Changes in plasma metabolic profile of long-transported Charolais young bulls

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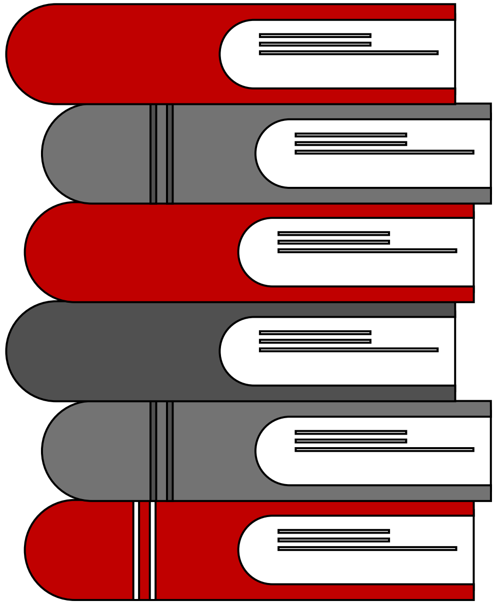


Introduction

INTRODUCTION: Transport

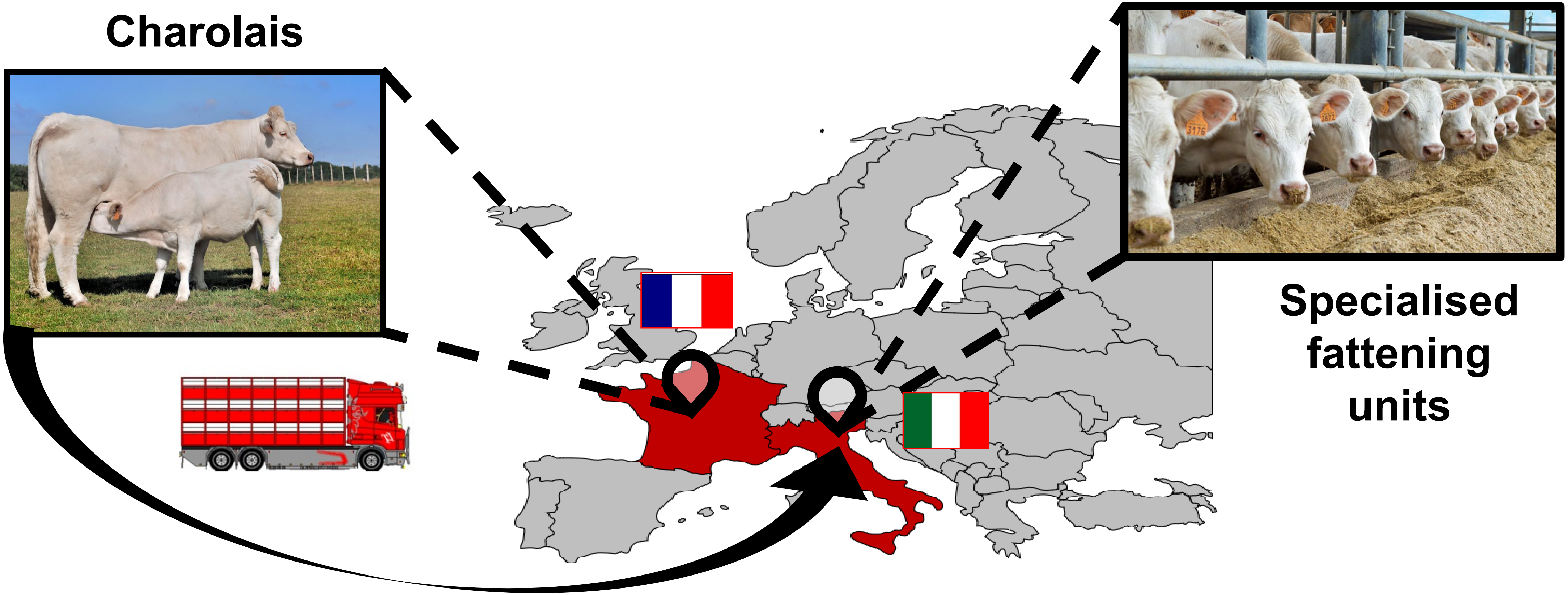
Around **1.4 billion** animals are transported across Europe yearly, with over **125,000 long-distance journeys** (more than 8 h).

Long-distance transport induces severe **stress**, increasing **disease risk** and **mortality** in cattle (Ashenafi et al., 2018; Rumor et al., 2015).

Monitoring stress via **blood parameters** is crucial to mitigate transport-induced health issues (EFSA, 2022).

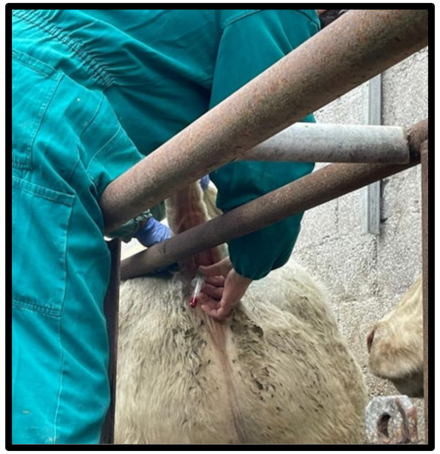
INTRODUCTION: Case study

Each year, around **900,000** young cattle are imported into Italy from France, commingled, and stratified by sex and BW before transport to fattening units (ISMEA, 2022).



EFSA suggestions:

- **Check animal welfare**: animal's temperature before truck loading.
- **Environmental Comfort**: Ensure on-truck adequate space (1.84 m^2/animal).
- **Transport Management**: Reduce the transport duration, provide access to water and eventually rest areas, and travel when temperatures are lower (during the night).



EFSA: https://www.efsa.europa.eu/en/infographics/animal-welfare-during-transport-free-moving-animals

INTRODUCTION: Possible stress mitigation strategies

Yeast: *Saccharomyces cerevisiae* improves cattle performance and rumen health by preventing subacute ruminal acidosis (SARA) and enhancing immune function.

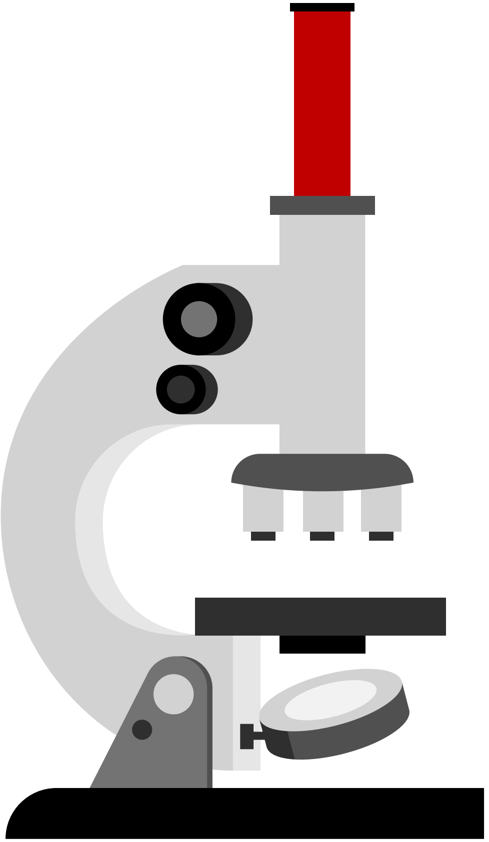
Selenium: Selenium-enriched yeast boosts immune responses and reduces oxidative stress, helping manage stress from transport and dietary changes.

Immune responses

Gut health

Oxidative stress

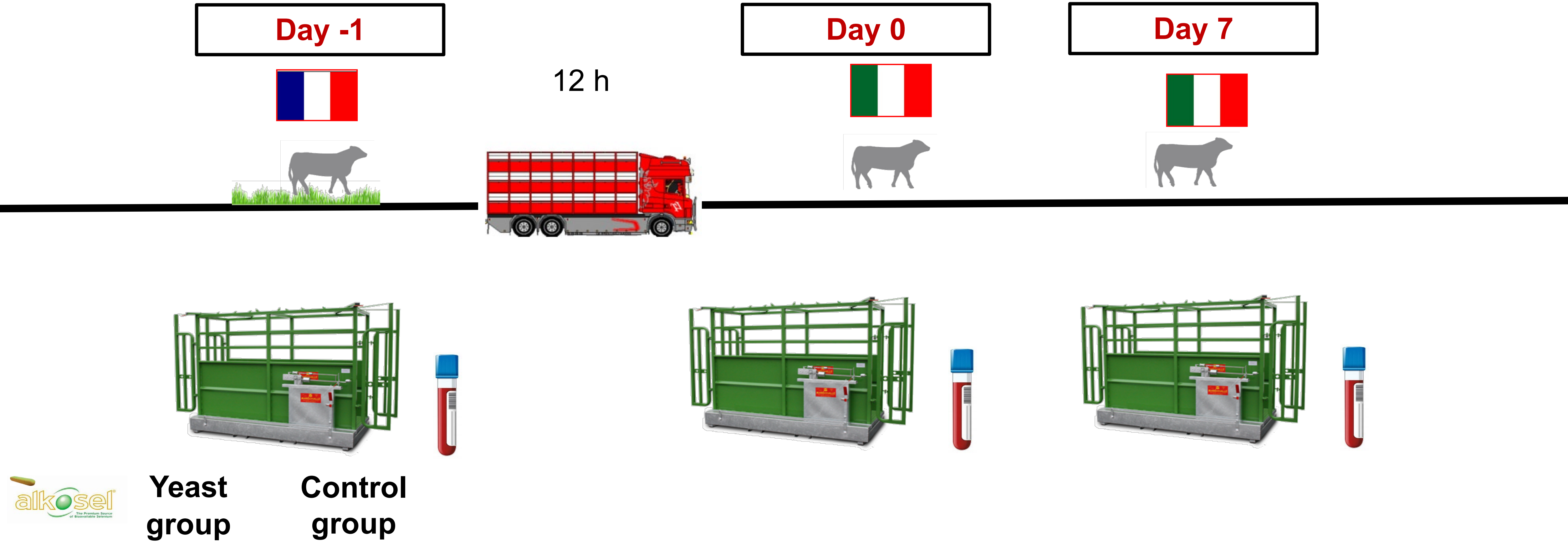
The study assessed the impact of **long-distance transport** on Charolais bulls supplemented with yeast and selenium-enriched yeast by evaluating **blood metabolites and growth performance.**



Materials and methods

MATERIALS AND METHODS: study design

✓ The study involved **80 Charolais young bulls** transported from 2 neighbouring French collection centers to an Italian fattening unit.



MATERIALS AND METHODS: study design

Since yeast did not affect blood parameters during transport and its effects appeared mostly after the first week of fattening, we've omitted further details here, except for Selenium. For more information, please scan the QR Code to access the additional presentation.

Effects of live yeast and selenium supplementation on rumen parameters in long-transported Charolais bulls

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MATERIALS AND METHODS: Metabolites

Protein Profile: abumin (ALB); creatinine (CREA); globulins (GLOB); total proteins (TP); total blood urea (UREA).

Energy Profile: cholesterol (CHOL); glucose (GLU); triglycerides (TG); Non-Esterified Fatty Acids (NEFA).

Hepato-Muscle Profile: alkaline Phosphatase (ALP); alanine aminotransferase (ALT); aspartate aminotransferase (AST); creatine kinase (CK); lactate dehydrogenase (LDH); gamma-glutamyl transferase (GGT); total bilirubin (TBIL); direct bilirubin.

Mineral Profile: calcium (Ca); chlorine (Cl); iron (Fe); potassium (K); magnesium (Mg); sodium (Na); phosphorus (P); selenium (Se).

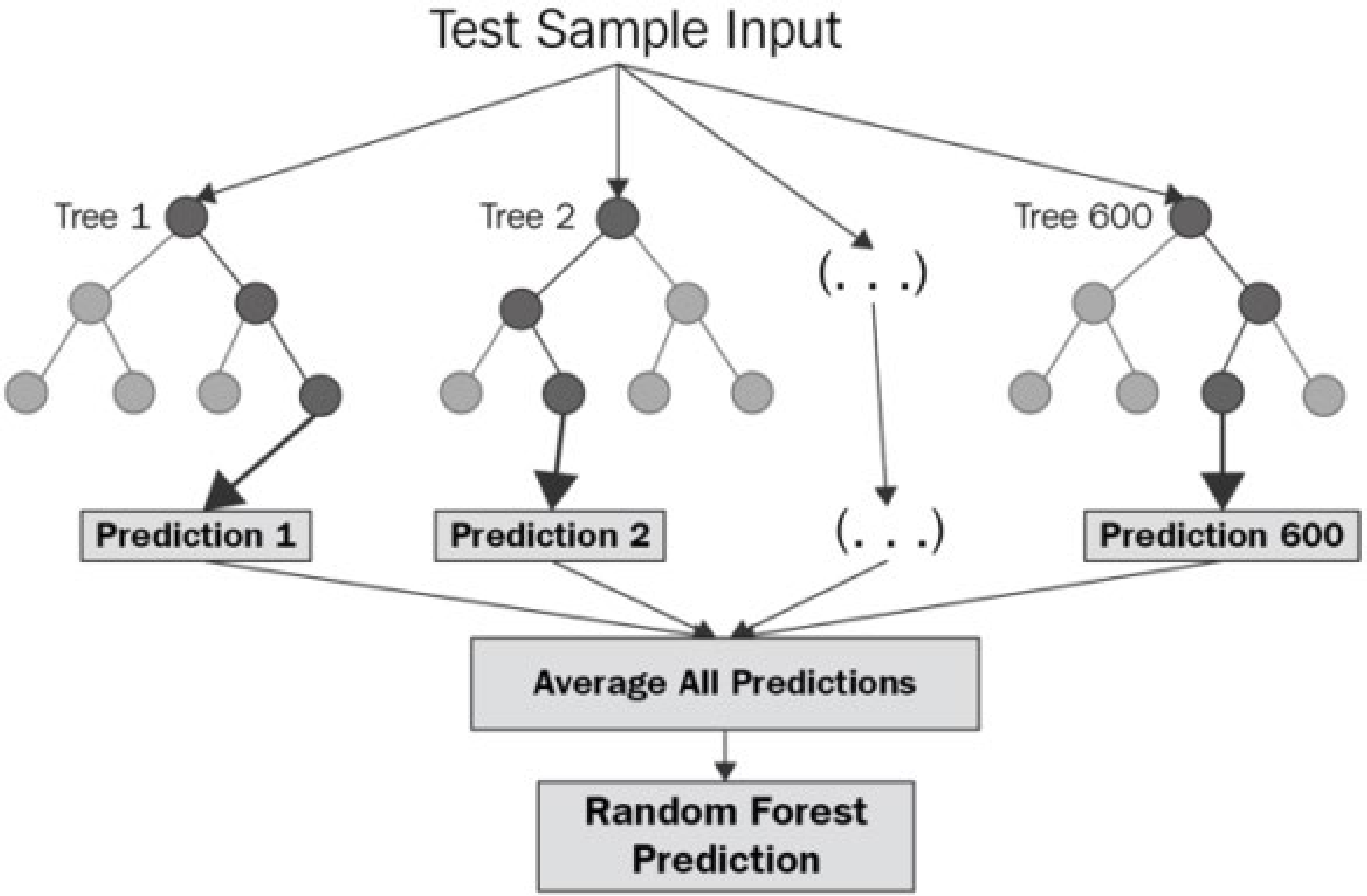
Stress profile: Cortisol (COR).

MATERIALS AND METHODS: statistical analysis

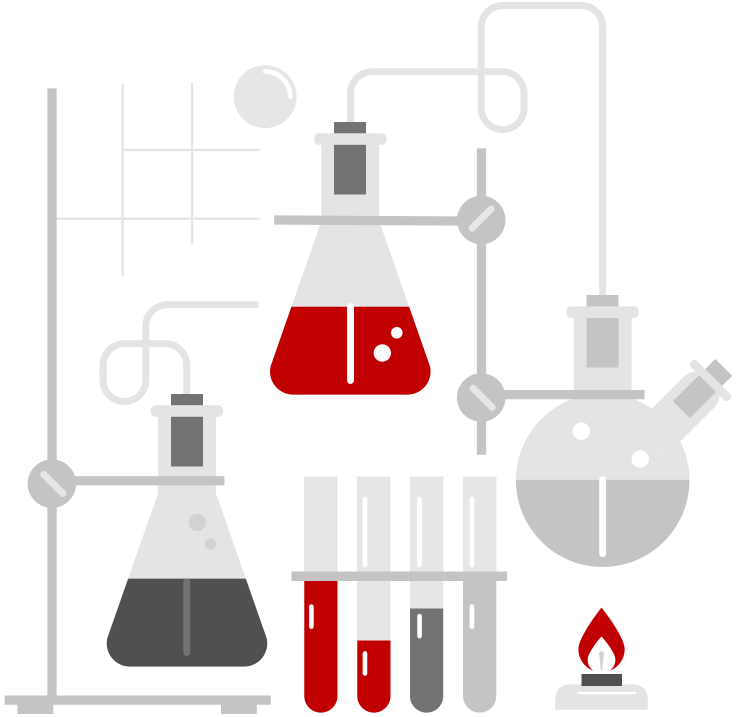
The effects of transport and supplementation on metabolic profile and growth performance (BW) at day -1, 0 and 7 have been analyzed through the following generalized linear mixed model:

$$y_{ijklm} = \mu + Time_i + Supplementation_j + Pen_k(Supplementation_j) + (Time \times Supplementation)_{ij} + Age_l + animal_m + e_{ijklm}$$

MATERIALS AND METHODS: statistical analysis

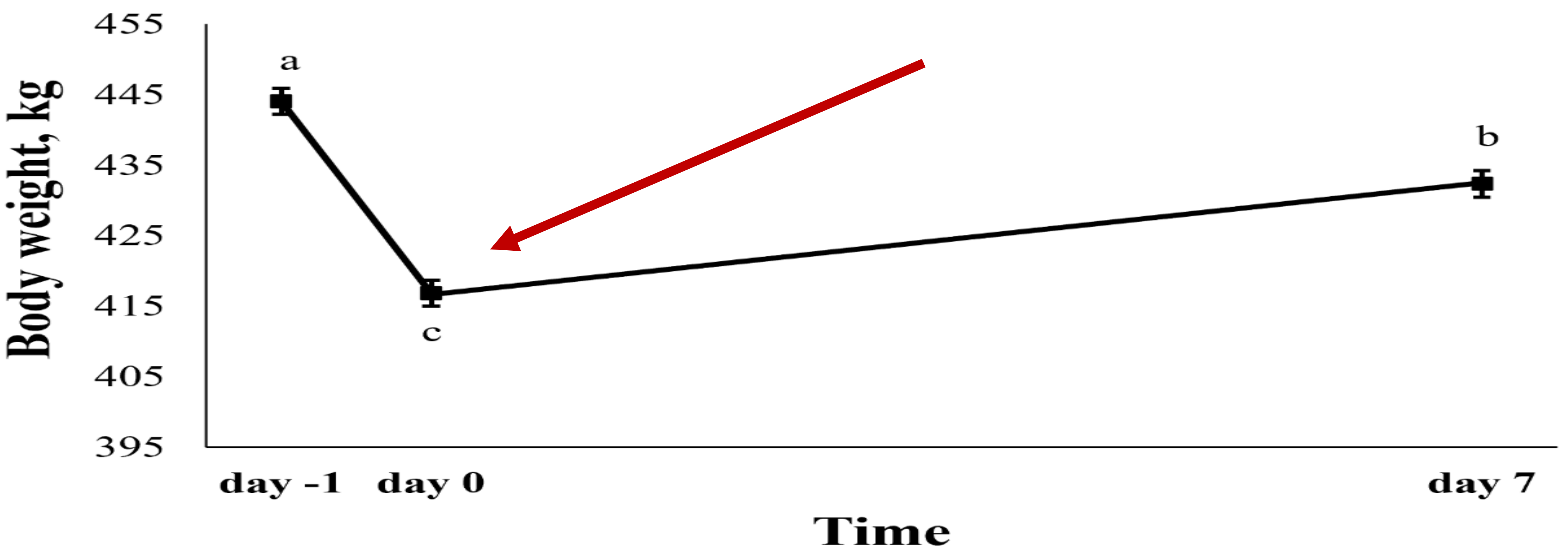


Using the Random Forest (RF) approach, the dataset was split into 70% training and 30% testing sets. All blood metabolites were analyzed to identify the most significant contributors to variations in the animal metabolic profile before and after transport, using the **mean decrease Gini (MDG) index**. The RF model was validated through 10-fold cross-validation, iterated 2000 times, to ensure the stability of the MDG and overall model performance.



Results and discussion

RESULTS AND DISCUSSIONS: Model



Trait	Time			SEM	*P-value*
	day -1	day 0	day 7		
Stress profile					
Cortisol, nmol/L	36.6[c]	60.4[a]	48.9[b]	3.1	<0.001

RESULTS AND DISCUSSIONS: Model

Traits	Time			SEM	*P-value*
	day -1	day 0	day 7		
Protein profile					
Albumin, g/L	33.6[b]	34.6[a]	31.7[c]	0.30	<0.001
Creatinine, µmol/L	151[b]	145[c]	157[a]	2.80	<0.001
Globulin, g/L	[illegible]	[illegible]	[illegible]	[illegible]	<0.001
Total protein, g/L	[illegible]	76.0[a]	74.9[a]	0.50	<0.001
Urea, mmol/L	3.60[a]	3.70[a]	3.20[b]	0.10	<0.001
Energy profile					
Cholesterol, mmol/L	[illegible]	[illegible]	2.11[b]	0.06	<0.001
Glucose, mmol/L	4.80[b]	5.30[a]	4.90[b]	0.1	<0.001
Triglycerides, mmol/L	[illegible]	[illegible]	0.18[c]	0.01	<0.001
Non-esterified fatty acids, mEq/L	0.71[b]	0.99[a]	0.72[b]	0.03	<0.001

Cattle show stress-induced changes in protein levels, energy mobilization due to transportation and adaptation, denoting dehydration, inflammation, and significant shifts in metabolic profiles.

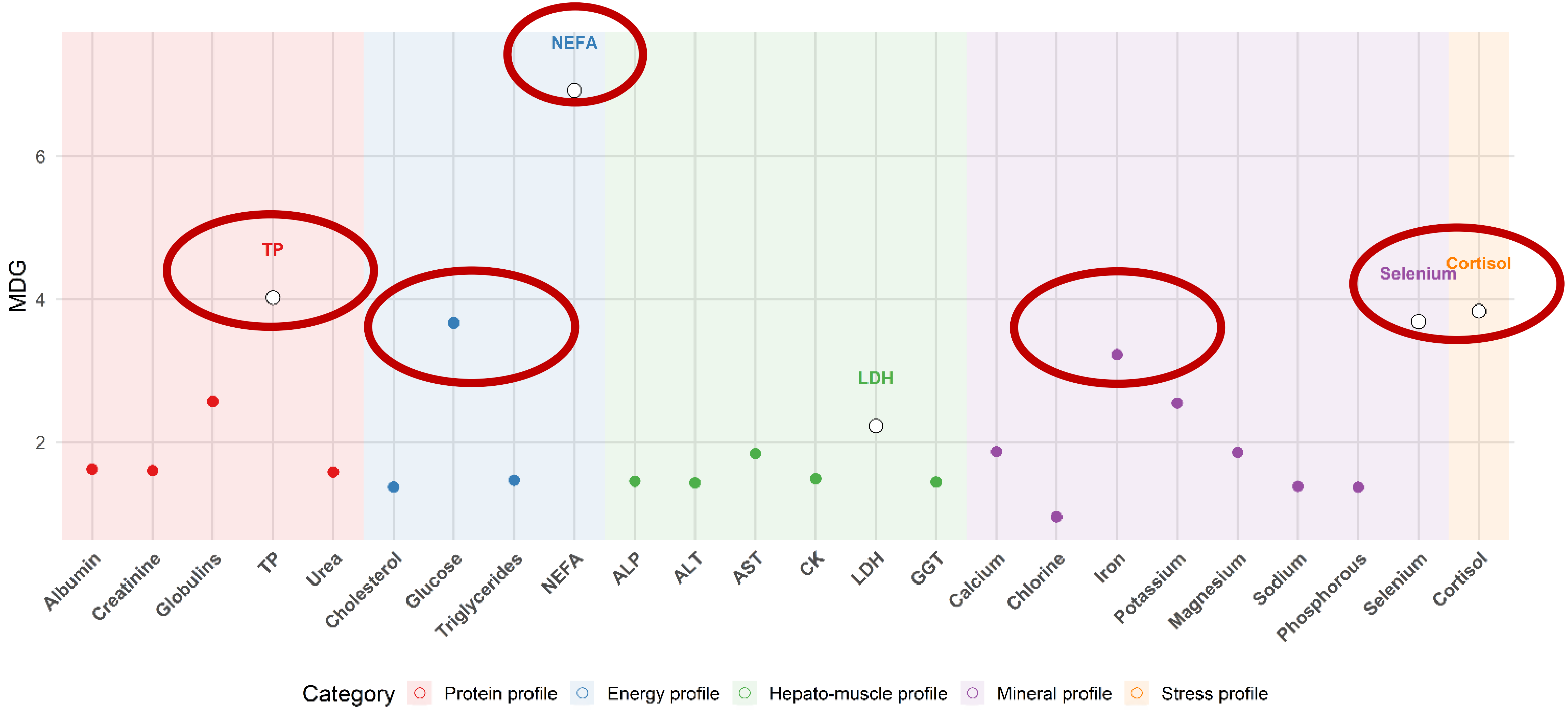
RESULTS AND DISCUSSIONS: Model

Trait	Time			SEM	*P-value*
	day -1	day 0	day 7		
Hepato-muscle profile					
Alka[illegible] phosphatase, U/L	[illegible]34[a]	[illegible]	76[illegible]	3.80	<0.001
Alanine aminotransferase, U/L	25.7[b]	27.7[a]	22.6[c]	0.50	<0.001
Aspart[illegible] U/L	[illegible]	[illegible]	[illegible]	[illegible]	<0.001
Creatine kinase, U/L	346[a]	394[a]	217[b]	1.10	<0.001
Lactate dehydrogen[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	<0.001
Gamma-glutamyl transferase, U/L	17.0[a]	15.2[b]	12.2[c]	0.40	<0.001
Total bilirubin (OR: <2.5 µmol/L)[2]	0.37[b]	0.29[b]	0.80[a]	0.06	<0.001
Direct bilirubin (OR: <1.5 µmol/L)[2]	0.56[b]	0.72[b]	0.98[a]	0.42	<0.001
Mineral profile					
Calcium, mmol/L	2.37[b]	2.42[a]	2.40[ab]	0.01	0.001
Chl[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]001
Iron, µg/dL	73.3[b]	59.4[c]	110[a]	2.50	<0.001
Pota[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]001
Magnesium, mmol/L	0.86[a]	0.83[b]	0.83[b]	0.01	0.001
Sodium, mmol/L	[illegible]	[illegible]	[illegible]	[illegible]	0.010
Phosphorous, mmol/L	2.33	2.31	2.33	0.03	0.763
Selenium, µg/L	42.9[c]	63.2[b]	90.2[a]	2.00	<0.001

Increased AST, ALT, LDH, and CK indicate muscle and liver stress from transport. Similar results have been reported in literature (Zaitsev et al., 2020)

Mineral changes reflect stress and dehydration, except for Se. Low blood iron levels can result from poor diet or inflammation (Ashenafi et al., 2018).

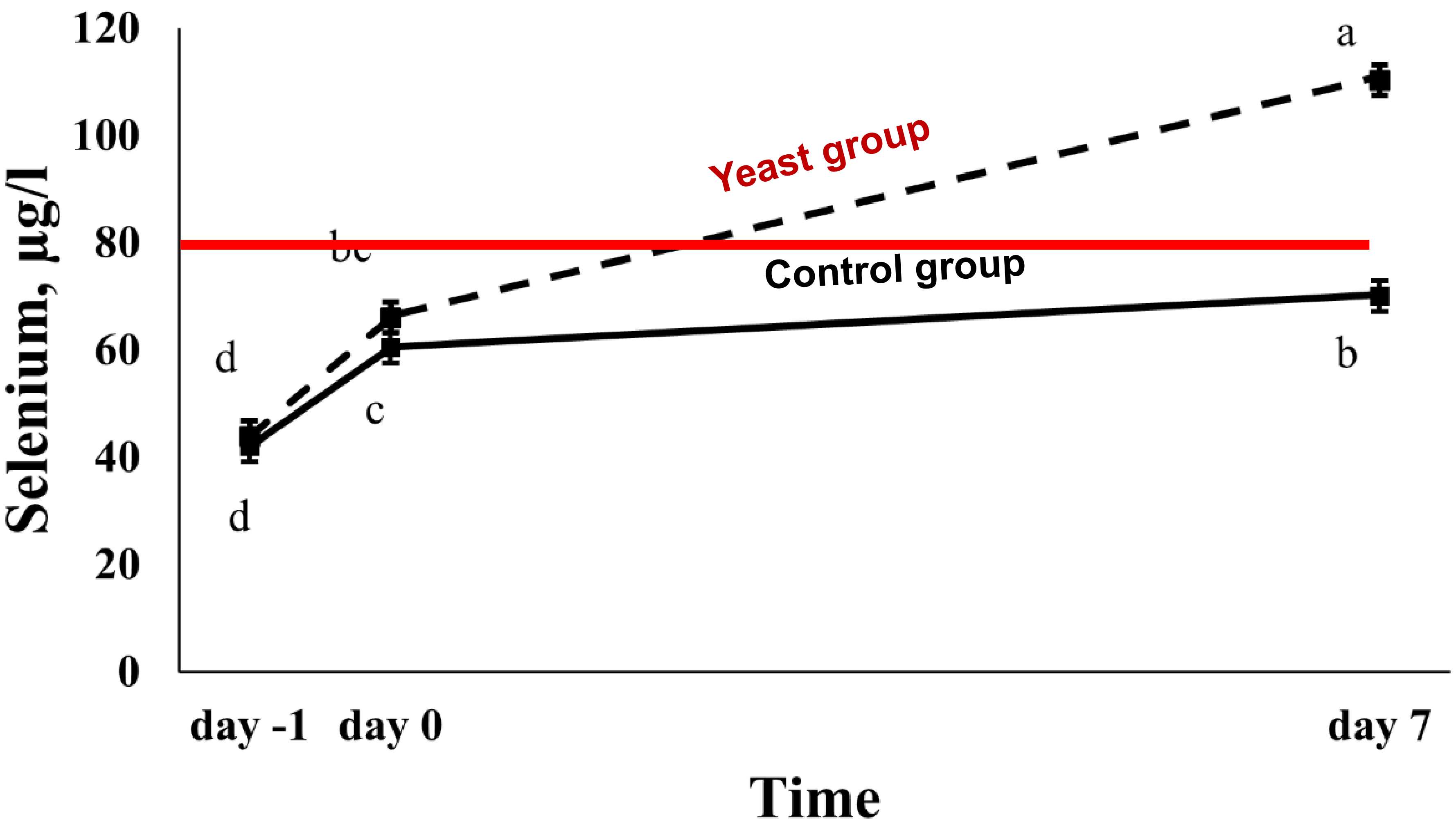
RESULTS AND DISCUSSIONS: random forest



RESULTS AND DISCUSSIONS: Model

Trait	Time		Supplementation		Time × Supplementation	
	F	*P*	**F**	***P***	F	*P*
Protein profile						
Albumin, g/L	58.1	<0.001	**0.25**	**0.618**	0.11	0.893
Creatinine, µmol/L	13.2	<0.001	**0.03**	**0.856**	0.21	0.81
Globulins, g/L	37.0	<0.001	**0.22**	**0.643**	1.48	0.231
Total protein, g/L	40.6	<0.001	**0.09**	**0.764**	1.55	0.215
Urea, mmol/L	9.00	<0.001	**2.11**	**0.148**	1.17	0.312
Energy profile						
Cholesterol, mmol/L	26.1	<0.001	**1.63**	**0.203**	1.11	0.331
Glucose, mmol/L	30.1	<0.001	**3.38**	**0.068**	4.47	0.22
Triglycerides, mmol/L	54.9	<0.001	**0.29**	**0.591**	0.31	0.733
Non-esterified fatty acids, mEq/L	25.1	<0.001	**0.04**	**0.841**	1.23	0.296
Hepato-muscle profile						
Alkaline phosphatase, U/L	173	<0.001	**0.77**	**0.381**	0.4	0.669
Alanine aminotransferase, U/L	69.0	<0.001	**0.01**	**0.928**	0.08	0.924
Aspartate aminotransferase, U/L	59.9	<0.001	**0.01**	**0.950**	3.01	0.08
Creatine kinase, U/L	32.6	<0.001	**3.16**	**0.078**	0.05	0.955
Lactate dehydrogenase, U/L	154	<0.001	**1.16**	**0.284**	1.19	0.306
Gamma-glutamyl transferase, U/L	58.4	<0.001	**0.14**	**0.710**	0.62	0.539
Total bilirubin (OR: <2.5 µmol/L)[2]	17.8	<0.001	**0.05**	**0.826**	1.08	0.343
Direct bilirubin (OR: <1.5 µmol/L)[2]	12.2	<0.001	**0.15**	**0.704**	0.89	0.413
Mineral profile						
Calcium, mmol/L	6.91	0.001	**0.01**	**0.926**	0.98	0.376
Chlorine, mmol/L	82.3	<0.001	**0.08**	**0.774**	2.41	0.093
Iron, µg/dL	127	<0.001	**0.95**	**0.330**	0.12	0.89
Potassium, mmol/L	24.3	<0.001	**0.07**	**0.788**	0.62	0.537
Magnesium, mmol/L	6.98	0.001	**0.03**	**0.861**	0.04	0.961
Sodium, mmol/L	4.71	0.05	**0.53**	**0.469**	0.51	0.602
Phosphorous, mmol/L	0.27	0.763	**0.01**	**0.952**	0.86	0.425
Selenium, µg/L	300	<0.001	**21.42**	**<0.001**	**67.45**	**<0.001**
Stress profile						
Cortisol, nmol/L	17.84	<0.001	**1.99**	**0.161**	0.63	0.536

RESULTS AND DISCUSSIONS: Model



CONCLUSIONS

CONCLUSIONS

Selenium-enriched yeast increased **Selenium** in the blood, however they did not impact other blood metabolites.

BW shrinkage and metabolic changes reflect **stress**, **energy deficit**, **dehydration,** and **muscle damage**, starting before and during transport.

However, stress is unavoidable during transport, monitoring **key biomarkers** helps detect stress early to improve animal welfare.

Probably the management of stress during transport can still be mitigated at the commingling center.

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Metabolic profile of Charolais young bulls transported over long-distance

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THANK YOU

For more details: https://doi.org/10.1016/j.prevetmed.2024.106296