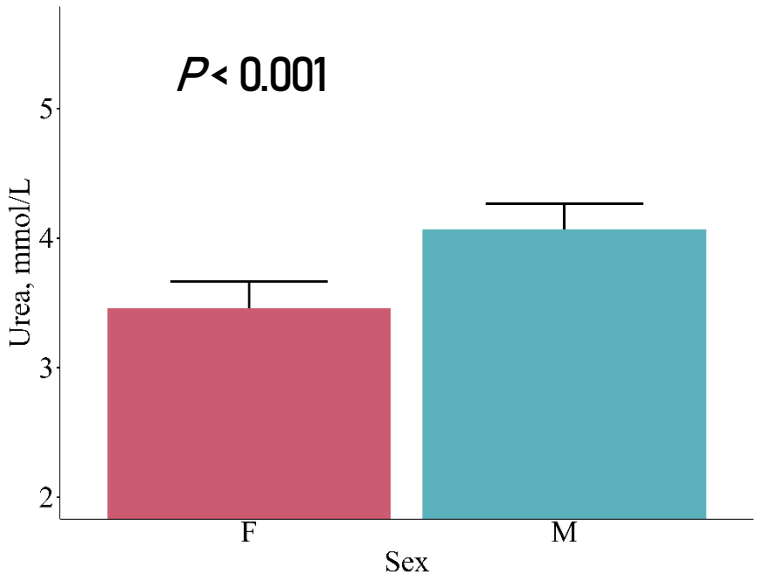


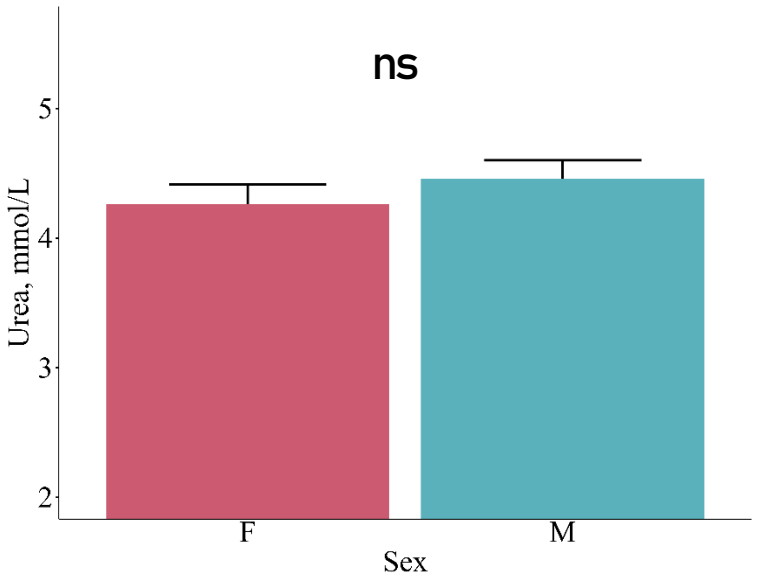
T1

ENERGY-RELATED METABOLITES

SEX EFFECT - UREA

T0



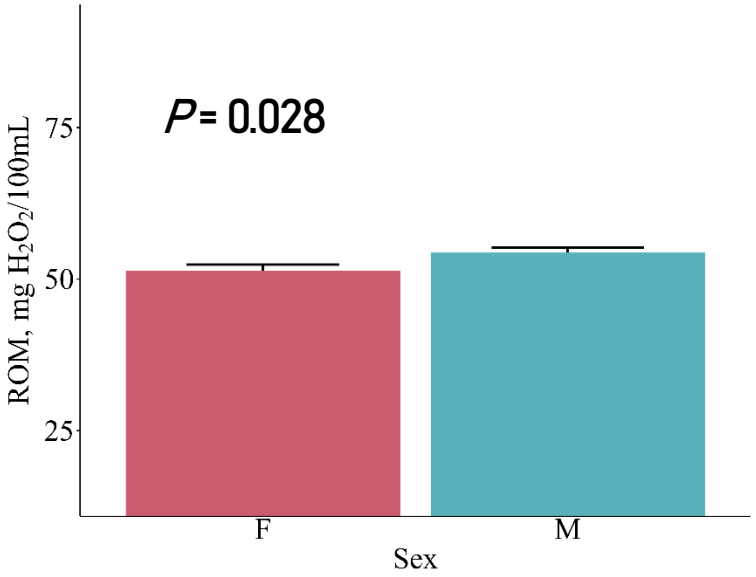


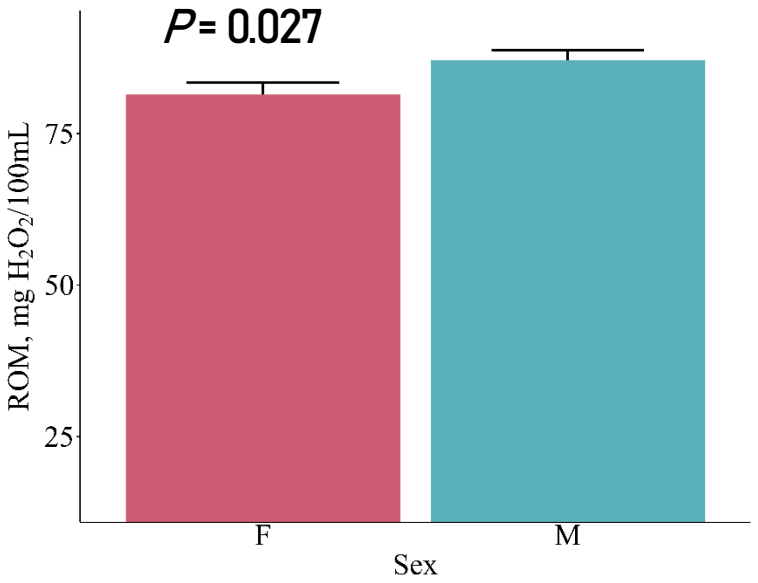
T1

OXIDATIVE STRESS METABOLITES

SEX EFFECT – REACTIVE OXIGEN METABOLITES

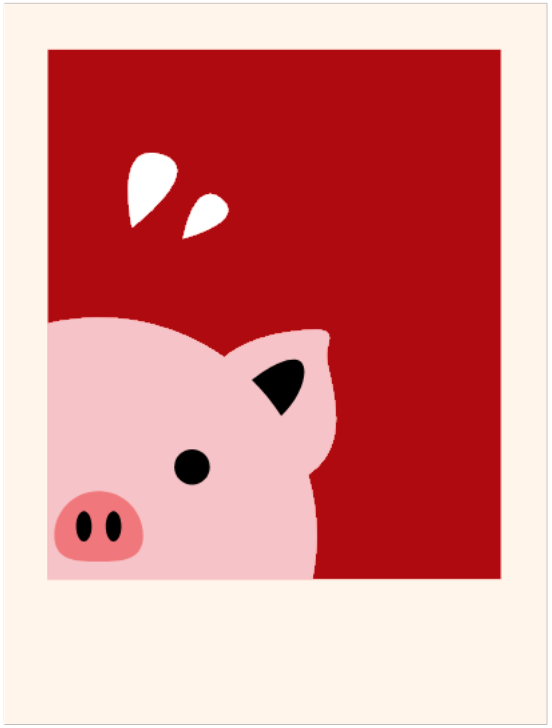
T0





T1

PRINCIPAL OUTCOMES



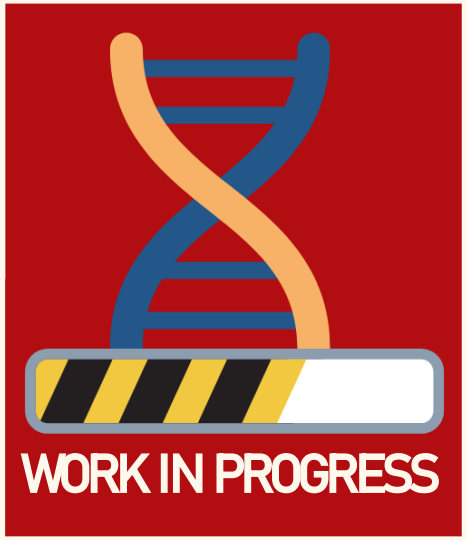
No significant differences among feeding strategies

Some differences in blood metabolites due to sex effect

No metabolic problems observed after consumption of *A. platensis*

⇨ Feasibility in use *A. platensis* nucleus as feed ingredient

FUTURE PERSPECTIVE



- Asses the impact of *A. Platensis* through omics approach
- Transcriptomic analyses on liver, muscle and intestinal samples
- Metabarcoding analyses on fecal and intestinal samples

Thanks!!

Questions?

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HEMATOCHEMICAL PARAMETERS

Analysed in serum using Cobas Pure e303 analyzer
(Roche Diagnostics, Mannheim, Germany)

total proteins (PROTt)
alanine transaminase (ALT)
albumin (ALB)
alkaline phosphatase (ALP)
aspartate transaminase (AST)
calcium (Ca)
cholesterol (Chol)
chlorine (Cl)
creatinine
creatinine kinase (CK)
Glucose
γ-glutamyl transferase (GGT)
iron (Fe)
lactate transaminase (LDH)
magnesium (Mg)
phosphorus (P)
potassium (K)
sodium (Na)
triglycerides (TG),
total and direct bilirubin (BILt and BILd)
urea

Colorimetric method (Diacron Labs, Grosseto, Italia)
applied to Cobas Pure e303 analyzer

reactive oxygen metabolites (ROM)
plasma protection against oxidation (OXY)

Colorimetric method
(Tridelta Development Ltd, Co. Kildare, Irlanda)

haptoglobin (Hp)

Globulins concentration was calculated by
the difference of albumin from total protein

HEMATOCHEMICAL PARAMETERS

PHYSIOLOGICAL TRESHOLD

- Total protein 58-83 g/L
- Albumin 23-40 g/L
- Globulin 39-60 g/L
- Urea 3.3-8.3 mmol/L
- Creatinine 40-130 µmol/L
- Glucose 3.9-6.4 mmo/L
- Cholesterol 2-3.3 mmol/L
- Triglycerids < 0.5 mmol/L
- AST < 80 U/L
- ALT < 126 U/L
- ALP < 274 U/L
- GGT < 79 U/L
- CK < 4769 U/L
- LDH < 545 U/L
- Ca 2.4-3.5 mmol/L
- P 2.1-3.3 mmol/L
- Mg 1.1-1.5 mmol/L
- Na 140-160 mmol/L
- K 4-5 mmol/L
- Cl 102-106 mmol/L
- Fe 91-199 µg/dL
- Haptoglobin 0-220 mg/dL