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EFFICIENZA PRODUTTIVA NEL POLLO DA CARNE: APPROCCI TRADIZIONALI ED INNOVATIVI

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UNIBO poultry research centre

Dipartimento di Scienze e Tecnologie Agro-Alimentari
Ozzano dell'Emilia (BO)

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Zootechnical trials

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UNIBO poultry research centre

Meat-type chickens:
1,000 birds divided in 40 pens of 2.5 m^2 each

Egg-type chickens:
300 birds divided in 30 enriched cages

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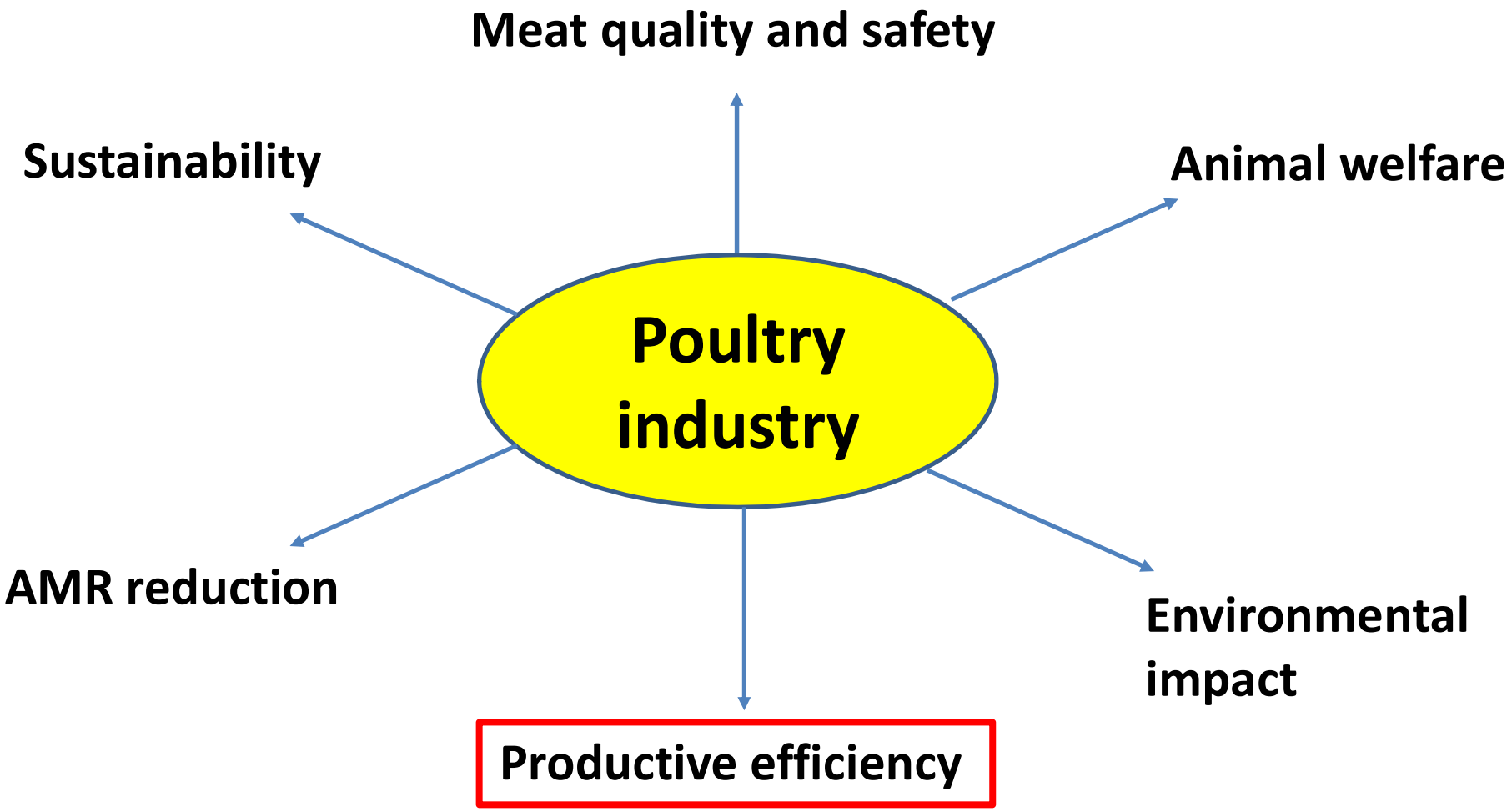
Current challenges of the poultry industry



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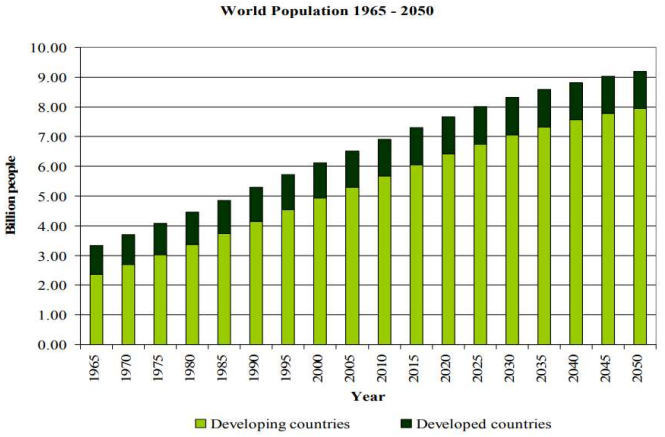
Why should we be efficient?

Because we need to feed the world

Estimated world's population by 2050:
9.1 billions (+34% than today)
Increase in food production: +70%
Increase in meat production: +135%



SUSTAINABLE increase in terms of:

- Environmental impact
  - Animal welfare
  - Resources utilization

Source: How to Feed the World in 2050 (FAO, 2009).

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General Introduction

FEED EFFICIENCY

In livestock, **<u>from 50 to 70% of total production costs is given by feeding.</u>**

Improving “feed utilization” is a fundamental aspect for maintaining a sustainable production.

- *Feed conversion ratio (FCR) =* $\frac{Feed\ intake\ (g)}{Weight\ gain\ (g)}$
- *Residual feed intake (RFI) =* $Actual\ Feed\ Intake\ -Expected\ Feed\ Intake$

The lower FCR and RFI values, the higher the FE.

2 pt. FCR improvements in broilers can save 656,638 ha/year

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General Introduction

Homeostatic aspects of FE

Journal of Animal Science and Biotechnology

Review | Open Access | Published: 10 September 2018

Application of omics technologies for a deeper insight into quali-quantitative production traits in broiler chickens: A review

Marco Zampiga, Joshua Flees, Adele Meluzzi, Sami Dridi & Federico Sirri

Journal of Animal Science and Biotechnology **9**, Article number: 61 (2018) | Download Citation

Source: Zampiga et al. (2018)

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How to improve FE

Artificial selection

- Main strategy (-50% FCR in the last 50 years)
- Up to 85% of the improvements in FE, moderate heritability for FE parameters
- Biological potential for genetic improvements is minimal compared to the progresses already obtained as artificial selection for efficiency will inevitably face biological limits and animal welfare concerns (Tallentire et al., Nature, 2018)

Environmental factors

- Nutritional strategies
- Environmental conditions
- Management practices

Physiological and metabolic features

- Digestive physiology
- Immunological traits
- Metabolic processes

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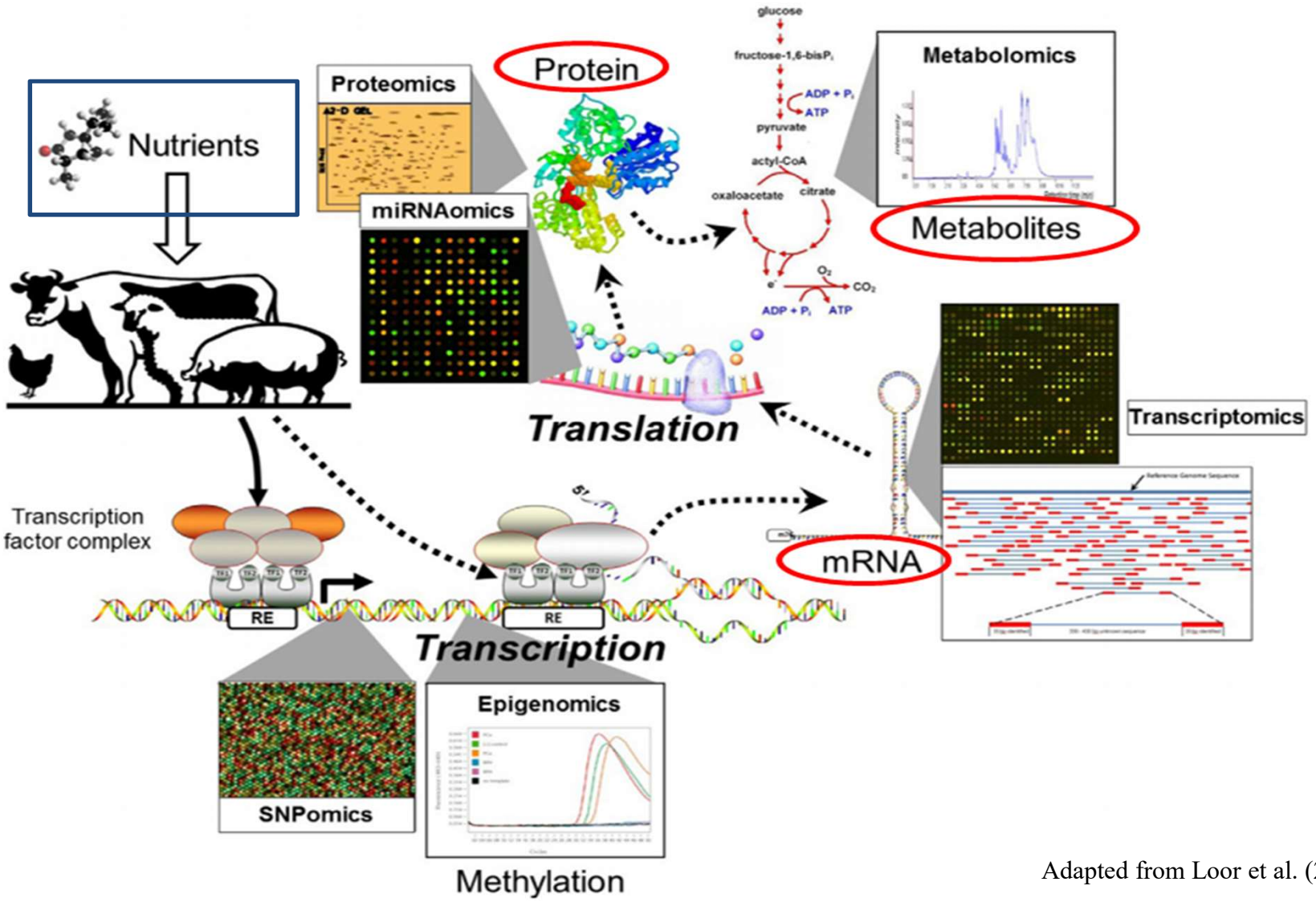
Omics technologies



Adapted from Loor et al. (2015).

Improving FE through nutritional treatments – Example 1

ITALIAN JOURNAL OF ANIMAL SCIENCE, 2016
VOL. 15, NO. 3, 521–528
http://dx.doi.org/10.1080/1828051X.2016.1192965

Taylor & Francis
Taylor & Francis Group

PAPER

OPEN ACCESS

Effect of dietary supplementation of lysophospholipids on productive performance, nutrient digestibility and carcass quality traits of broiler chickens

Marco Zampiga, Adele Meluzzi and Federico Sirri

Dipartimento di Scienze e Tecnologie Agro-Alimentari, University of Bologna, Bologna, Italy

Experimental groups (9 replicates/group, 65 birds/replicate)

- **CON**: basal diet (corn-wheat-soybean meal)
- **CONST**: basal diet + constant level of lysophospholipids-based emulsifier (1 kg/ton) from 0 to 42 d
- **VARI:** basal diet + increasing levels of emulsifier according to the feeding phase (1 kg/ton from 0 to 26 d and 1.5 kg/ton from 27 to 42 d).

	Treatments				
	CON	CONST	VARI	SE	Probability
No. replications	9	9	9		
Feed conversion rate					
0–12	1.583	1.579	1.541	0.02	ns
13–26	1.791	1.759	1.745	0.02	ns
27–36	2.019	1.976	1.979	0.02	ns
37–42	2.077	2.013	2.029	0.02	ns
0–42	1.913[a]	1.875[b]	1.871[b]	0.01	<0.05

No significant effect on:

- Other productive traits
- Nutrient digestibility
- Slaughter yields
- Skin pigmentation
- Footpad condition

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Improving FE through nutritional treatments – Example 2

PLOS ONE

https://doi.org/10.1371/journal.pone.0176309

Effect of dietary supplementation with *Lactobacillus acidophilus* D2/CSL (CECT 4529) on caecum microbioma and productive performance in broiler chickens

Alessandra De Cesare, Federico Sirri, Gerardo Manfreda, Paola Moniaci, Alberto Giardini, Marco Zampiga, Adele Meluzzi

Experimental groups (16 replicates /group, 25 birds/replicate)

- **CON**: basal diet (corn-wheat-soybean meal)
- **LA:** basal diet supplemented with *Lactobacillus acidophilus* D2/CSL (bacterial conc. 5.0 x 10^{10} cfu/g) at the dosage of 20 g/ton feed .

	CON	LA	SE	P-value
n.	*16*	*16*		
		0–41 d		
Body weight (g/bird)	2,757	2,784	13.64	0.17
Daily weight gain (g/bird/d)*	65.83	66.31	0.37	0.37
Daily feed intake (g/bird/d)*	106.2	105.3	0.46	0.30
Feed conversion rate*	1.613 a	1.588 b	0.008	0.03
Mortality (%)	2.00	2.75	0.03	0.25

Birds treated with LA showed a lower occurrence of pasty vent at both 14 and 28 d.

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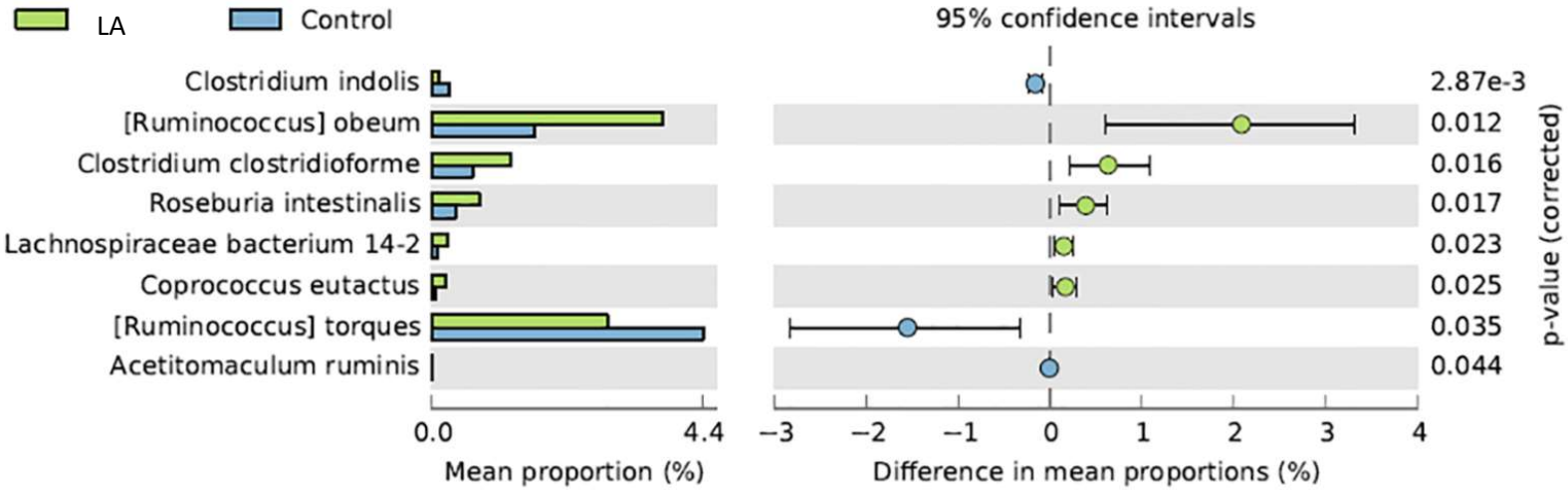
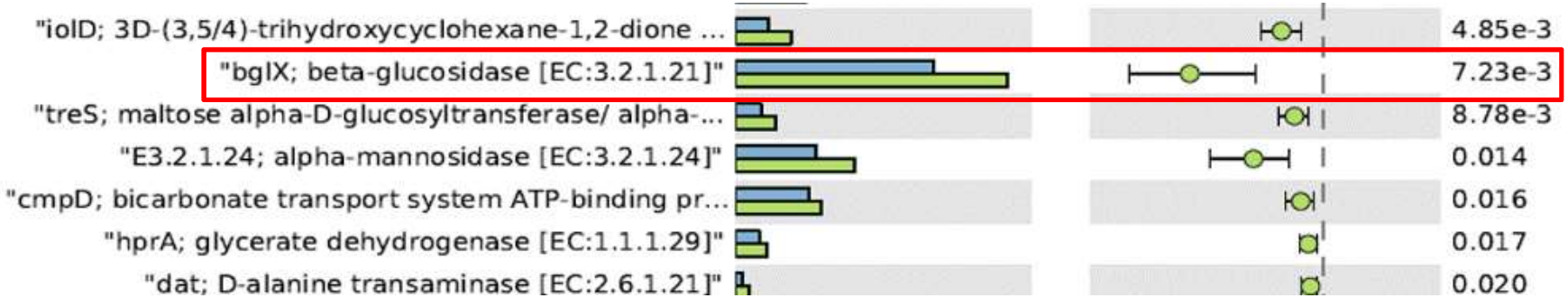
Improving FE through nutritional treatments – Example 2

Cecum microbiota composition



Metabolic activity



De Cesare et al., 2017.

Improving FE through nutritional treatments – Example 3

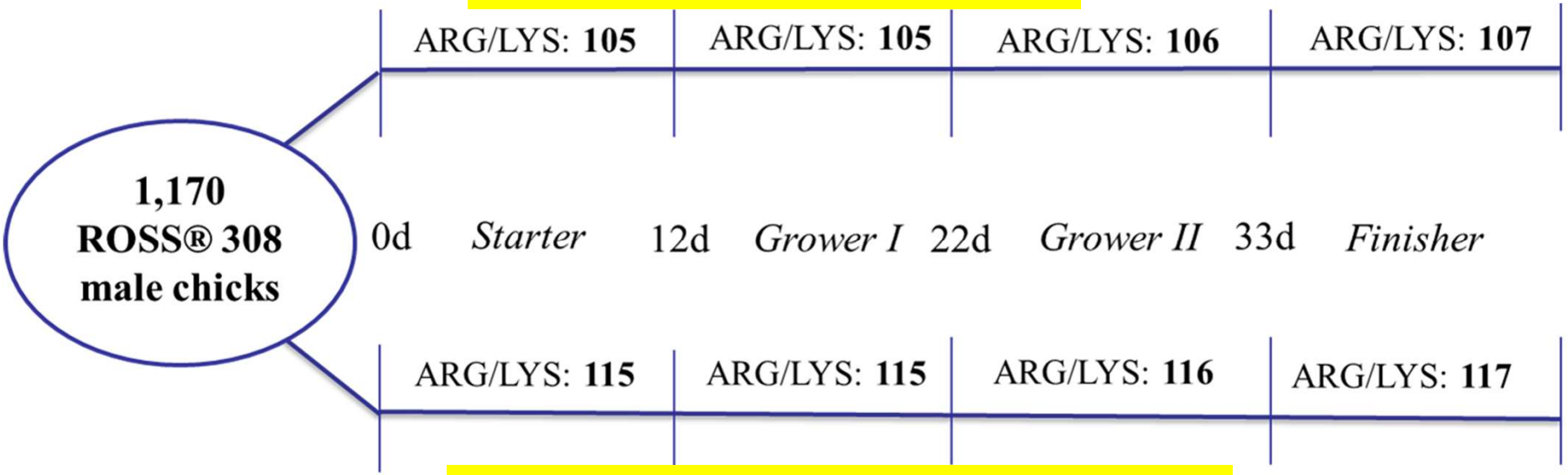
Journal of Animal Science and Biotechnology

Effect of dietary arginine to lysine ratios on productive performance, meat quality, plasma and muscle metabolomics profile in fast-growing broiler chickens

Marco Zampiga, Luca Laghi, Massimiliano Petracci, Chenglin Zhu, Adele Meluzzi, Sami Dridi & Federico Sirri

Journal of Animal Science and Biotechnology **9**, Article number: 79 (2018) | Download Citation

CON group: commercial **basal diet**



ARG group: **basal diet** + **feed grade L-arginine**

Zampiga et al., 2018.

9 replicates/group of 65 birds each (585 birds/group)

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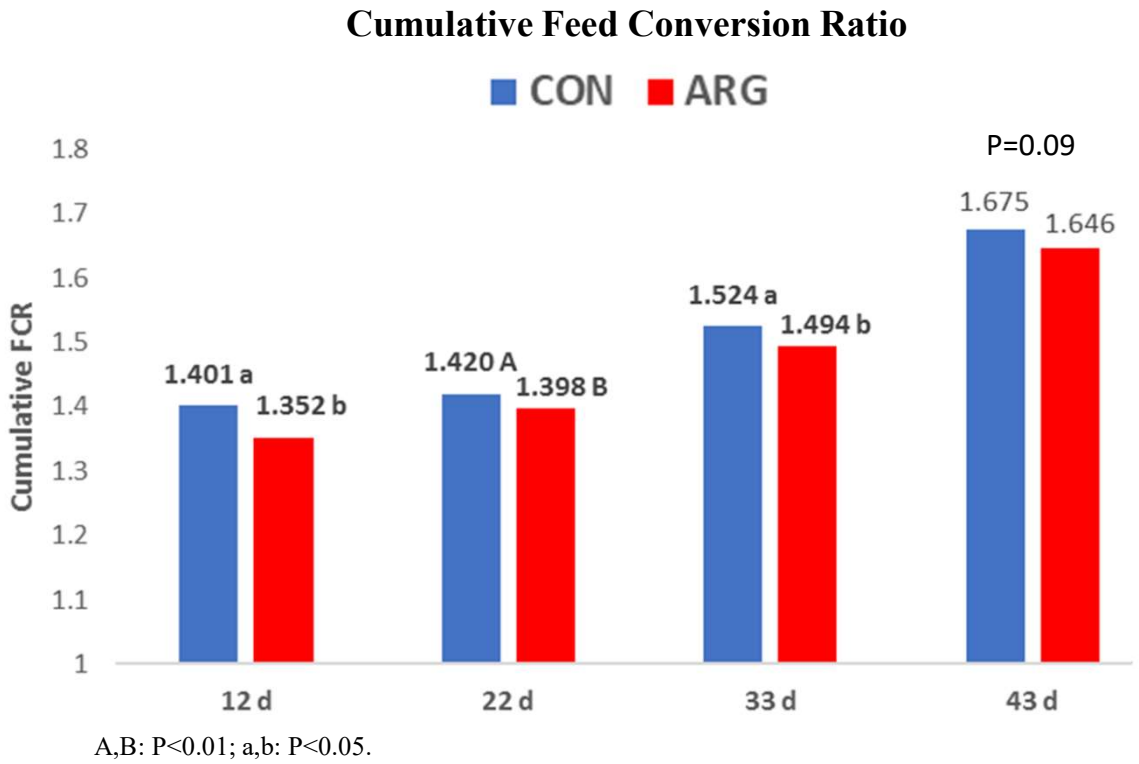
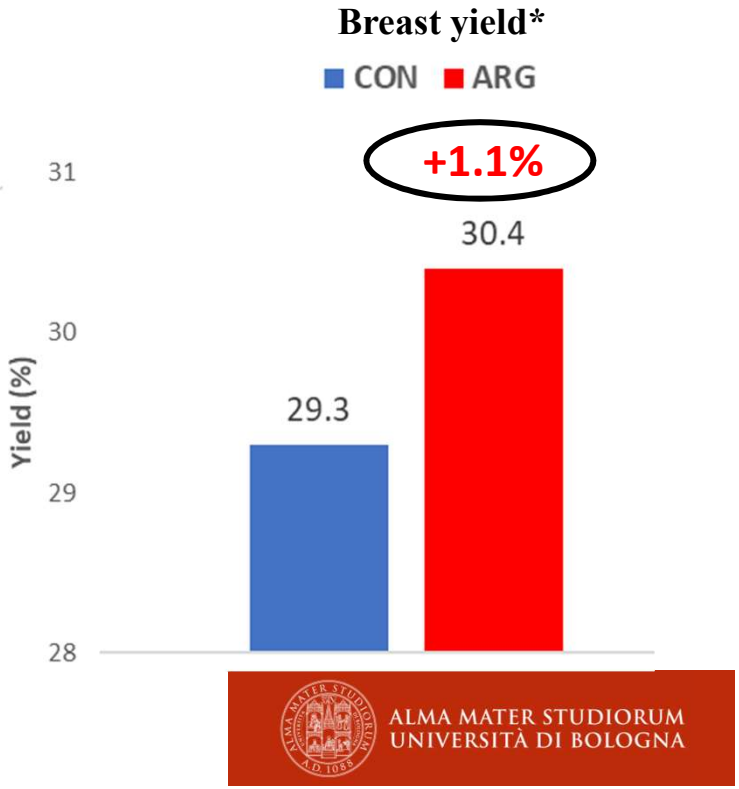
Improving FE through nutritional treatments – Example 3



A,B: P<0.01; a,b: P<0.05.



N° CTR: 532
N° ARG: 528
* Calculated as percentage of eviscerated carcass weight

Zampiga et al., 2018.

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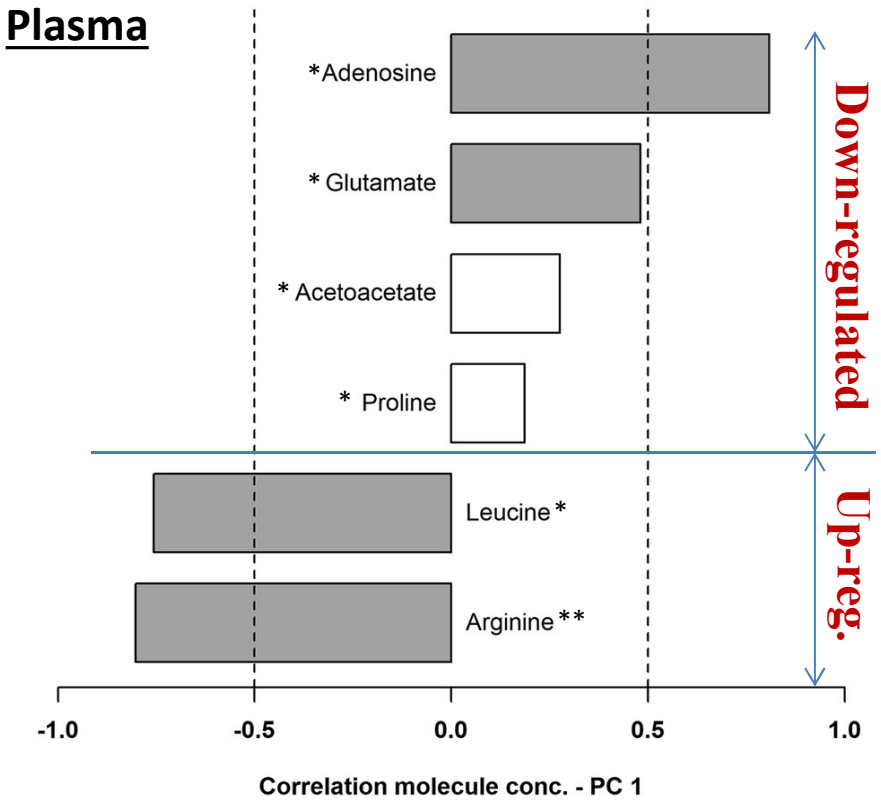
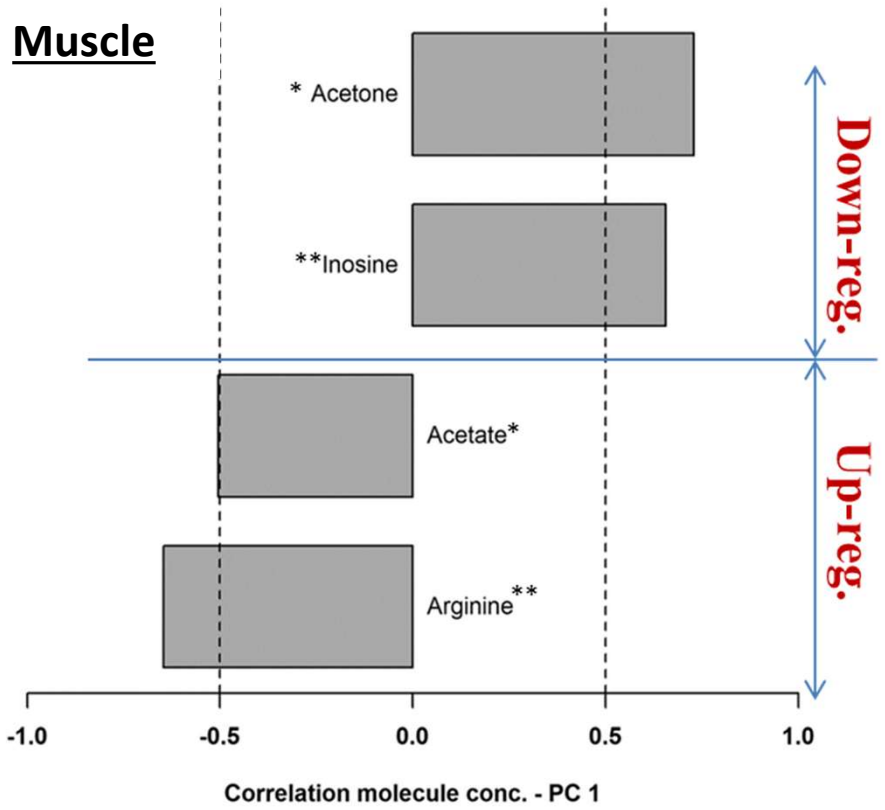
Improving FE through nutritional treatments – Example 3

Significantly up- and down-regulated metabolites in plasma and muscle of ARG birds (n=9/group) according to NMR analysis





*: P<0.05; **: P<0.01.

Zampiga et al., 2018.

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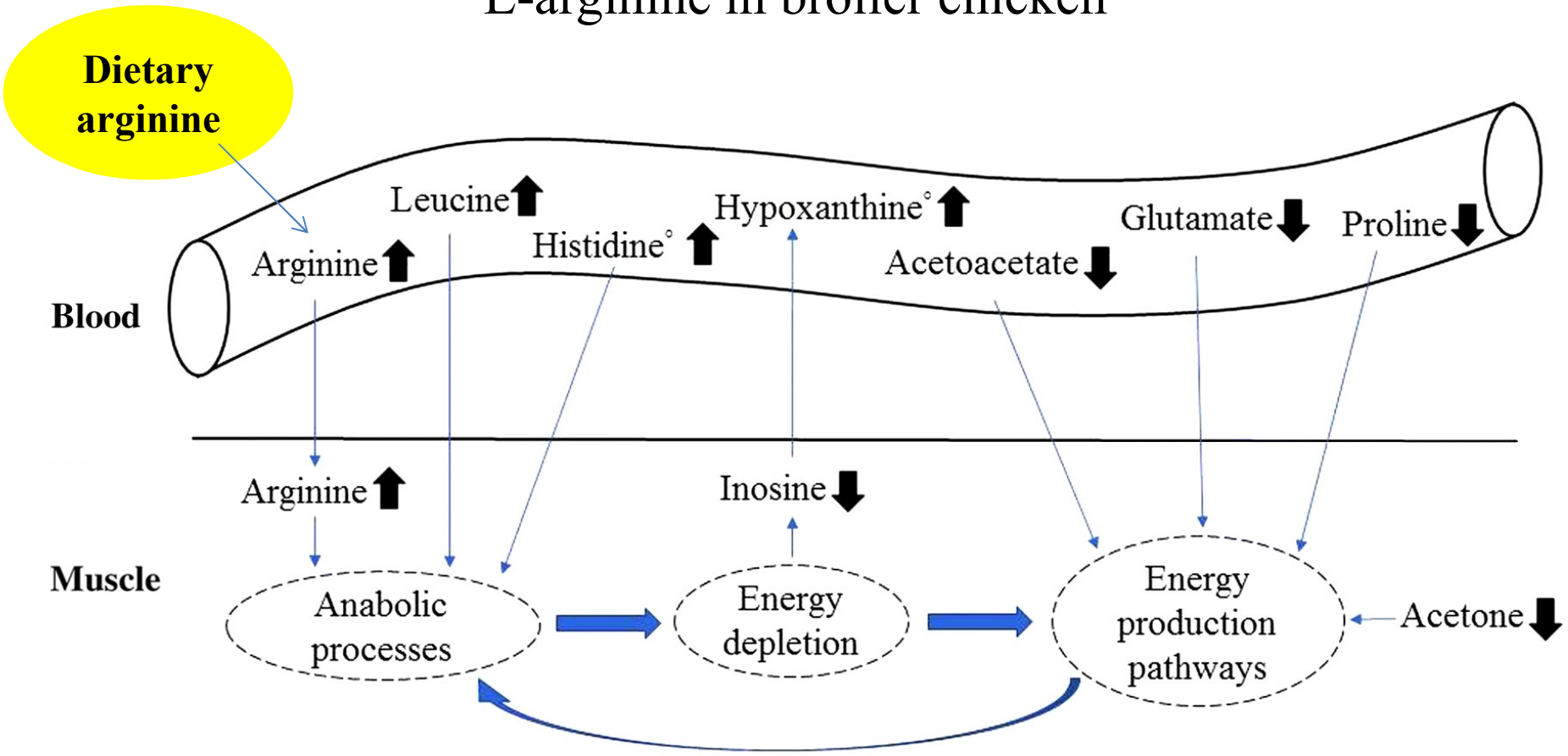
Improving FE through nutritional treatments – Example 3

Hypothetical molecular responses to the dietary supplementation of L-arginine in broiler chicken



⬆ Significantly upregulated; ⬇ Significantly downregulated; °: *P*-value<0.1.

Zampiga et al., 2018.

Feed efficiency: physiological and metabolic aspects

Journal of Animal Physiology and Animal Nutrition

ORIGINAL ARTICLE | Free Access

Differences in productive performance and intestinal transcriptomic profile in two modern fast-growing chicken hybrids

Marco Zampiga, Micol Bertocchi, Paolo Bosi, Paolo Trevisi, Adele Meluzzi, Federico Sirri

Fast-growing hybrid **HA**

Fast-growing hybrid **HB**

- Raised in the **same environmental conditions**
- Fed the **same diet**

585 birds/genotypes
9 replicates/genotype
65birds/replicates

- **Productive traits**, with special regard to **feed efficiency**
- **Ileum transcriptomic profile** through microarray analysis (**Functional analysis**: Gene Set Enrichment Analysis software)

GSEA
Gene Set Enrichment Analysis

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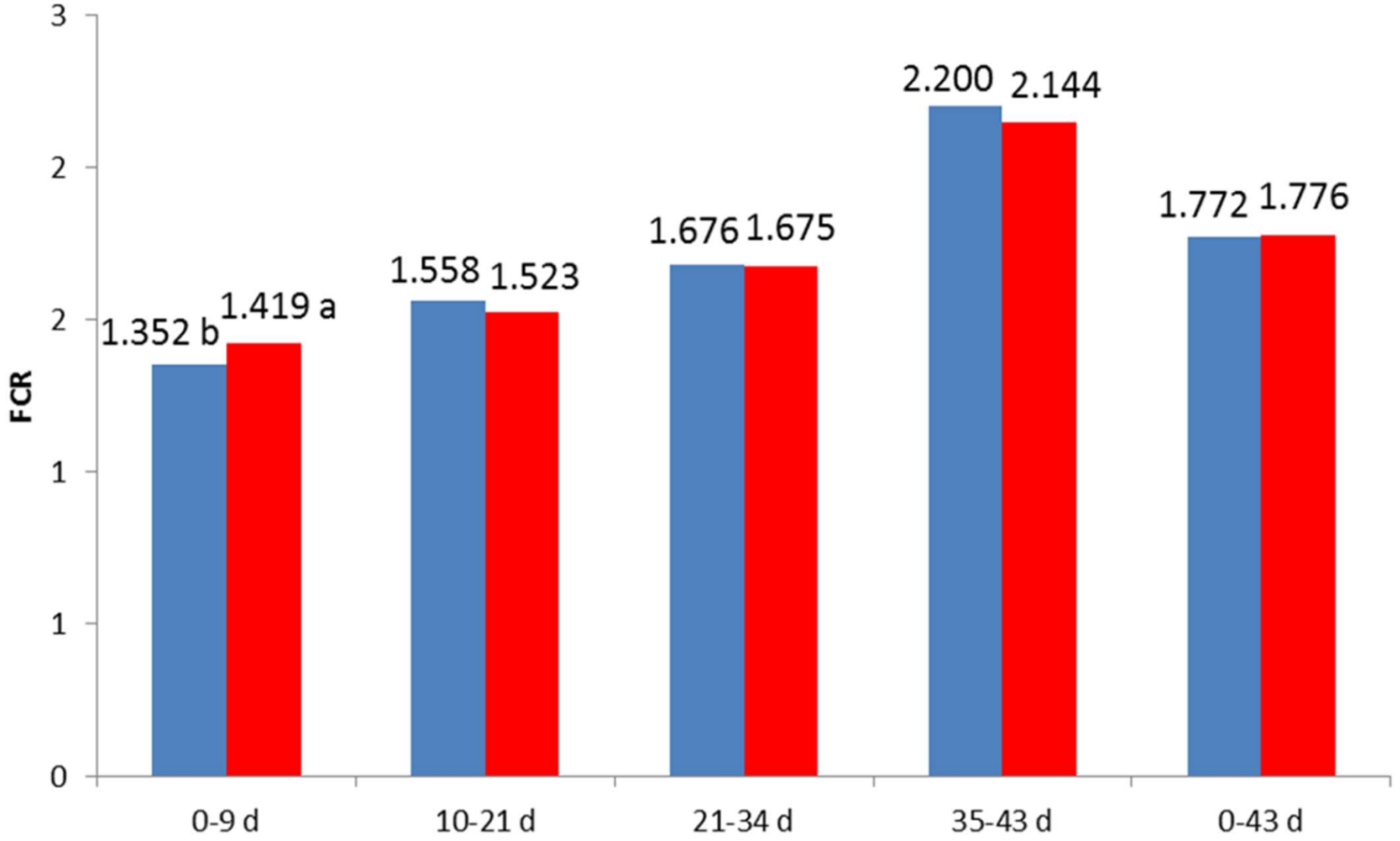
Feed efficiency: physiological and metabolic aspects



A, B: P<0.01; a,b: P<0.05

Zampiga et al., 2018.

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Feed efficiency: physiological and metabolic aspects

Intestinal transcriptomic profile

Main biological functions of enriched gene sets	% of total enriched gene sets
HA genotype*	
Cellular energy metabolism	43%
Mitochondria structure and functionality	23%
Ribosome structure and protein synthesis	11%
Cell structure and integrity	8%
Antioxidant and detox mechanisms	6%
Other	9%
HB genotype*	
Immune system activation	28%
Signal transduction and cell signalling	20%
DNA remodelling and replication, chromatin/histone modification	15%
Cell activation, migration and adhesion	12%
Inflammation	7%
Bone remodelling	4%
Other	14%

A total of 114 and 179 gene sets were significantly enriched in HA and HB groups, respectively.
Zampiga et al., 2018

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Feed efficiency: physiological and metabolic aspects

Fast-growing hybrid **HA**

Fast-growing hybrid **HB**

- Raised in the **same environmental conditions**
- Fed the **same commercial diet**

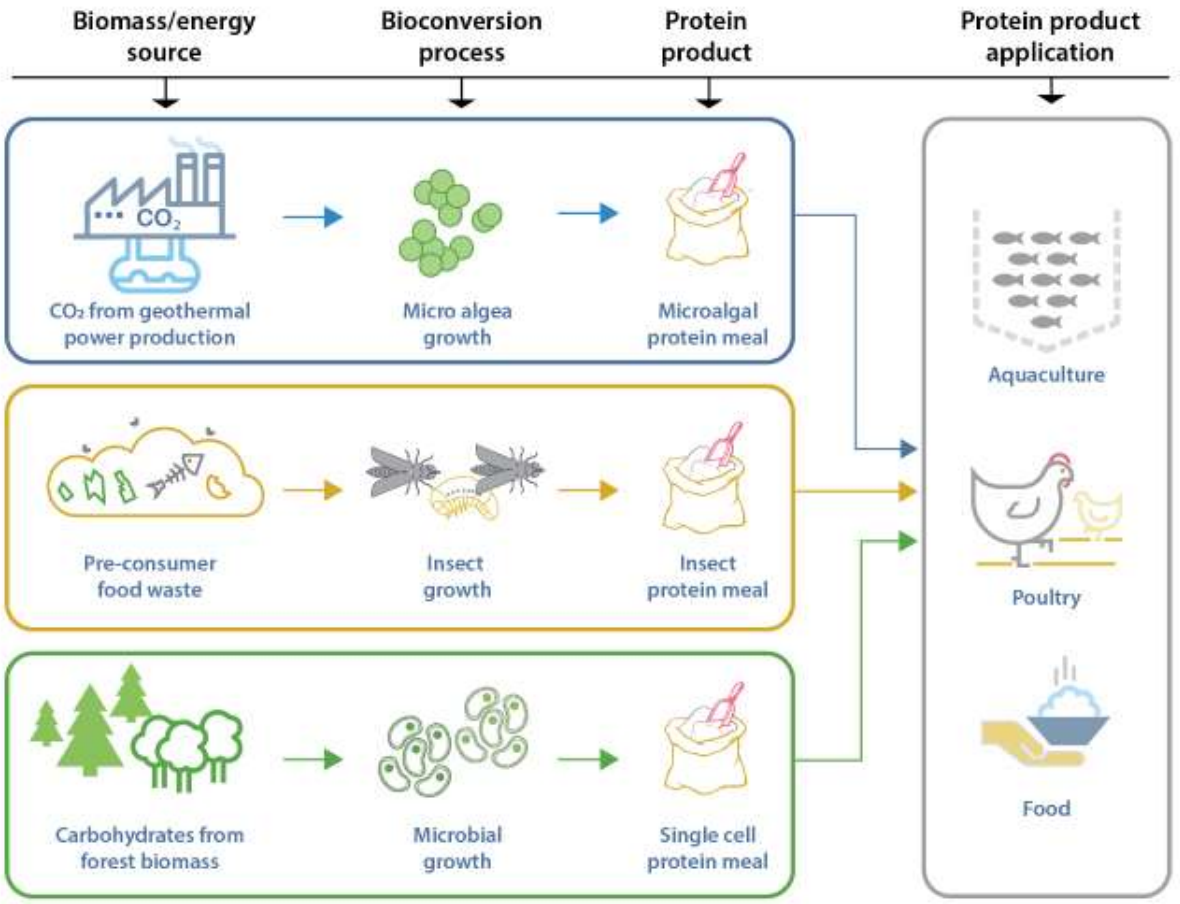
Completely different response in terms of metabolic functions in the gut
HB potentially presenting an inflammatory condition likely triggered by excessive nutrient intake («metabolic inflammation» by Kogut et al., 2018)

Zampiga et al., 2018.

Future outlooks: alternative protein sources

NEXTGEN PROTEINS

Horizon 2020 Project



- Sustainability
- Efficiency
- Animal health
- Product quality

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Conclusions

1. The results obtained combining both traditional and innovative techniques (transcriptomics and metabolomics) in a holistic approach can shed some light on important nutritional and molecular aspects involved in productive efficiency of broiler chickens.

2. Nutritional strategies can play a fundamental role for further improvements of FE (… but not all are really effective!)

Conclusions

3. Need to better understand the complex interaction between genotype and nutrition to improve productive efficiency (precision feeding concept: formulation of genotype-tailored diets?)

4. A better and detailed knowledge of these aspects in modern fast-growing broiler chicken hybrids may allow an optimization of productive strategies to efficiently sustain the increasing demand of poultry meat while improving animal welfare, product quality and environmental sustainability.

Special thanks

- **Research group at UNIBO:**

  Prof. Federico Sirri
  Prof.ssa Adele Meluzzi
  Dott. Stefano Pignata
  Sig. Roberto Donatini

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- **Other colleagues from DISTAL and other Universities**

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Thanks for your attention!

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