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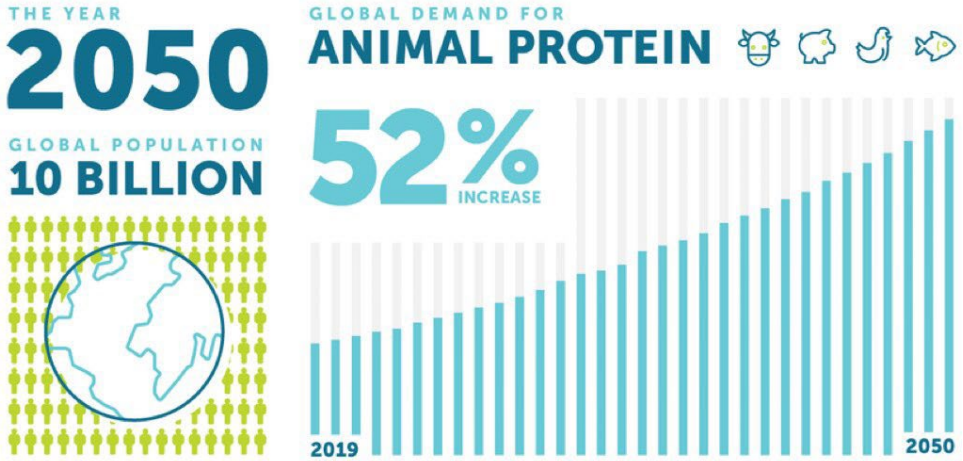
Fat chemical characteristics of the Black soldier fly larvae fed different diets

M. Tognocchi, S. Tinagli, G. Foggi, A. Serra, M. Mele, **G. Conte**

PLAS TEAM
Pisa Livestock farming, Animal food quality, and Sustainability

Introduction



Feed shortage
Producing with less soil
Reduction of sustainability

High nutritional value

Circular economy

Reduced soil requirement

Drought-resistant crops
Halophyte crops
Alternative sources (i.e. insects)

Introduction – Lipid composition

According to the nutritional composition of the insects, **lipids represent the second largest component**, behind only the protein content

Fat composition depends by several aspects:

- ✓ Feed
- ✓ Life stage
- ✓ Specie
- ✓ Origin

Aim of the study

- ✓Investigation of different type of organic substrate waste on lipid profile of Black Soldier Fly Larvae (BSFL)
- ✓Comparison of lipid profile of two different BSFL populations

Experimental design

4 batch (80 larves) per substrate

4th instar larval stage for both populations

4 batch (80 larves) per substrate

Reared on

Control
6 g poultry feed
9 mL H_2O

Meat
4.5 g chicken breast
1.5 g poultry feed
9 mL H_2O

Fruit
1.5 g banana
1.5 g apple
1.5 g orange
1.5 g poultry feed
9 mL H_2O

Vegetable
1.5 g potato
1.5 g sweet pepper
1.5 g celery
1.5 g Poultry feed
9 mL di H_2O

Mix
1.5 g chicken breast
0.5 g banana
0.5 g apple
0.5 g orange
0.5 g potato
0.5 g sweet pepper
0.5 g celery
1.5 g poultry feed

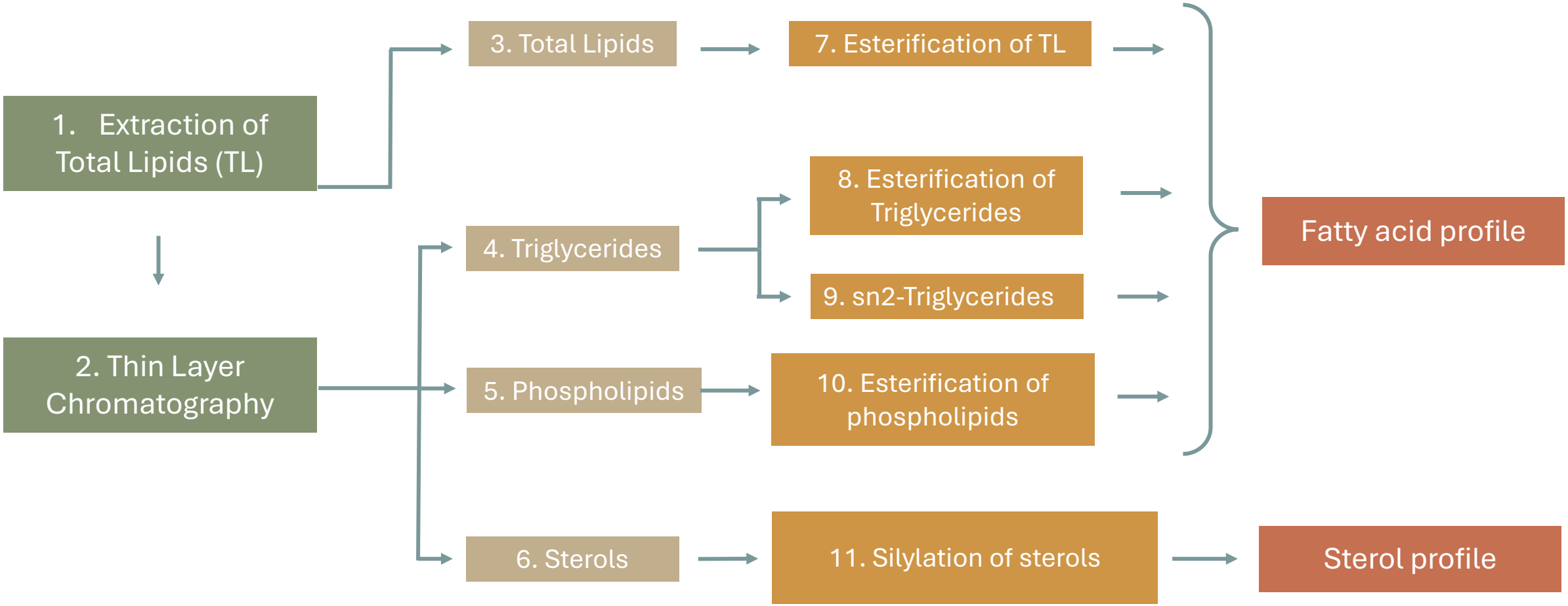
All substrates were characterized for chemical and fatty acid composition

Substrate composition

g/100g of substrate

	g/100g of substrate				
	Control	**Meat**	**Fruit**	**Vegetable**	**Mix**
Moisture	56.71	70.68	65.46	74.31	70.77
Proteins	3.42	20.80	1.29	2.49	13.90
Lipids	1.14	4.80	1.09	0.58	4.81
Carbohydrates	38.73	3.72	32.66	21.82	10.52
C16:0	0.13	0.13	0.12	0.14	0.13
C18:0	0.02	0.05	0.02	0.03	0.04
C18:1c9	0.28	0.22	0.22	0.23	0.23
C18:2n-6	0.47	0.35	0.38	0.39	0.37
C18:3n-3	0.03	0.02	0.03	0.03	0.03

Materials and Methods



Statistical Analysis

Univariate approach

$$y_{ijk} = \mu + S_i + C_j + S_i x C_j + b_k + \varepsilon_{ijk}$$

y_{ijk}= fatty acids and sterols;

μ = mean;

S_i = fixed effect of i^{th} substrate (Control; Meat; Fruit; Vegetable; Mix);

C_j = fixed effect of the j^{th} strain (Italy, Greece);

b_k = random effect of the k^{th} batch of larvae (40 levels);

ε_{ijk} = random error.

Multivariate approach
(Principal Component Analysis)

$$y_i = a_{1i}X_1 + a_{2i}X_2 + \ldots + a_{ni}X_n$$

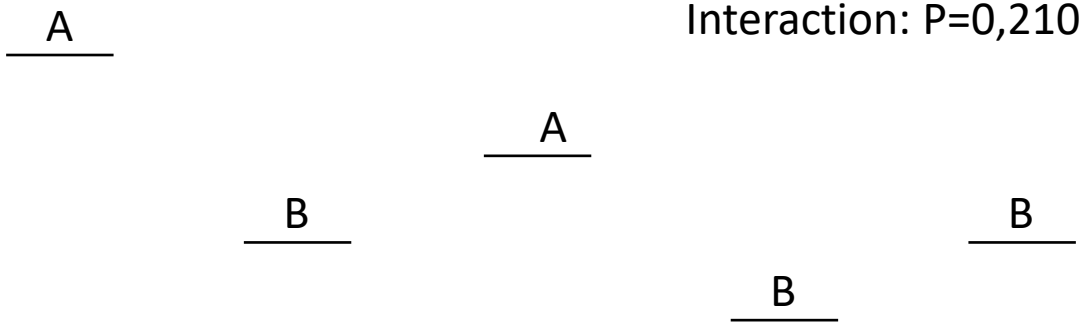
y_i = principal component

a_{ij} = coefficient of the eigenvalue

X_i = original variable

Results – Lipid content

Substrate: P<0,001
Strain: P<0,001
Interaction: P=0,210



- ✓ Significant differences between the two strains
- ✓ Larvae reared on Control and Fruit diet had the highest lipid content

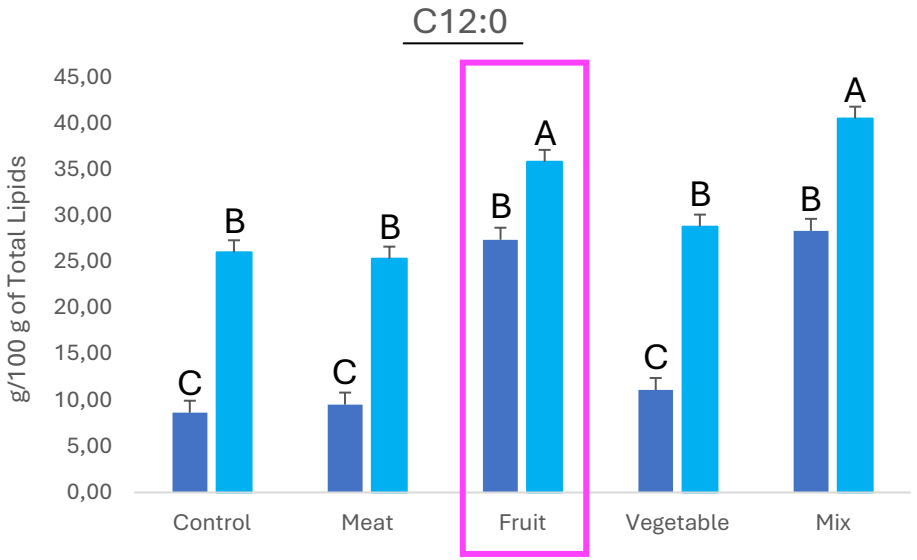
ITA

GRE

Results – Total lipids

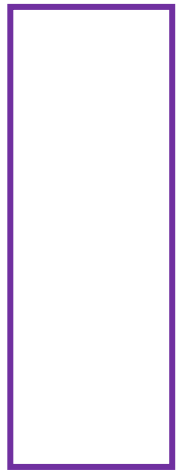
The fruit-based substrate further increases the C12:0 content

Considering the beneficial effects on intestinal health and microbial growth inhibition, C12:0 could improve the performance and welfare of pigs and poultry (Spanghers et al., 2017).



Vegetable substrate promotes the increase of CLA content.

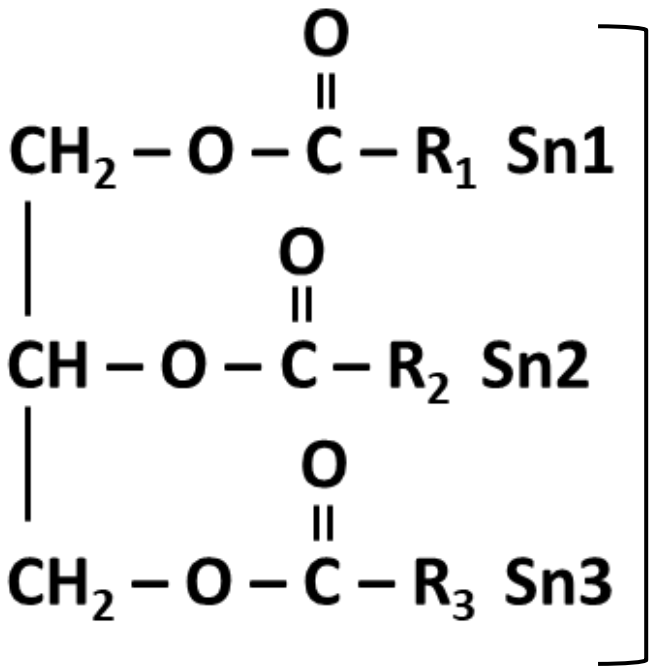
According to Meynadier et al. (2018), BSFL have the Δ9-desaturase, an enzyme responsible for desaturation of C18:1t11 to C18:2c9t11.



ITA

GRE

Results – sn2 position



C12:0 and C14:0

CLA
with fruit or meat in the substrate

C18:1t11
with fruit or vegetable on the substrate

C10:0, C20:0, C20:1c11, CLA, C21:0, C18:4n3, C20:2n6, C20:3n6, C20:4n6, C22:0, C20:5n3 e C22:5n3

Results – Sterols

ITA

GRE

Results – PCA

Blue= Triglycerides
Red = Phospholipids

◆●■▲▼ ITA
◇○□△▽ GRE

■ Control
● Meat
▲ Fruit
◆ Vegetable
▼ Mix

Conclusion

- the **fat composition** of the BSFL was affected by the **diet** and the **population**, demonstrating the possibility to modify the lipid profile, adapting it to technological and feed needs
- our results confirmed **the ability of BSFL to utilize food waste**, accumulating molecules with nutritional properties, such as **lauric acid, CLA and phytosterols**, in the lipid fraction
- the differences observed are linked to a **different lipid metabolism** dictated by a **different genetic adaptation** which may be due to various conditions that are not easily explained
- the **larvae** may be enriched in different **fatty acids** on the basis of an excellent source of nutrients for fish feeding and other species with an economic interest, which can contribute substantially to obtaining high quality animal products for human consumption, successfully contributing to human health

Thank you for your attention

giuseppe.conte@unipi.it

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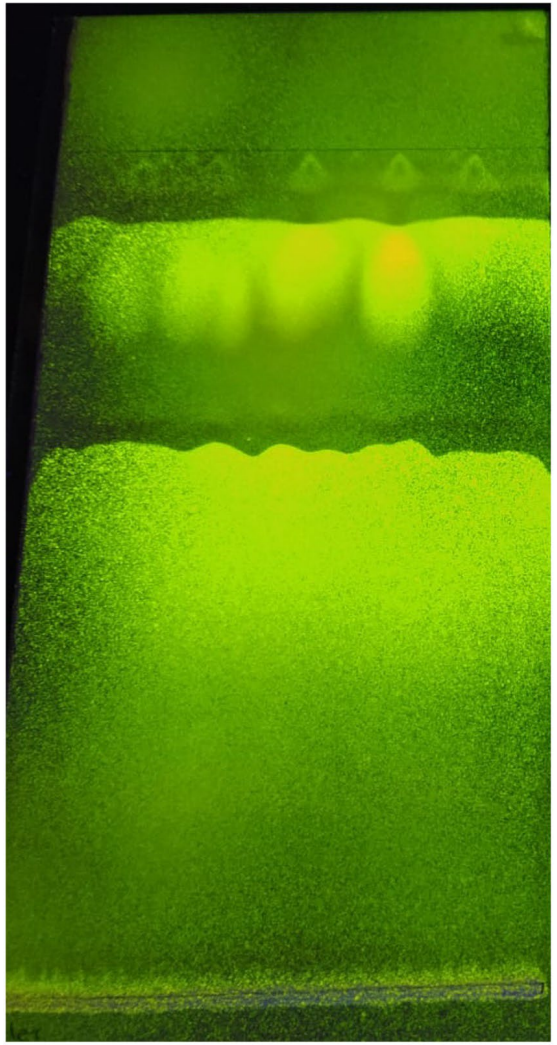
Supplementary Material



Triglycerides

Free Fatty Acids

Free Sterols

Phospholipids

Supplementary Material

Fatty Acid	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Eigenvalue	5.89	4.65	3.30	2.55	2.04	1.28	1.15	1.10
Variance Explained (%)	20.80	16.40	11.69	9.03	7.22	4.52	4.08	3.90
Cumulative Variance (%)	20.80	37.20	48.89	57.93	65.14	69.67	73.74	77.64

Supplementary Material

Rearing protocol for the larvae

- ✓ Laboratory conditions: 28 °C, 60% RH, and photoperiod 16:8 = L:D)
- ✓ After oviposition, the eggs were retrieved using a wet brush with a fine tip from the support, which was a groove of wooden measuring 20 x 3 x 1 cm.
- ✓ They were then placed in plastic boxes measuring 29 x 18 x 9 cm, containing the artificial diet made of water and chicken feed in a 40:60 ratio, respectively.
- ✓ Gauze was used to cover each plastic box to maintain humidity. As soon as the first pupae emerged, the box was placed within a cage (47.5 x 47.5 x 93 cm, model BugDorm-4M4590DH) for the emergence of the new adults.
- ✓ A plant branch was added to the cage along with unlimited supplies of water and sugar to enhance the amount of surface area available for the adults to lean on and engage in their mating behavior, known as ‘‘lekking”.