Extruded or Enzyme-Treated *Chlorella vulgaris* in Broilers Diets: Effects on Performance and Digesta Viscosity

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   - Challenges to address
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Why incorporate *Chlorella vulgaris* into broiler diets?

Chlorella vulgaris is a protein-rich microalga, frequently used as a feed additive in poultry production.

Nutritional Composition	
Crude protein (%)	13.6–65.5
Crude carbohydrates (%)	8.08–65.0
Non-fibre carbohydrates (starch)	2.00–4.41
Crude fibre (%)	1.63–5.98
Ash (%)	6.30–27.3
Crude fat (%)	5.10–19.7

Adapted from Spinola, et al., 2023

- ✓ High levels of **fatty acids**, particularly Eicosapentaenoic Acid (**EPA**) and Docosahexaenoic Acid (**DHA**)
- ✓ High levels of **vitamins**, particularly Vitamin **B12**, Vitamin **E**, and **beta-carotene**
- ✓ Contains all **essential amino acids**
- ✓ Contains **bioactive peptides** and **polysaccharides**
- ✓ **Rich in natural pigments**, particularly **chlorophyll** and **carotenoids**
- ✓ **High antioxidant capacity**

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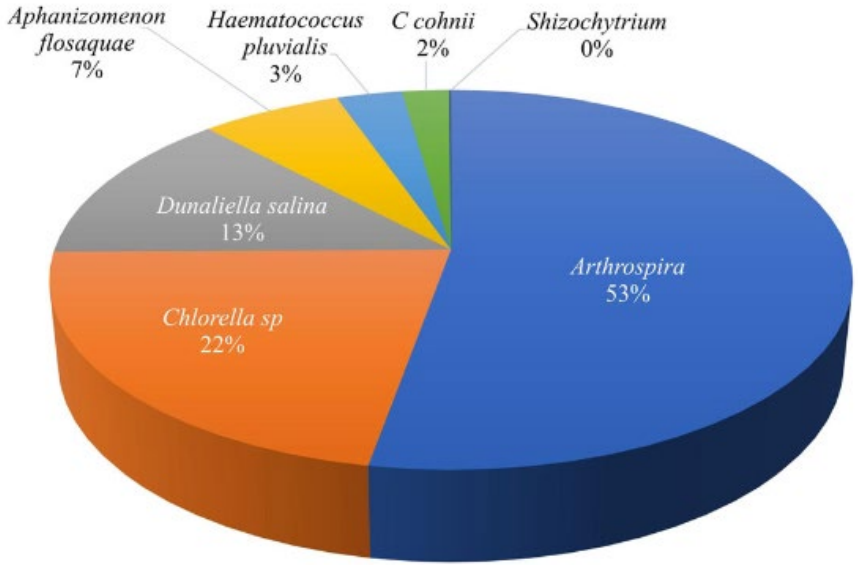
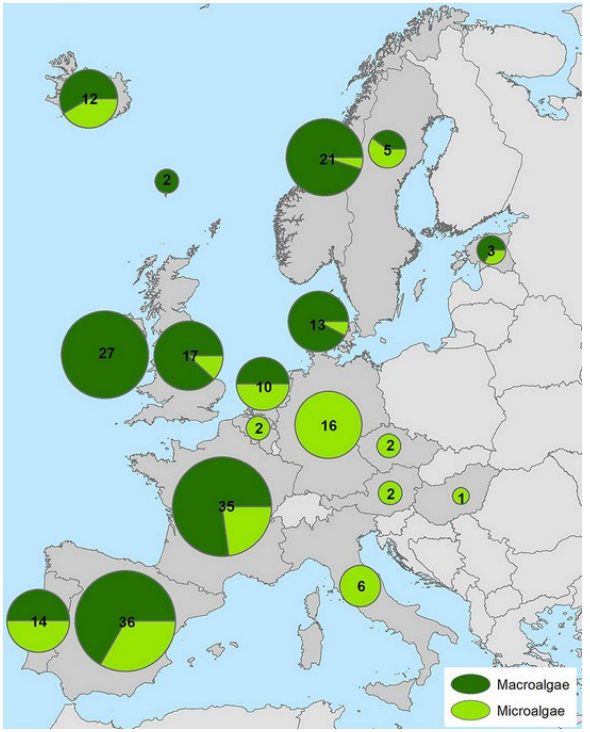


Annual commercial production of the major genera of microalgae worldwide

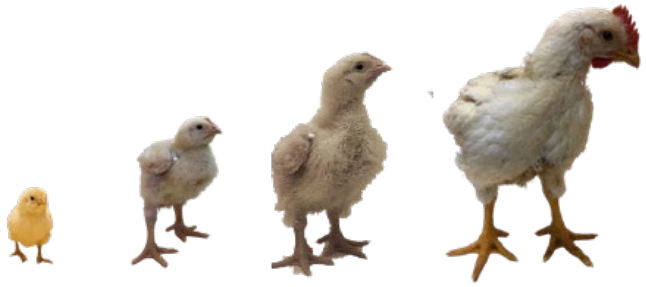
Saadaoui, et al., 2021

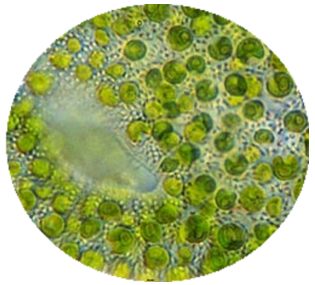


Number of companies producing algae

Araújo, et al., 2021

Challenges to address





Complex cell walls

Pretreatments

Extrusion

Enzyme addition

Objectives

Chlorella vulgaris has recalcitrant cell walls that hinder efficient digestion and absorption in broilers

Incorporate *Chlorella vulgaris* as an ingredient in broiler diets at a 20% inclusion level

+

To evaluate enzymatic treatment and extrusion effects

↓ ↓

Effects animal performance

Effects on digesta viscosity

To our knowledge, no studies have reported a 20% incorporation in broiler diets with additional treatments to enhance digestibility

Digestibility Study

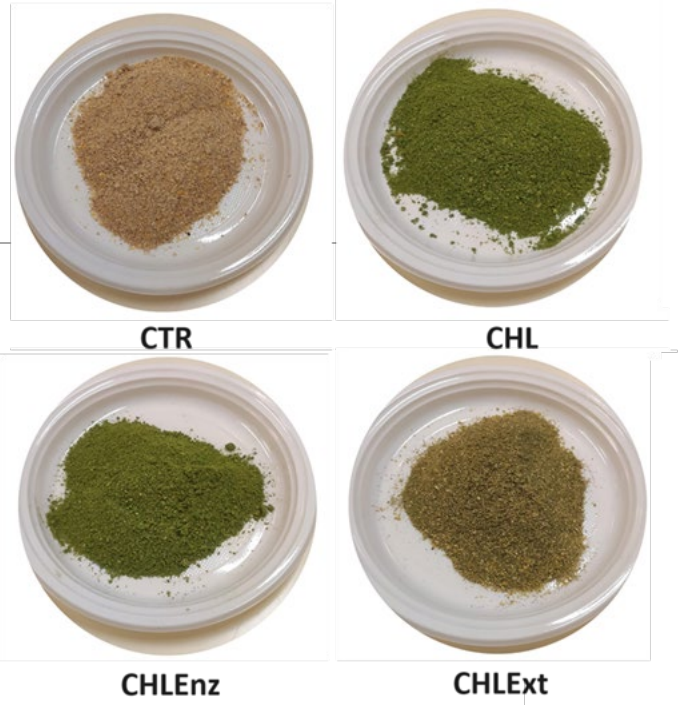
Item	*Chlorella vulgaris*		Extruded *C. vulgaris*	
TME (Kcal/kg dry)	3534		3656	
Crude Protein (%)	29.0		30.5	
Aminoacids	**Content (%)**	**Average Digestibility (%)**	**Content (%)**	**Average Digestibility (%)**
Arginine	1.960	89.7	2.010	89.4
Glycine	1.330	49.8	1.360	63.4
Histidine	0.530	82.2	0.540	82.0
Isoleucine	0.970	78.7	1.040	80.9
Lysine	2.500	66.6	2.510	73.0
Methionine	0.550	85.1	0.560	87.5
Phenylalanine	1.080	78.4	1.140	80.2
Threonine	1.050	78.2	1.090	81.1
Tryptophan	0.410	94.4	0.420	95.5
Valine	1.490	81.4	1.570	84.7
Total	24.4		25.3	

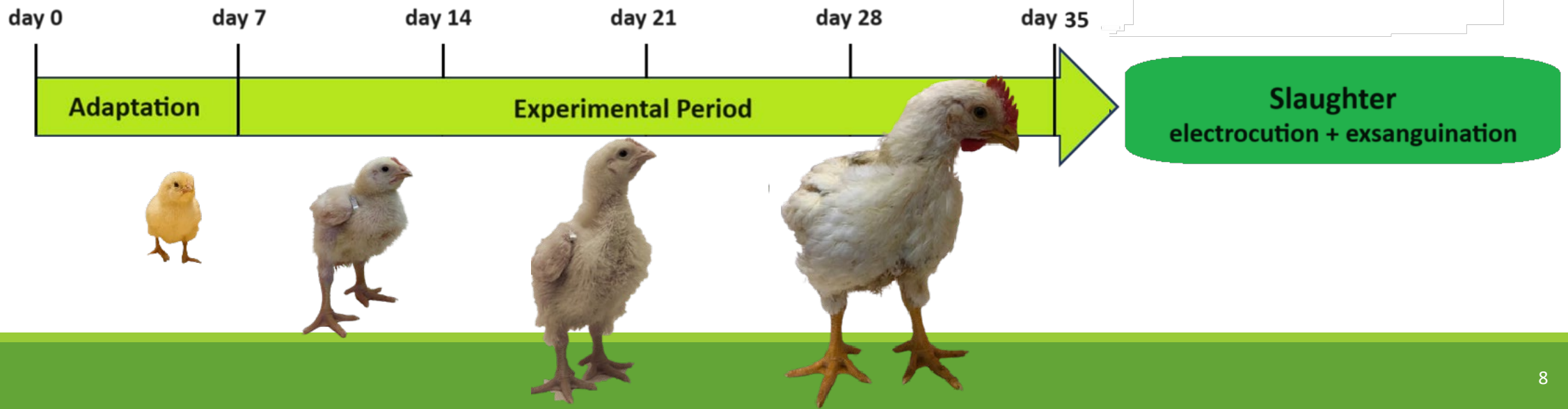
Mendes, et al., unpublished data

Live animal trial

120 one-day-old Ross 308 male chicks were distributed across four experimental diets:

- CTR – maize and soybean meal-based
- CHL – 20% *Chlorella vulgaris* incorporation
- CHLEnz – 20% *Chlorella vulgaris* incorporation + 0.30% pancreatine enzyme
- CHLExt – 20% extruded *Chlorella vulgaris* incorporation





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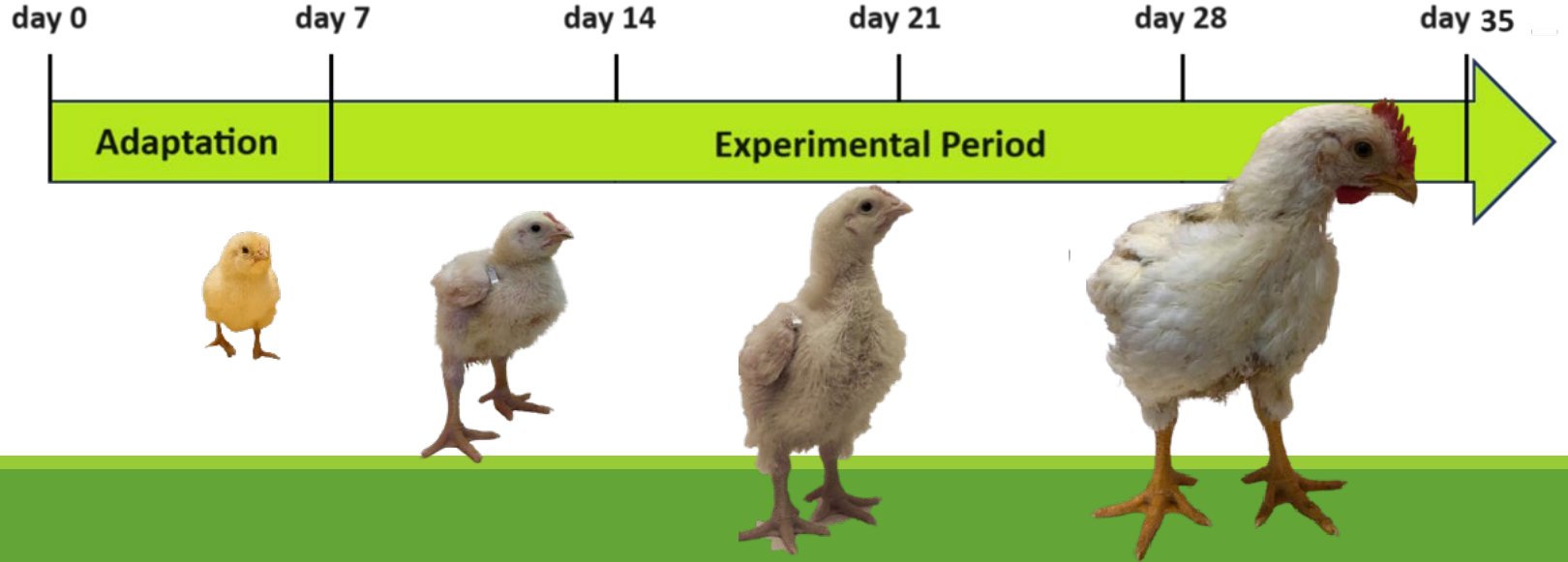
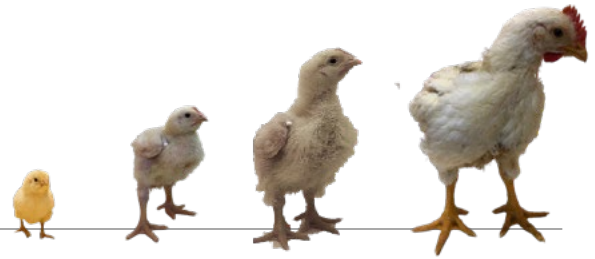


Weekly data:
- Live Weight
- Feed intake
- Weight gain
- Feed conversion ratio
- Beak condition
- Excreta quality

After slaughter:
- Organ measures
- Digesta samples
- Carcass yield
- Samples collection

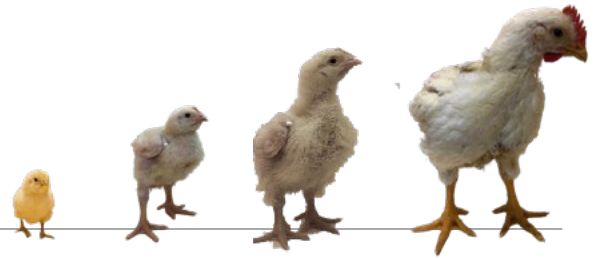
Effect on Performance

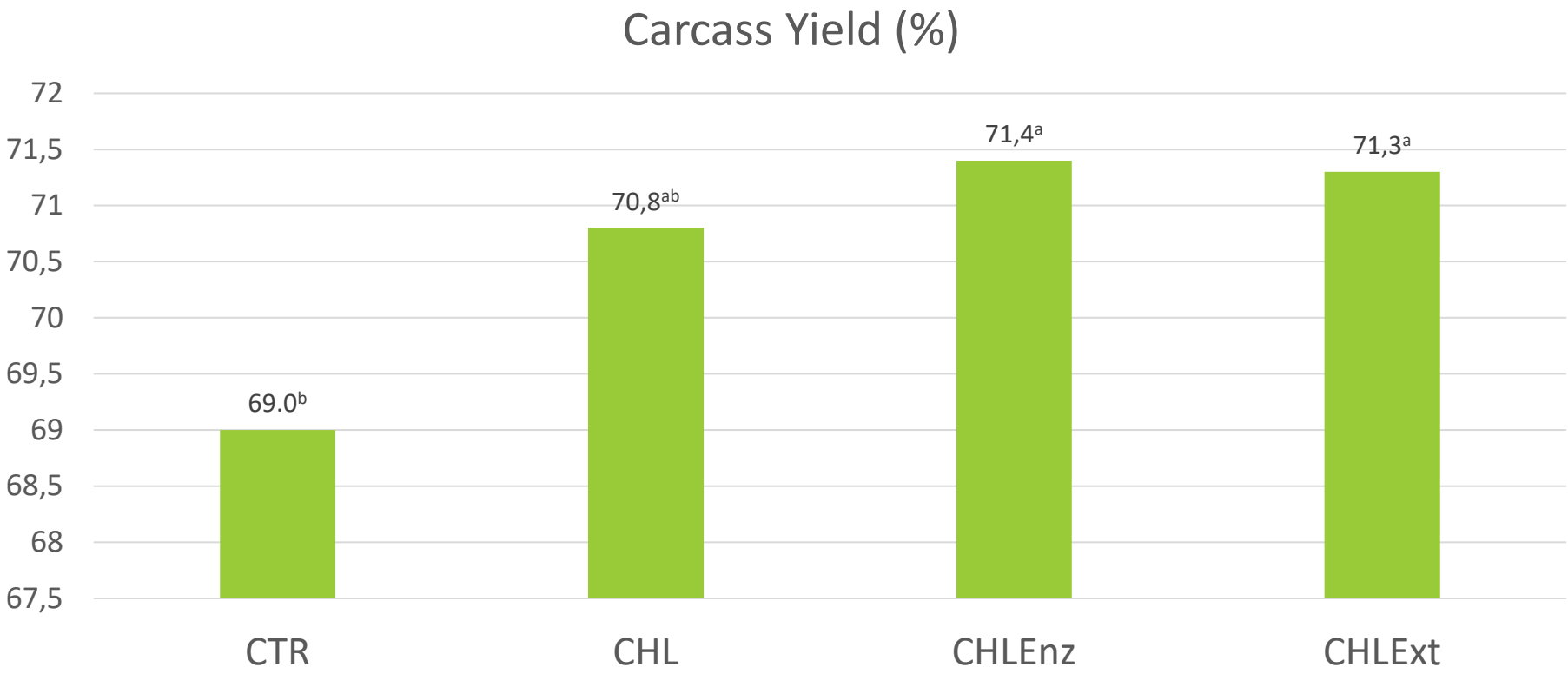


Experimental Period	CTR	CHL	CHLEnz	CHLExt	P-value
Initial Weight (g)	162	162	162	162	0.9999
Final Weight (kg)	1485^{a}	1254^{b}	1361^{ab}	1258^{b}	<.0001
Daily ingestion/EU (g)	229^{a}	188^{c}	207^{b}	200^{bc}	<.0001
ADG/animal (g)	47.3^{a}	39.0^{b}	42.8^{b}	39.1^{b}	<.0001
Feed Conversion Ratio	1.62^{b}	1.61^{b}	1.61^{b}	1.71^{a}	<.0001

ADG - Average Daily Gain
EU – Experimental Unit
a, b, c – averages in the same variable with distinct letters are significantly different ($P < 0.05$)

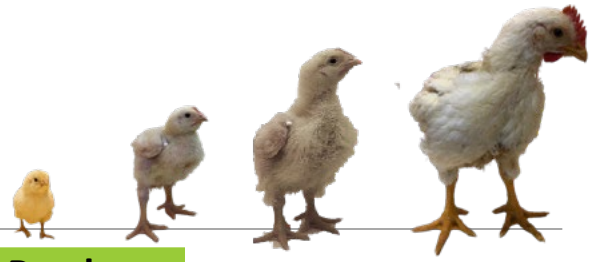
Effect on Performance





a, b – averages in the same variable with distinct letters are significantly different ($P < 0.05$)

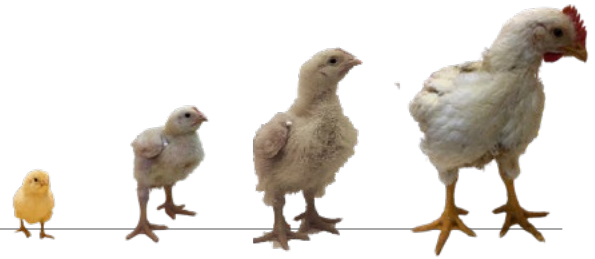
Effect on Performance

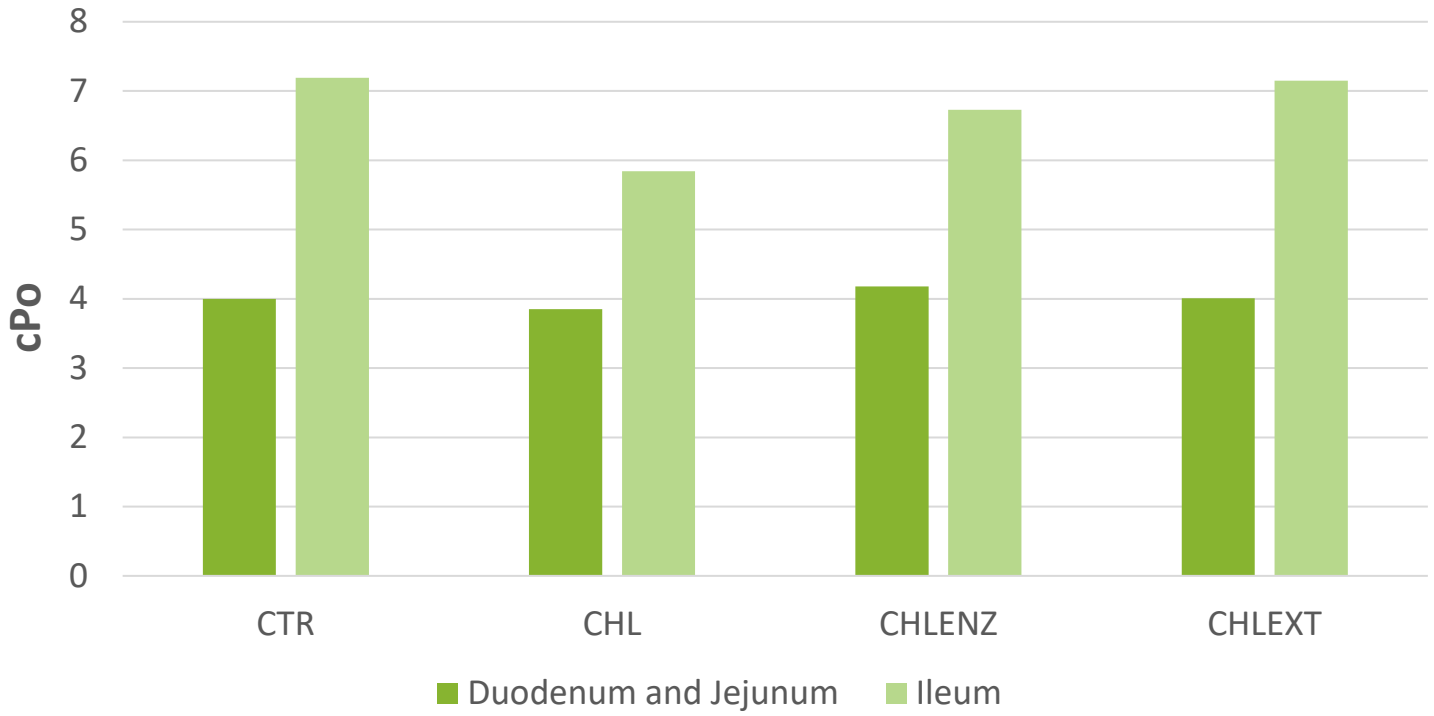


	CTR	CHL	CHLENZ	CHLEXT	P-value
Relative weight of GI tract. g/kg body weight					
Crop	3.36	3.55	3.49	3.48	0.9609
Proventriculus	5.01^{a}	4.22^{ab}	4.12^{b}	4.82^{ab}	0.0239
Liver	29.0^{a}	23.8^{ab}	22.1^{b}	23.3^{b}	0.0111
Duodenum	6.37	5.84	6.06	6.11	0.4273
Jejunum	11.8^{a}	10.0^{ab}	9.78^{b}	10.9^{ab}	0.0368
Ileum	10.3	9.57	9.66	9.38	0.5283
2 Caecum	4.84	5.15	4.87	5.08	0.7310
Relative length of GI tract. cm/kg body weight					
Duodenum	19.0^{b}	22.0^{a}	20.3^{ab}	21.8^{a}	0.0173
Jejunum	48.8^{b}	56.1^{a}	50.4^{b}	51.1^{a}	0.0003
Ileum	48.8^{b}	62.1^{a}	57.2^{a}	56.0^{a}	0.0001
Left Caecum	11.4^{b}	13.5^{a}	13.0^{ab}	13.1^{ab}	0.0414

a, b – averages in the same variable with distinct letters are significantly different ($P < 0.05$)

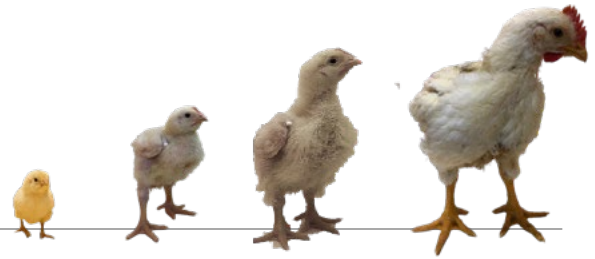
Effect on Digesta Viscosity





No significant differences ($P < 0.05$)

Conclusions



- Feed intake and average daily gain decreased across **all *C. vulgaris* diets** compared to the **CTR**.
- **CVEnz** and **CVExt** diets improved carcass yield relative to CTR.
- **CVEnz** yielded body weights and feed conversion ratios comparable to **CTR**, maintaining growth performance despite high *C. vulgaris* inclusion.
- Digesta viscosity was not significantly affected by diet, indicating no negative impact on gut health.

In the future…

1. Analyse beak condition and excreta quality
2. Determine meat quality effects
3. Proteomic analysis
4. Evaluate health parameters

Mendes, et al., unpublished data

Adapted from Garcia, et al., 2019

Thank you for your attention!

Rita Mendes

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