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MUTATEC
Bioconversion by insects



Hermetia illucens oil in dairy cow diet: effects on fatty acids of rumen digesta



P. Toral¹, **L. Rastello**^{1,2}, G. Hervás¹, L. Gasco³, M. Gerbelle⁴, M. Coppa³,
C. Lussiana³, A. Galli⁵, C. Guidou⁶, C. Trespeuch⁶, P. Frutos¹, M. Renna²

¹ Instituto de Ganadería de Montaña (CSIC-ULE), León, Spain

² University of Turin, Dept. Veterinary Sciences, Grugliasco (TO), Italy

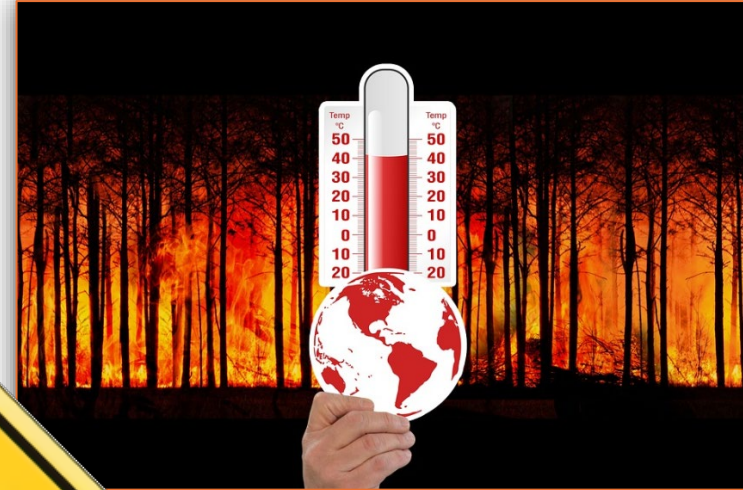
³ University of Turin, Dept. Agricultural, Forest and Food Sciences, Grugliasco (TO) Italy

⁴ Institut Agricole Régional, Aosta (AO), Italy

⁵ Ferrero Mangimi SpA, Farigliano (CN), Italy

⁶ Mutatec, Cavaillon, France

INTRODUCTION



INTRODUCTION

GLOBAL POPULATION RISE



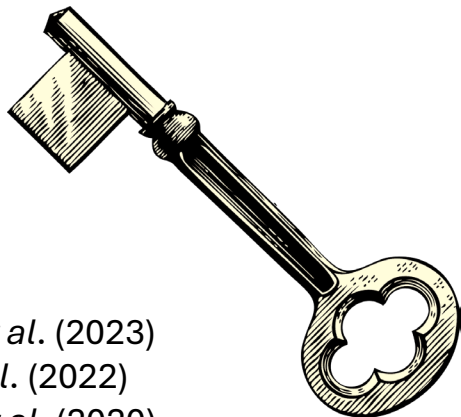
COMPETITION FOR FEW LIMITED NATURAL RESOURCES



INSECT-DERIVED PRODUCTS



- ↑ Proteins, amino acids and fats
- ↓ Carbon and Water Footprint
- ↓ GHG emissions
- ↓ Land use
- ↑ Circular Economy
- ↑ Food waste reuse



Renna *et al.* (2023)
Toral *et al.* (2022)
Gasco *et al.* (2020)

INTRODUCTION



FEW AVAILABLE PUBLISHED STUDIES ON THIS TOPIC



  							
Insects as feed - Regulation (EU) No 68/2013 on the Catalogue of feed materials and in accordance with Regulation (EC) No 999/2001 and Regulation (EC) No 1069/2009	Ruminant animals 	Aquaculture 	Poultry 	Pigs 	Pets 	Fur and other animals (e.g. zoo) 	Technical uses(e.g. cosmetic industry, bio-based fuels, production of other bio-based materials such as bioplastics) 
Insect proteins (under entry 9.4.1. 'Processed animal protein')		 **	 **	 **			
Insect fats (under entry 9.2.1 'animal fat')							
Whole insects (untreated) (under entry 9.16.2. 'terrestrial invertebrates, dead')					 ***	 ***	
Whole insects (treated- e.g. Freeze drying) (under entry 9.16.2. 'terrestrial invertebrates, dead')					 ***	 ***	
Live insects (under entry 9.16.1 'terrestrial invertebrates, live')		 *	 *	 *	 ***	 ***	
Hydrolysed insect proteins (under entry 9.6.1. 'Hydrolysed animal proteins')							

IPIFF (2022) Guide on good hygiene practices for EU producers of insects as food and feed

INTRODUCTION

Renna et al.
Journal of Animal Science and Biotechnology (2022) 13:138
<https://doi.org/10.1186/s40104-022-00792-2>

Journal of Animal Science and
Biotechnology

RESEARCH

Open Access

Full-fat insect meals in ruminant nutrition: in vitro rumen fermentation characteristics and lipid biohydrogenation



Manuela Renna¹, Mauro Coppa², Carola Lussiana³, Aline Le Morvan⁴, Laura Gasco^{3*}  and Gaelle Maxin⁴

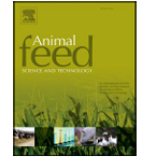
Animal Feed Science and Technology 285 (2022) 115222



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Insect oils and chitosan in sheep feeding: Effects on in vitro
ruminal biohydrogenation and fermentation

G. Hervás, Y. Boussalia, Y. Labbouz, A. Della Badia, P.G. Toral^{*}, P. Frutos

Instituto de Ganadería de Montaña (CSIC-University of León), Finca Marzanas s/n, 24346 Grulleros, León, Spain



We moved to *in vivo* trials!!



AIM OF THE STUDY

Vegetable oil



Hydrogenated Palm Fat

Evaluate the **effects** of replacing hydrogenated palm fat with *Hermetia illucens* oil on ruminal biohydrogenation



Insect oil



Hermetia illucens Oil

MATERIALS & METHODS

Experimental Design

- 26 Valdostana Red Pied cows
- Housed indoors in tie-stall conditions
- 2 dietary treatments (CTRL and HIO); 70:30 F:C ratio
- CTRL: mixed hay *ad libitum* + 5.4 kg/head × day concentrate with palm fat
- HIO: mixed hay *ad libitum* + 5.4 kg/head × day concentrate with HIO

Main nutrients	Concentrates	
	CTRL	HIO
DM (g/100g)	86.58	85.92
Ash	8.23	8.22
CP	19.93	20.03
EE	5.17	5.15
NSC ^a	38.34	40.73
aNDFom	28.39	25.93
ADFom	12.12	10.79
ADL	2.79	2.58
NE _L (Mcal/kg DM)	1.83	1.82

- DM, ash, CP, EE, NSC^a, aNDFom, ADFom, ADL, NE_L (Mcal/kg DM) (2000; 2003)
- Fatty acids

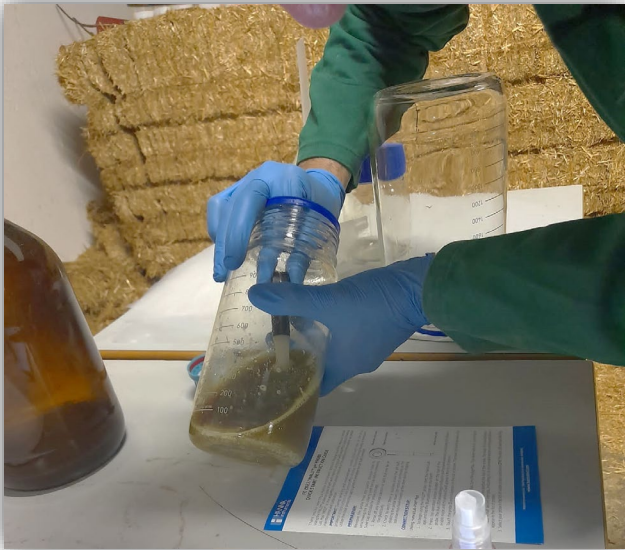
Ingredients (g/100g as fed)	Concentrate
Corn	30.10
Dehulled sunflower 36% CP	16.80
Wheat bran	16.20
Wheat middlings	10.80
Barley	8.00
Soybean meal 44% CP	5.90
Palm fat / HI oil	3.00
Pitted carobs	3.00
Calcium carbonate	2.05
Cane molasses	1.40
Sodium chloride	1.00
Dolomite	1.00
Sodium bicarbonate	0.50
Vit mix	0.25
Total	100

MATERIALS & METHODS

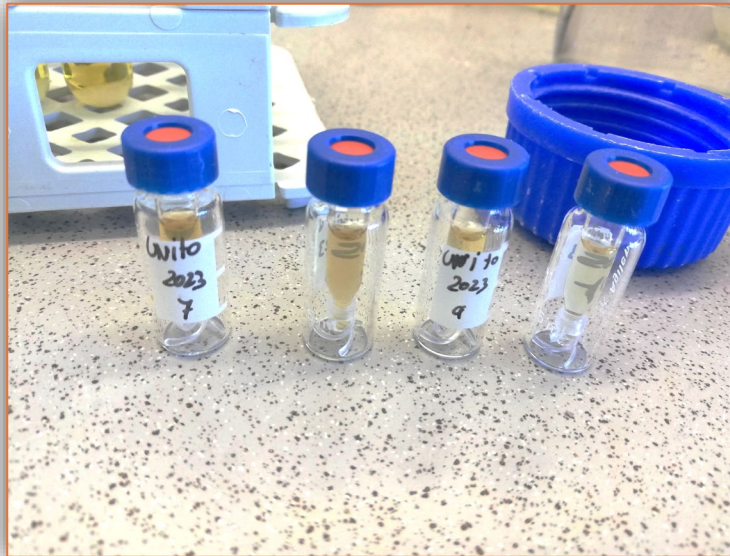


Instituto de Ganadería de Montaña
(León, Spain)

Samples collection



Preparation of ruminal FA samples



Gas-chromatography analyses



Toral *et al.* (2010)
Shingfield *et al.* (2003)
de la Fuente *et al.* (2015)

Statistical Analysis

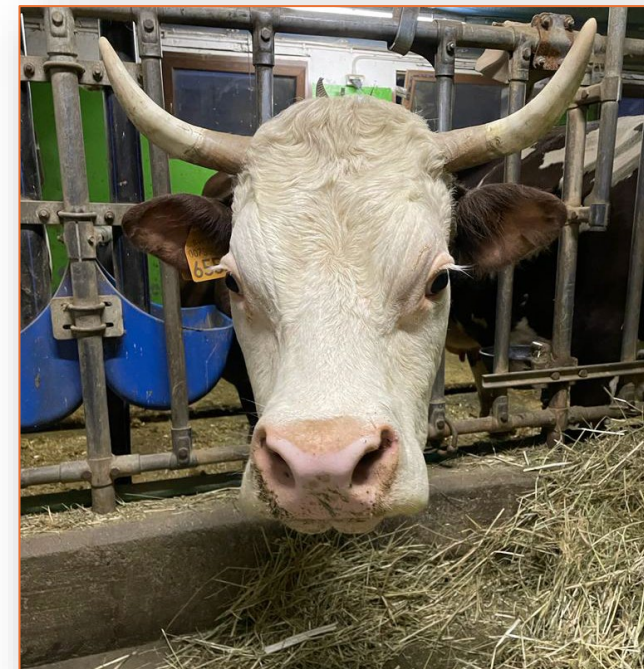
- MIXED procedure model with SAS v. 9.4 (SAS Inst. Inc, Cary, NC)
 - Fixed effect → Diet
 - Covariate → Collected measures at day 0

RESULTS & DISCUSSION

Intake of fatty acids (g/head × day) from the experimental diets



Fatty acids	Dietary Treatment		SEM	P
	CTRL	HIO		
C12:0	8.11	16.57	0.666	<.001
C14:0	5.46	6.52	0.092	<.001
C16:0	94.46	79.51	1.222	<.001
C18:0	41.40	27.45	1.085	<.001
C18:1 c9	37.02	41.02	0.377	<.001
C18:2 n-6	94.36	100.34	0.779	<.001
C18:3 n-6	0.29	0.26	0.006	<.001
C18:3 n-3	39.56	39.31	0.770	0.667
CLA c9t11	n.d.	0.37	-	-
Σ SFA ¹	150.33	130.84	1.580	<.001
Σ MUFA ²	44.05	48.95	0.484	<.001
Σ PUFA ³	134.70	140.51	1.477	0.006



¹Other: C20:0.

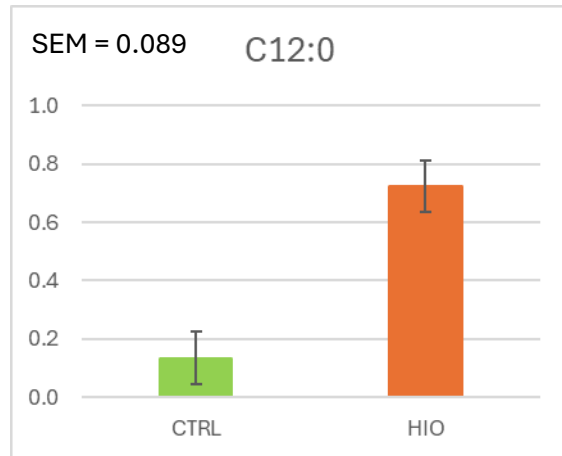
²Others: C16:1 t3 + C16:1 c9 + C16:1 c11 + C18:1 c11 + C20:1 c9.

³Other: C20:2 n-6.

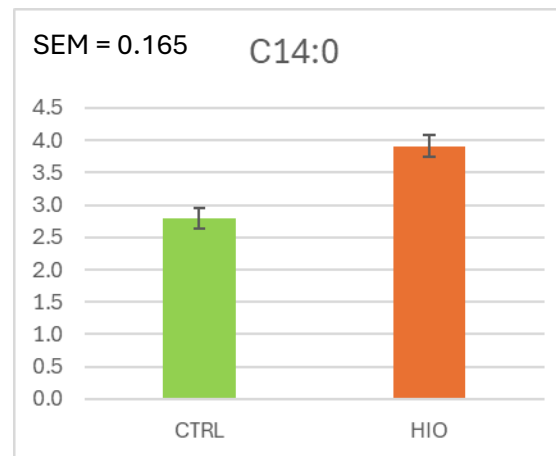
CTRL, concentrate containing Hydrogenated Palm Fat; HIO, concentrate containing *Hermetia illucens* Oil; n.d., not detected.

RESULTS & DISCUSSION

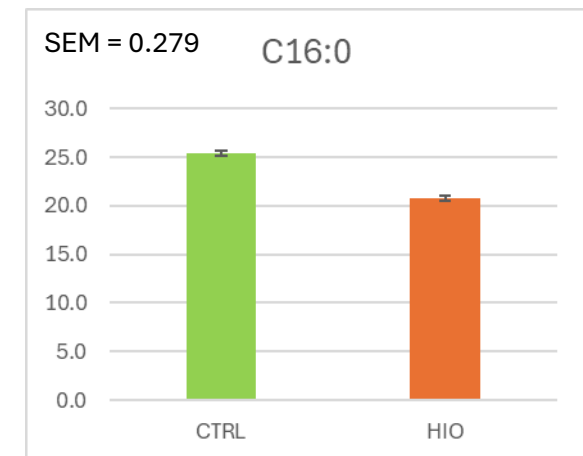
Primary dietary SFA (g/100g FA) of rumen digesta of dairy cows fed concentrates containing hydrogenated palm fat (CTRL) or *Hermetia illucens* oil (HIO)



$P < 0.001$



$P < 0.001$

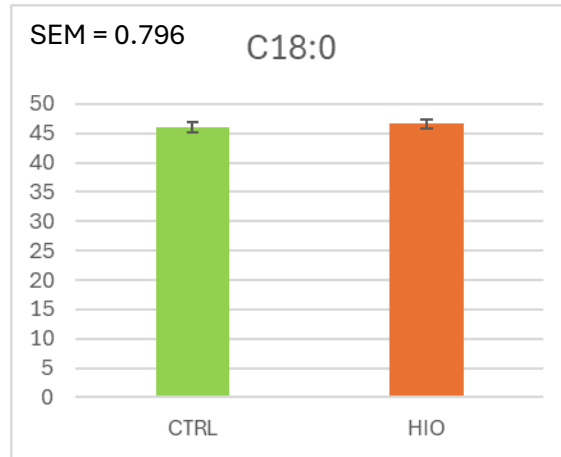


$P < 0.001$

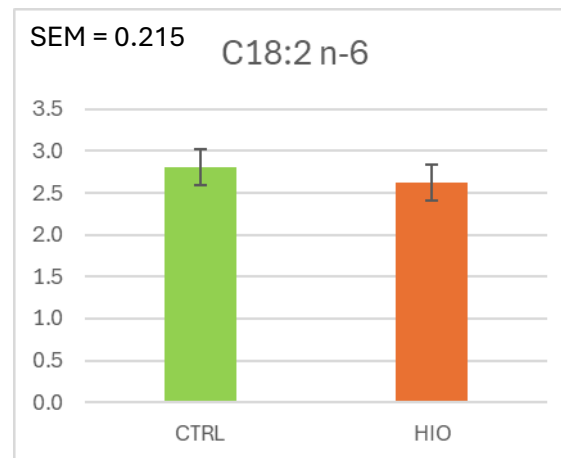
Dietary saturated fatty acids are NOT subjected to modifications inside the rumen

RESULTS & DISCUSSION

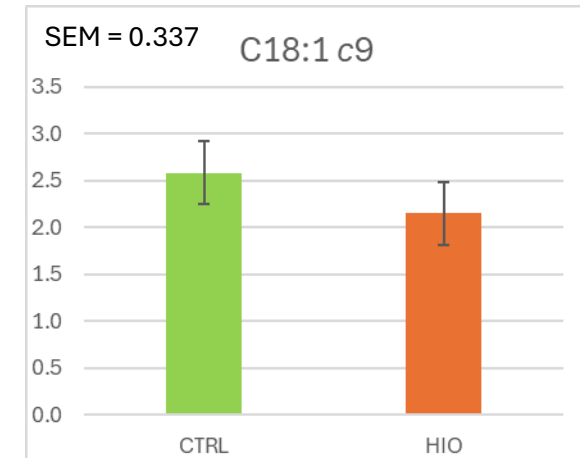
Individual FA (g/100g FA) of rumen digesta of dairy cows fed concentrates containing hydrogenated palm fat (CTRL) or *Hermetia illucens* oil (HIO)



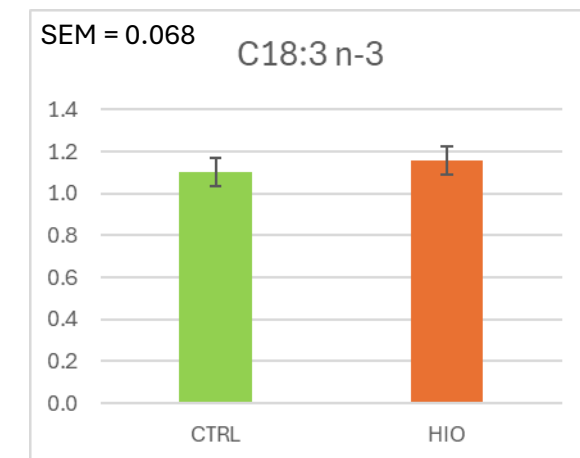
$P > 0.05$



$P > 0.05$



$P > 0.05$

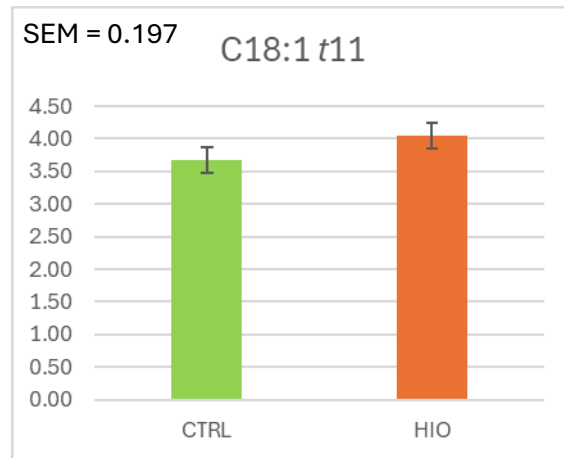


$P > 0.05$

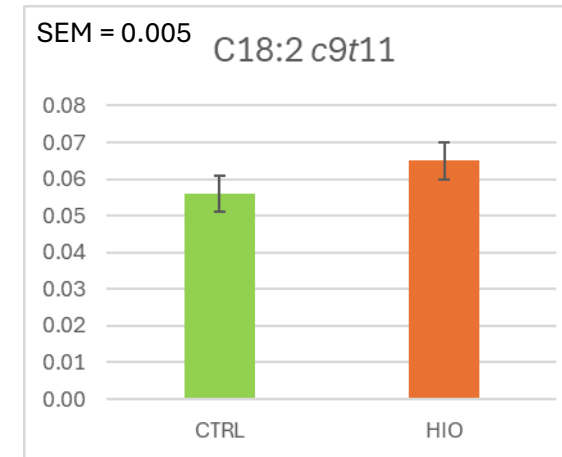


RESULTS & DISCUSSION

Vaccenic and rumenic acids (g/100g FA) of rumen digesta of dairy cows fed concentrates containing hydrogenated palm fat (HPF) or *Hermetia illucens* oil (HIO)



$P = 0.066$



$P = 0.071$

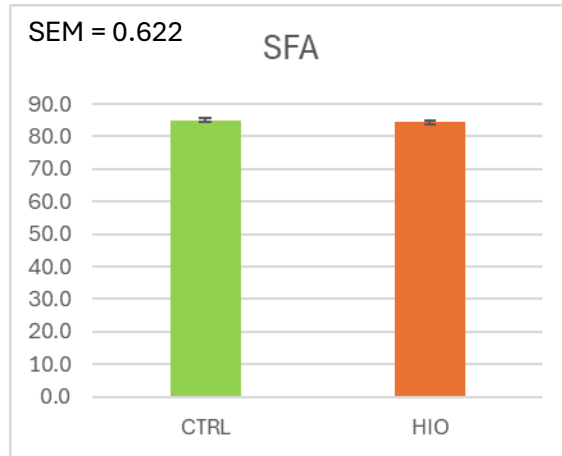
CLA precursor

Most abundant CLA found in nature

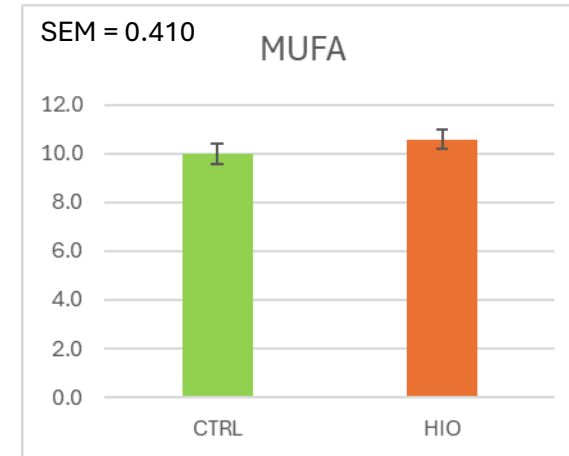
Found in ruminant-derived food products

RESULTS & DISCUSSION

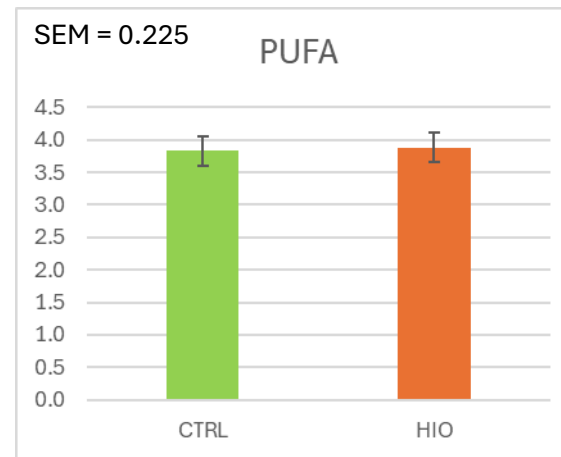
Groups of FA (g/100g FA) of rumen digesta of dairy cows fed concentrates containing hydrogenated palm fat (HPF) or *Hermetia illucens* oil (HIO)



$P > 0.05$



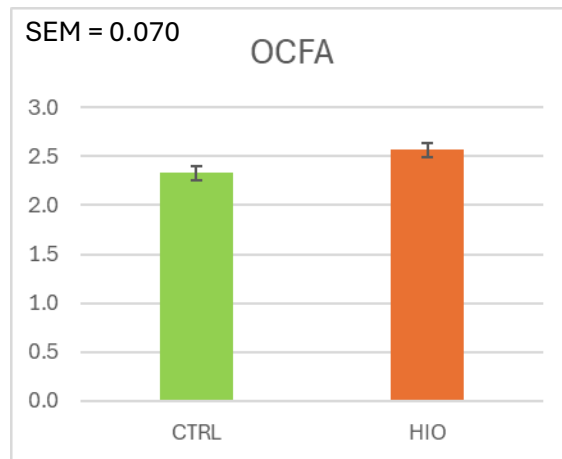
$P > 0.05$



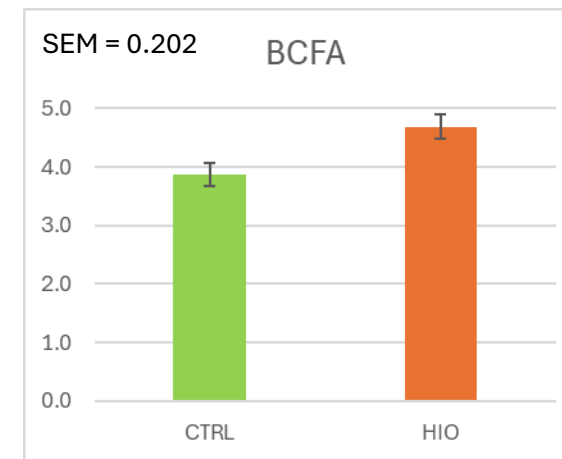
$P > 0.05$

RESULTS & DISCUSSION

Groups of FA (g/100g FA) of rumen digesta of dairy cows fed concentrates containing hydrogenated palm fat (HPF) or *Hermetia illucens* oil (HIO)



$P < 0.01$



$P = 0.001$

OBCFA are synthesized by rumen bacteria

OBCFA possess health-promoting effects comparable to those of CLAs

CONCLUSIONS & FURTHER INVESTIGATIONS

Sustainability

Oil crops:

- High greenhouse gas emissions
- Deforestation
- Biodiversity loss
- Abusive labor conditions

Beyer *et al.* (2020)
Russell (2020)

Animal performance

Insect oil:

- Valuable substitute with no detrimental effects on ruminal biohydrogenation

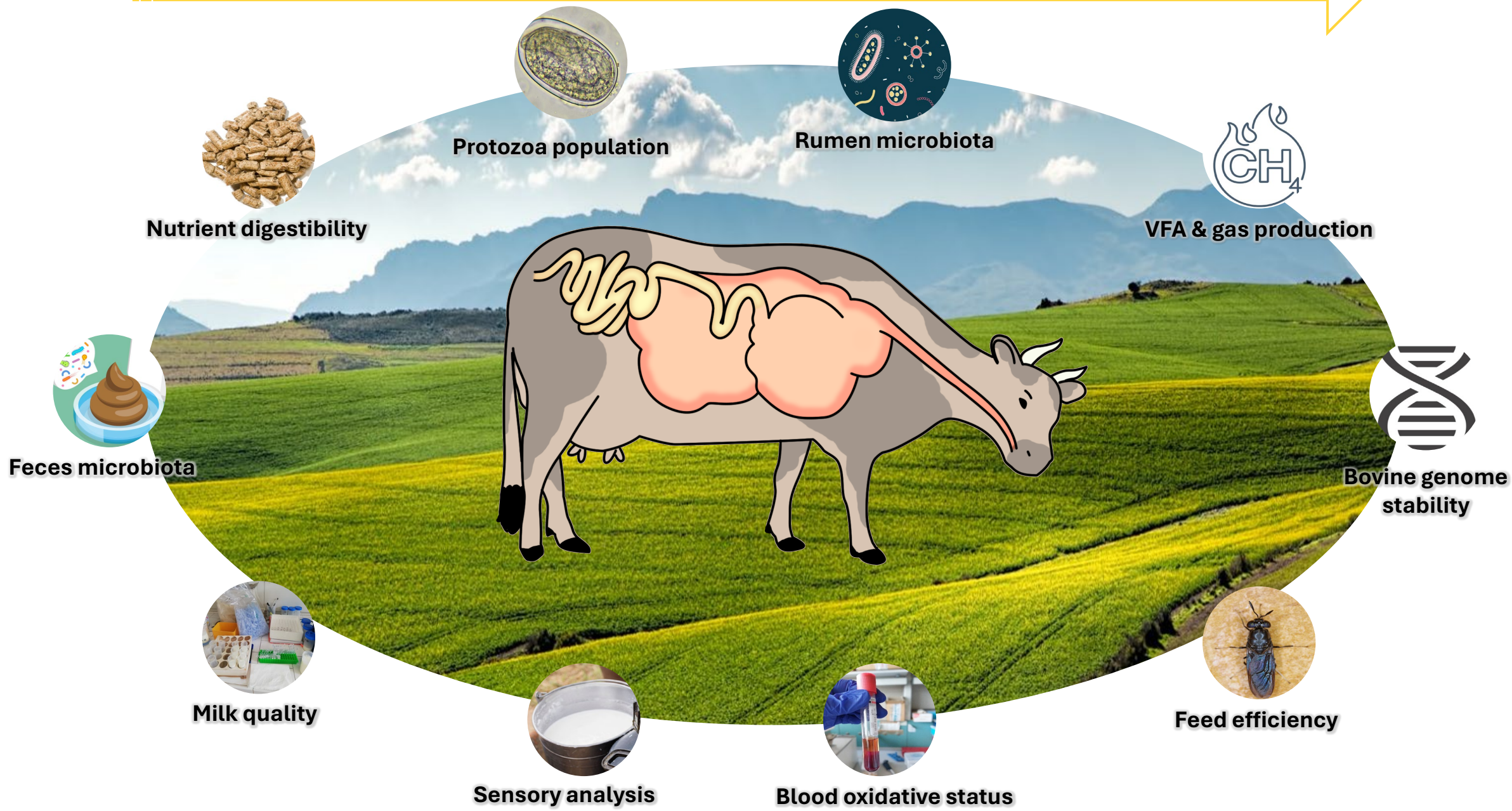
Effects on human health

- *Hermetia illucens* oil → increase vaccenic and rumenic acids concentration in ruminal digesta → higher formation of CLAs in mammary gland and milk

Toral *et al.* (2024)



CONCLUSIONS & FURTHER INVESTIGATIONS





The 75th EAAP Annual Meeting

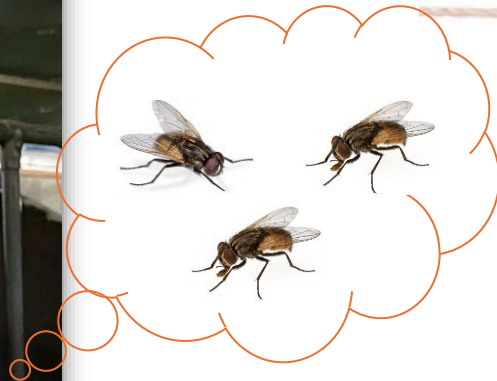
1/5 September 2024 - Florence, Italy



Junta de
Castilla y León



Hermetia illucens for a Green Agriculture



PhD Student
Lara Rastello
lara.rastello@unito.it

