Mitochondrial abundance and Complex activities in high and low RFI cattle

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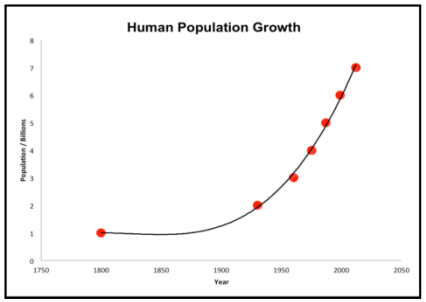
Feed efficiency

- Greatest impediment to successful economically sustainable beef production is increasing input costs
- Feed costs can account for up to 75% of the variable cost in beef cattle production (*Finneran et al., 2010*)
- RFI = actual intake – expected intake
- Alternative measure of FE (Koch et al.,1963)
- RFI measures variation in FI beyond that needed to support maintenance and growth requirements
- RFI is independent of growth
  - Genetically independent of BW and ADG (Arthur et al., 2001a,b)
  - Selection for RFI will not result in larger, faster growing cattle but has potential to reduce feed costs
- High RFI= inefficient , Low RFI=efficient



Variation in RFI

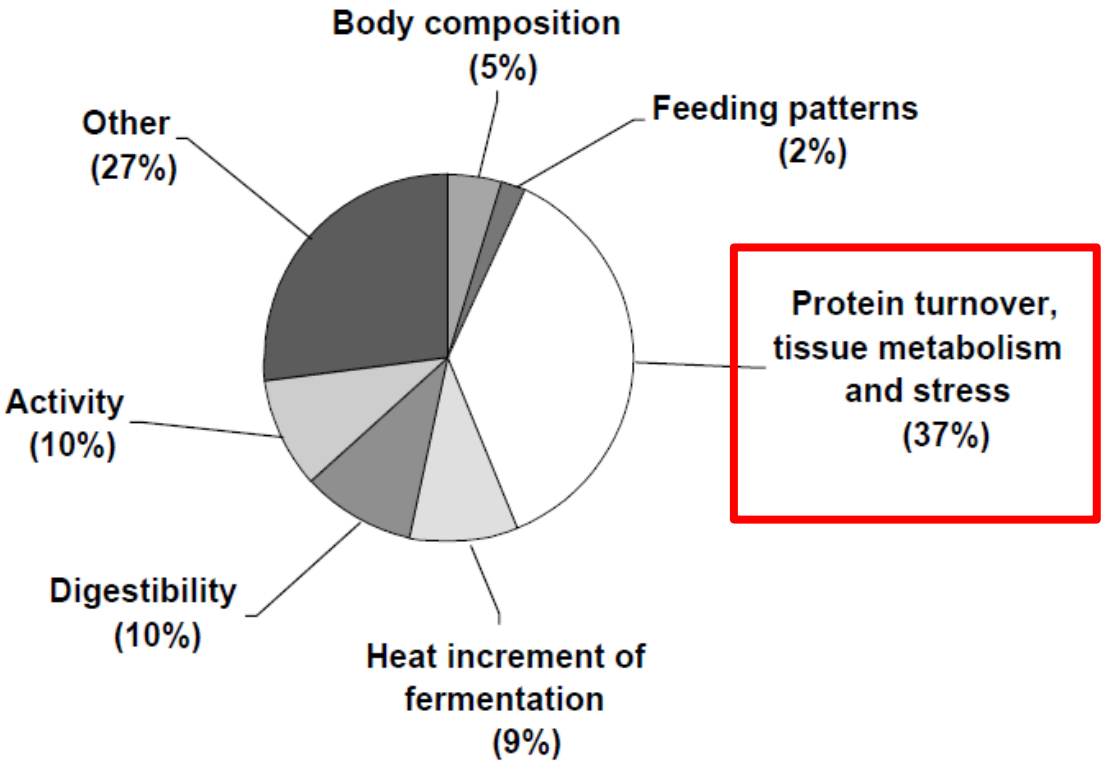
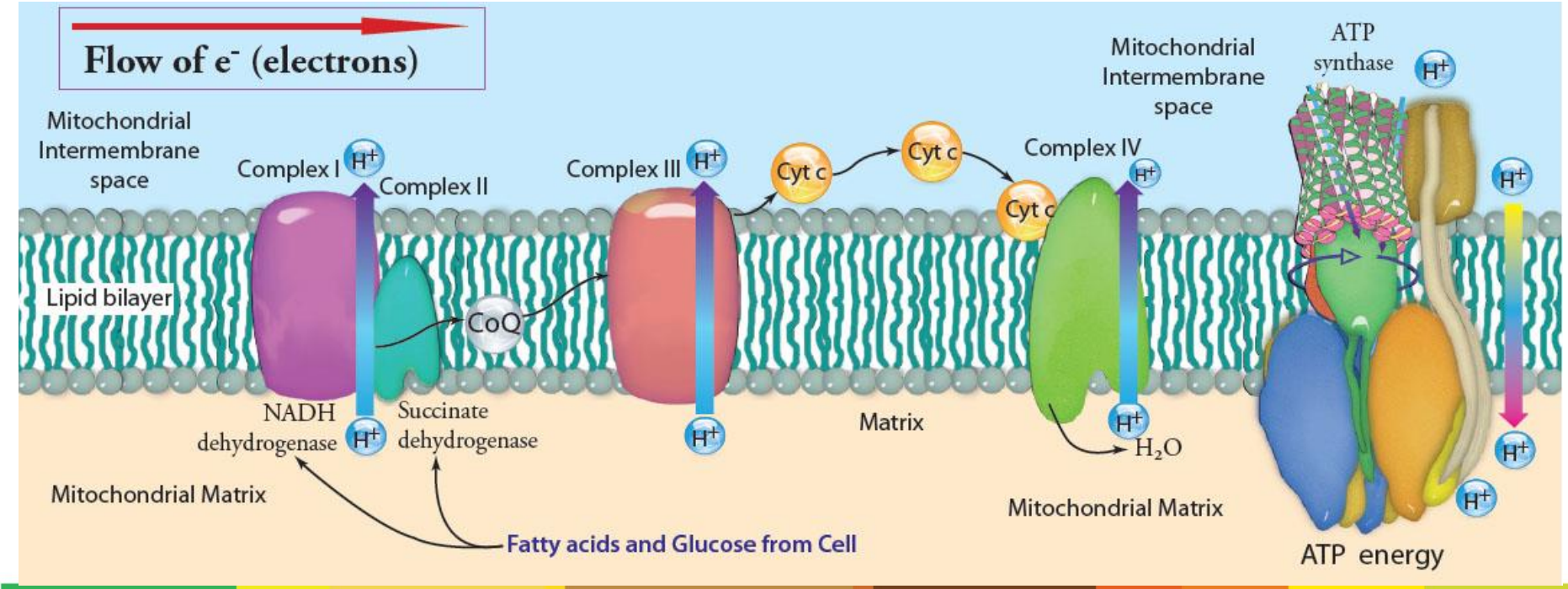


Figure 1. Contributions of biological mechanisms to variation in residual feed intake as determined from experiments on divergently selected cattle.

Herd and Arthur, 2009

Mitochondria

- 90% oxygen consumption in body and produce bulk of cellular energy(ATP)
- Key regulators in energy metabolism
- Structure/Function of IMM respiratory chain complexes important for optimal function of mitochondria



Mitochondria & Variation in RFI

Cattle

- More CI-CIV activity in muscle -low FE steers *(Sandelin. 2005)*
- ROS higher in muscle - low RFI *(Kolath.2006)*
- No difference in ATP production *(Kolath. 2006)*
- Differential expression genes involved in cellular EE , UCP3 & PGC1α in muscle *(Kelly et al., 2011b)*

Poultry

- More CI-CIV activity in muscle –high FE *(Iqbal et al., 2004)*
- More CI-CIV activity in duodenum–high FE *(Iqbal et al., 2004)*

Sheep

- More CI-CIV activity in muscle -low RFI lambs*(Sharifabadi et al., 2015)*

Objective of current study

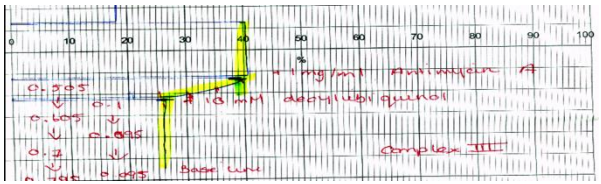
To examine the premise that efficiency of energy transduction in cattle is a function of mitochondrial abundance and mitochondrial functional efficiency in muscle and liver

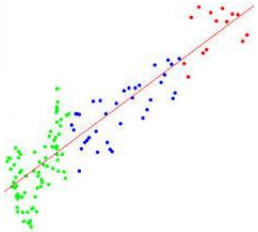
Materials and Methods – Animal Management

- 52 Purebred Simmental heifers/bulls housed in a concrete slatted floor shed
- Acclimatization period (14 d)
- Individual feed intakes recorded (70 d) daily using Calan gates
- Body weight recorded weekly
- *ad libitum* concentrate fed once daily & 3kg grass silage
- Blood sampled d2, d72
- Ultrasonic fat and muscle depth
- Muscle/liver biopsies collected

Materials and Methods- Laboratory & Statistical analyses

- Muscle & Liver homogenates prepared and total protein conc measured – Pierce BCA protein Assay kit
- Enzymatic assays performed using Shimazdu UV-Vis spectrophotometer
  - Citrate Synthase assay
  - Complex activity assay
- Statistical analysis:
  - MBW & ADG calculated
  - Expected DMI computed & RFI calculated
  - All data – PROC MIXED (SAS)
  - Blood metabolites – Repeated Measures (SAS)





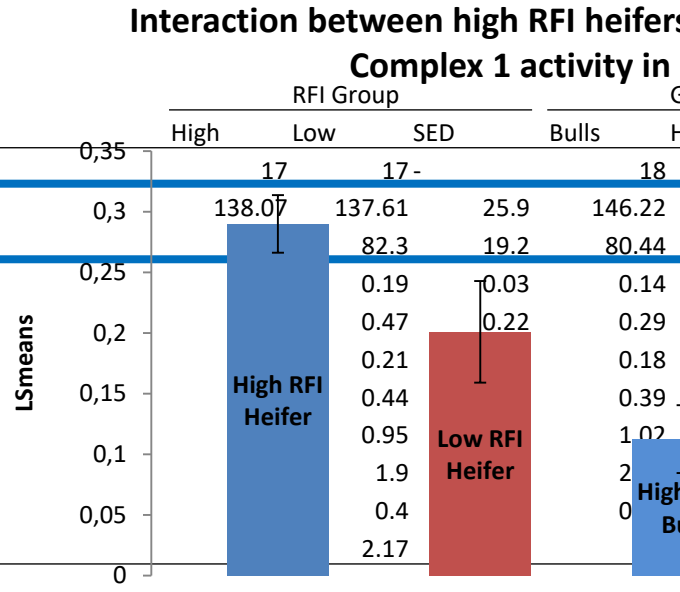
Results- Animal Performance

	RFI Group			Gender(G)			*P*-value		
Trait	High	Low	SED	Bulls	Heifers	SED	RFI	G	RFI x G
No. of animals	17	17	-	18	16	-	-	-	-
DMI,kg DM/d	9.7	8.8	0.2	9.47	9.1	0.2	0.0025	0.28	0.309
RFI, kg DM/d	0.3	-0.6	0.06	0.03	-0.09	0.07	<0.0001	0.0001	0.0038
Metabolic BW, kg0.7	95.6	95.2	2.5	97.18	93.79	2.5	0.87	0.2	0.79
Initial BW,kg	382.58	373.3	16.04	382.06	273.87	16.5	0.5	0.62	0.95
Final BW,kg	488.79	483.54	16.7	509.6	462.73	17.25	0.75	0.011	0.8215
ADG, kg/d	1.5	1.5	0.13	1.8	1.2	0.14	0.68	0.0009	0.62
Backfatchange mm	1.3	1.7	0.24	1.3	1.7	0.25	0.1	0.14	0.62

Results – Blood metabolites

	RFI			Gender (G)			Day(D)			*P*- value				
Variable	High	Low	SED	Bulls	Heifers	SED	1	72	SED	RFI	G	D	RFI x G	D x G
No.of animals	17	17	-	18	16	-	34	34	-	-	-	-	-	-
BHB, mmol/L	0.18	0.22	0.03	0.15	0.25	0.03	0.18	0.21	0.01	0.18	0.017	0.13	0.22	0.06
Albumin,g/L	34.7	33.7	0.9	32.5	35.9	1.06	31.7	36.7	0.3	0.32	0.006	<0.0001	0.59	0.86
Creatinine, µmol/L	117.6	118.35	5.7	116.2	119.71	6	110	125.7	1.72	0.9	0.56	<0.0001	0.45	0.7
Globulin, g/L	40.6	38.5	2.1	40.4	38.7	1.6	38.6	40.5	1.9	0.3	0.4	0.01	0.8	0.5
Glucose, mmol/L	4.7	4.8	0.11	4.9	4.6	2	4.5	5	0.11	0.53	0.09	0.0005	0.36	0.17
NEFA, mmol/L	0.08	0.04	0.017	0.02	0.09	0.018	0.06	0.06	0.006	0.05	0.002	0.18	0.77	0.21
Total Protein, g/L	75.4	72.2	2.3	73	74.6	2.5	70.3	77.3	0.85	0.2	0.51	<0.0001	0.73	0.53
Triglycerides, mmol/L	0.16	0.17	0.03	0.17	0.15	0.03	0.14	0.19	0.009	0.68	0.67	0.001	0.87	0.48
Urea, mmol/L	3.9	3.7	0.39	3.4	4.17	0.42	5.1	2.55	0.17	0.71	0.13	<0.0001	0.07	0.01

Results-Mitochondrial abundance & complex activities

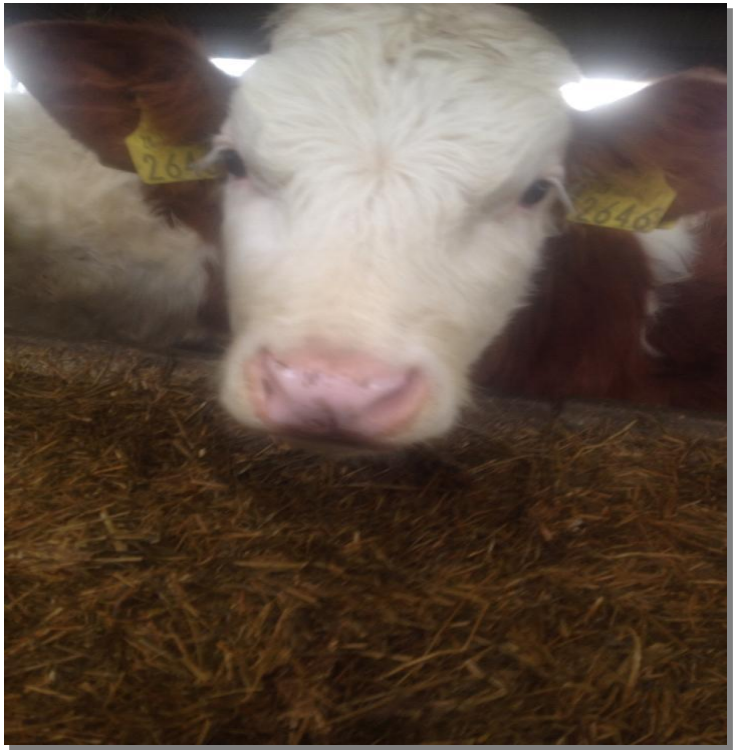


Enzyme activity	RFI Group			Gender			*P*-value		
	High	Low	SED	Bulls	Heifers	SED	RFI	Gender	RFI x Gender
No. of animals	17	17	-	18	16	-	-	-	-
C.S Muscle (nmol/min/mg)	138.07	137.61	25.9	146.22	129.46	26.6	0.98	0.53	0.23
C.S Liver (nmol/min/mg)		82.3	19.2	80.44	63.52	19.78	0.23	0.39	0.45
CI Muscle (unit/cs)		0.19	0.03	0.14	0.23	0.03	0.76	0.0075	0.02
CII Muscle (unit/cs)		0.47	0.22	0.29	0.5	0.23	0.74	0.22	0.64
CIII Muscle (unit/cs)		0.21		0.18	0.23		0.94	0.28	0.47
CIV Muscle (unit/cs)		0.44		0.39	0.81		0.31	0.2	0.35
CI Liver (unit/cs)		0.95		1.02	1.2		0.3	0.57	0.24
CII Liver(unit/cs)		1.9		2	1.8		0.85	0.75	0.41
CIII Liver (unit/cs)		0.4		0	0.59		0.32	0.2	0.3
CIV Liver (unit/cs)		2.17			2.9		0.02	0.27	0.17

Overall Conclusions

1. No effect of RFI status or gender on mitochondrial abundance in either muscle or liver tissue
2. Some evidence of differences between high and low RFI animals in complex activity but may be a function of gender, requires further investigation
3. Our data and work of others suggest that while mitochondrial function may be involved in variation in RFI it is not a major contributor to the process

Thank you!



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