Nutritional value of defatted larvae meal & whole larvae from black soldier fly

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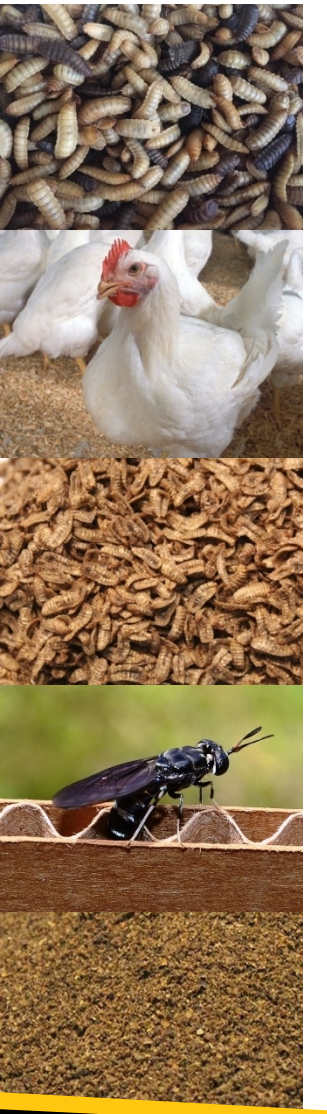
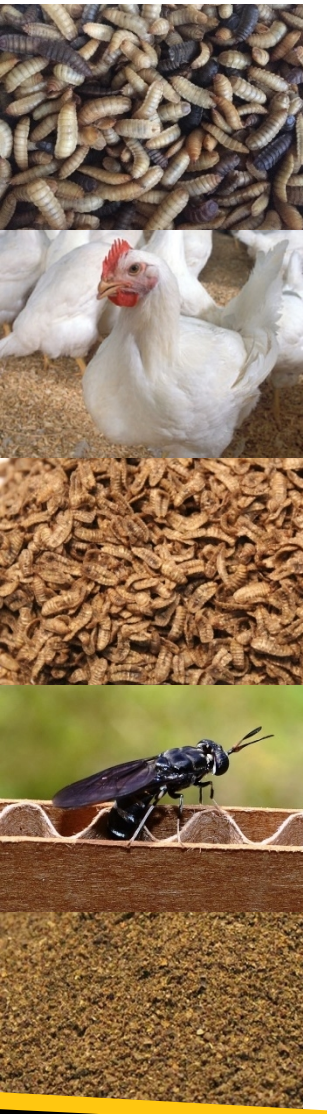
BSF larvae: A promising protein source



- **EU protein autonomy is a challenge** (*Farm to Fork Strategy*)
- **Insect meals, including black soldier fly (BSF):**
  - Protein-rich source to replace soybean meal
  - Local production
  - Circular economy benefits (recycling organic by-products/wastes)
- **In poultry, whole BSF larvae can also be used to improve animal welfare** (Bongiorno *et al.*, 2022; Ipema *et al.*, 2020)

⇒ Nutritional value of BSF products: whole larvae *vs.* protein meal?

Experimental design



- **48 Ross 308 male broilers**
- D0-D13: Collective rearing on litter → **D14-D25: Individual cages**

- **3 BSF products tested:** Larvae meal (**LM**), fresh larvae (**FL**) & dry larvae (**DL**)
- **4 experimental diets** (12 cages / diet)

Control
- Complete pellets

ExpLM

- Complete pellets
- 75% **Control** +25% **LM**

ExpFL

- 75% **Control**
- 25% **FL on top**

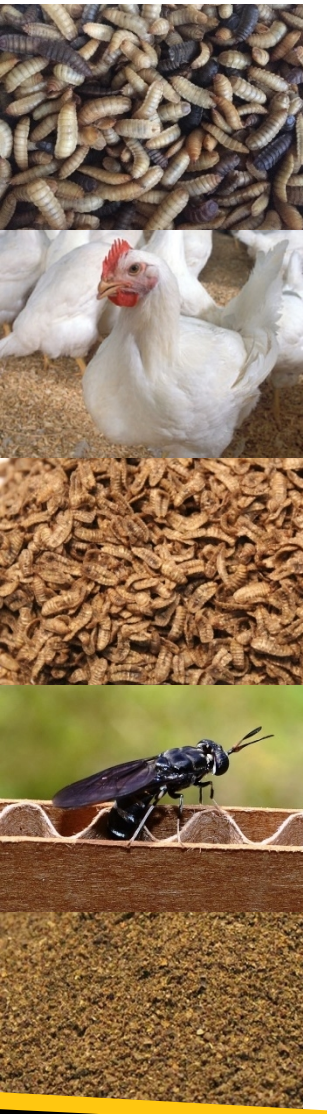
} % of theoretical DM daily intake

ExpDL

- 75% **Control**
- 25% **DL on top**

} % of theoretical DM daily intake

Composition of control diet & BSF products



Control diet		
Inclusion rates (%)	Maize	47.17
	Wheat	20.00
	Soybean meal	24.80
	Soybean oil	3.68
	Free amino acids	0.60
	TiO_2 (indigestible marker)	0.60
	Other (minerals, premix…)	3.15
Nutritional values (%)	AMEn** (kcal/kg)	2990
	Crude protein*	18.6
	Crude fat	6.0
	Digestible lysine	10.0

		BSF feedsutffs		
		Larvae meal	Fresh larvae	Dry larvae
	Dry matter (%)	95.9	30.2	97.1
% of dry matter	Crude fat	9.8	**32.8**	**34.7**
	Crude protein*	**57.2**	38.9	37.6
	Total Lys	**3.39**	1.81	1.45
	Total Met+Cys	**1.67**	1.05	1.11
	Total Thr	**2.11**	1.64	0.99
	Total Trp	0.31	**0.36**	**0.37**
	Total Val	**3.11**	2.40	1.26
	Total Arg	**2.69**	2.11	1.70
	Total P	0.11	**0.90**	**0.83**
	Total Ca	0.16	**2.46**	**1.26**

* AMEn : Apparent Metabolizable Energy corrected to zero N retention
** calculated as total N x 6.25

Measurements & Calculations

Animal performance

- Body weight
- Daily feed intake (pellets & larvae)

Control diet & BSF products

- Dry matter (DM)
- Crude protein* (CP)
- Crude fat (CF)
- Gross energy (GE)
- Amino Acids (AA)
- Titane (Ti)

Faeces

- Dry matter
- Crude protein*
- Crude fat
- Gross energy

Ileal digesta

- Titane
- Amino Acids

$$TTAD_X = \frac{X_{intake} - X_{faeces}}{X_{intake}} \times 100$$

- **Apparent Digestibility (TTAD)** (DM, crude prot. & fat, energy)
- **AMEn****

$$AMEn = \frac{GE_{intake} - GE_{faeces}}{Feed\ intake} - Correction_{N\ retention}$$

$$SID\ AA_{Diet} = 100 - \frac{[Ti]_{Diet} \cdot [AA]_{Digesta}}{[Ti]_{Digesta} \cdot [AA]_{Diet}} + Correction_{AA\ basal\ losses}$$

- **Standardized Ileal Digestibility of Amino Acids (SID AA)**

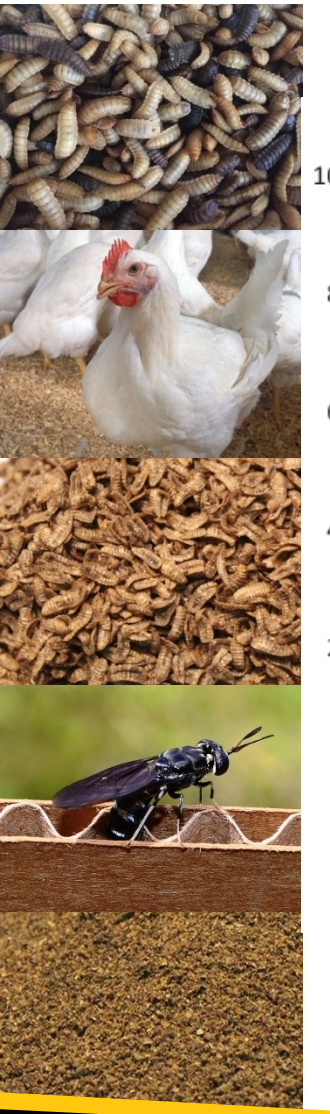
$$Dig_{Feedstuff} = \frac{Dig_{Diet} - (1 - I) \cdot Dig_{Control}}{I}$$

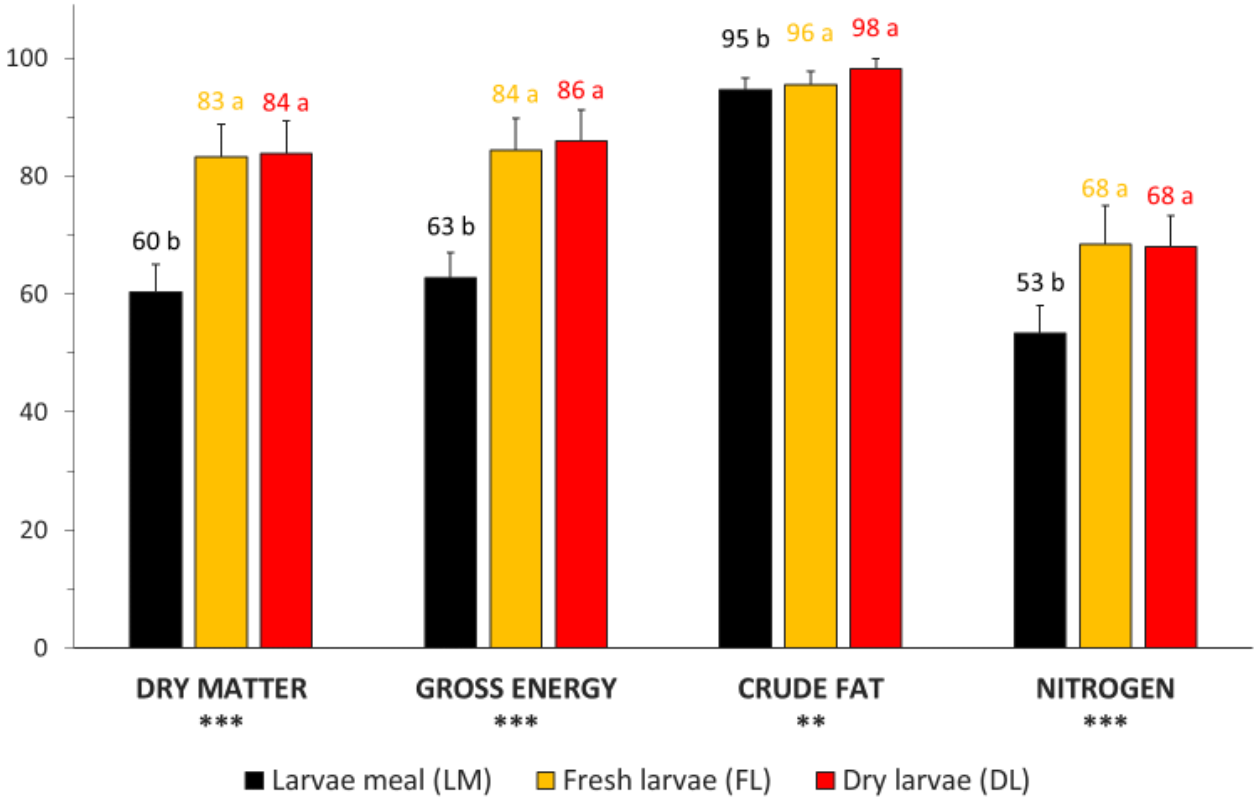
with $I = Intake_{Feedstuff} / Intake_{Diet}$

* calculated as total N x 6.25

** AMEn : Apparent Metabolizable Energy corrected to zero N retention

Total Tract Apparent Digestibility (%)





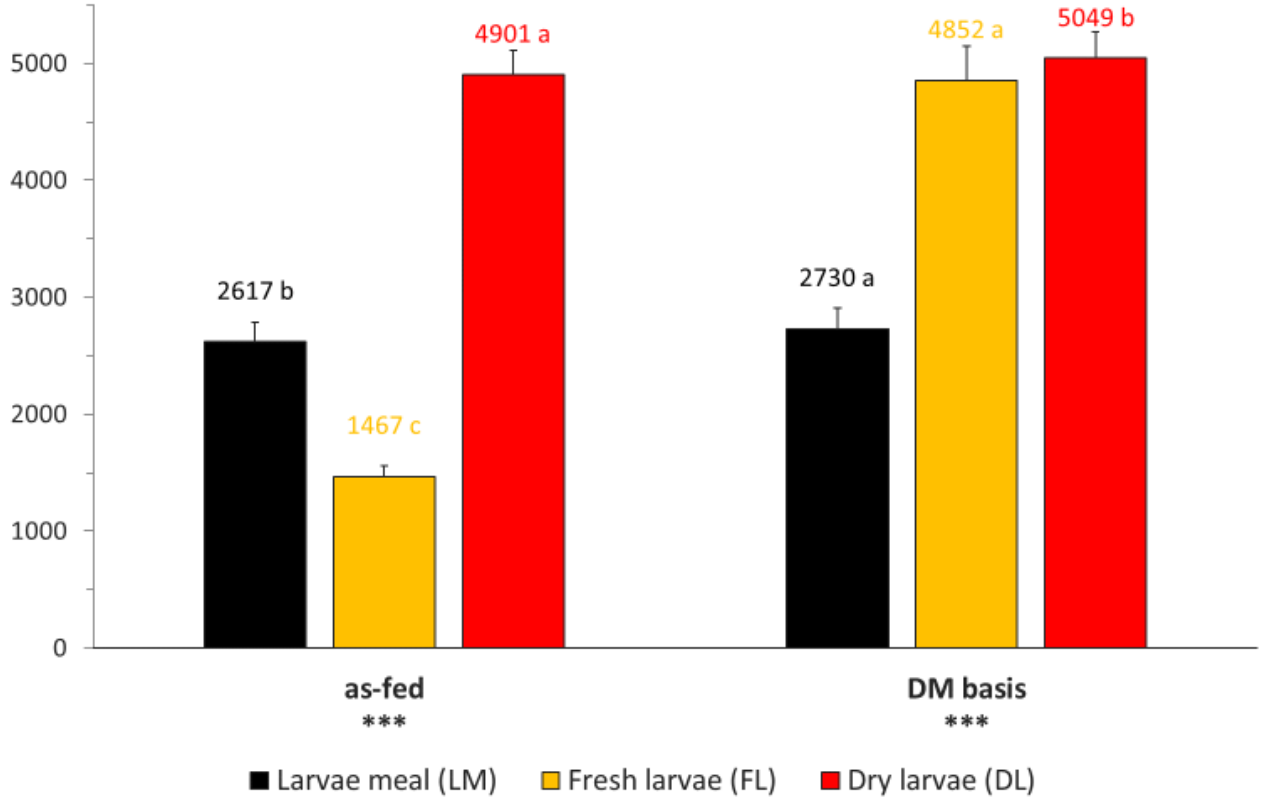
- **Large ↘ in DM, GE & N digestibility for LM** (-15 to 23 pts *vs.* FL/DL)

⇒ **Chitin effect?** (Marono *et al.*, 2015; Schiavone *et al.*, 2017)

- **Similar values for FL & DL** (no effect of drying process)

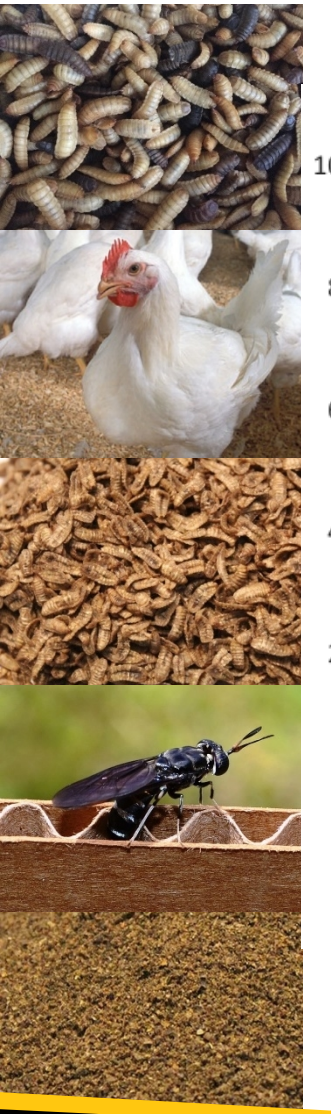
- **Crude fat is highly digestible** in all BSF products

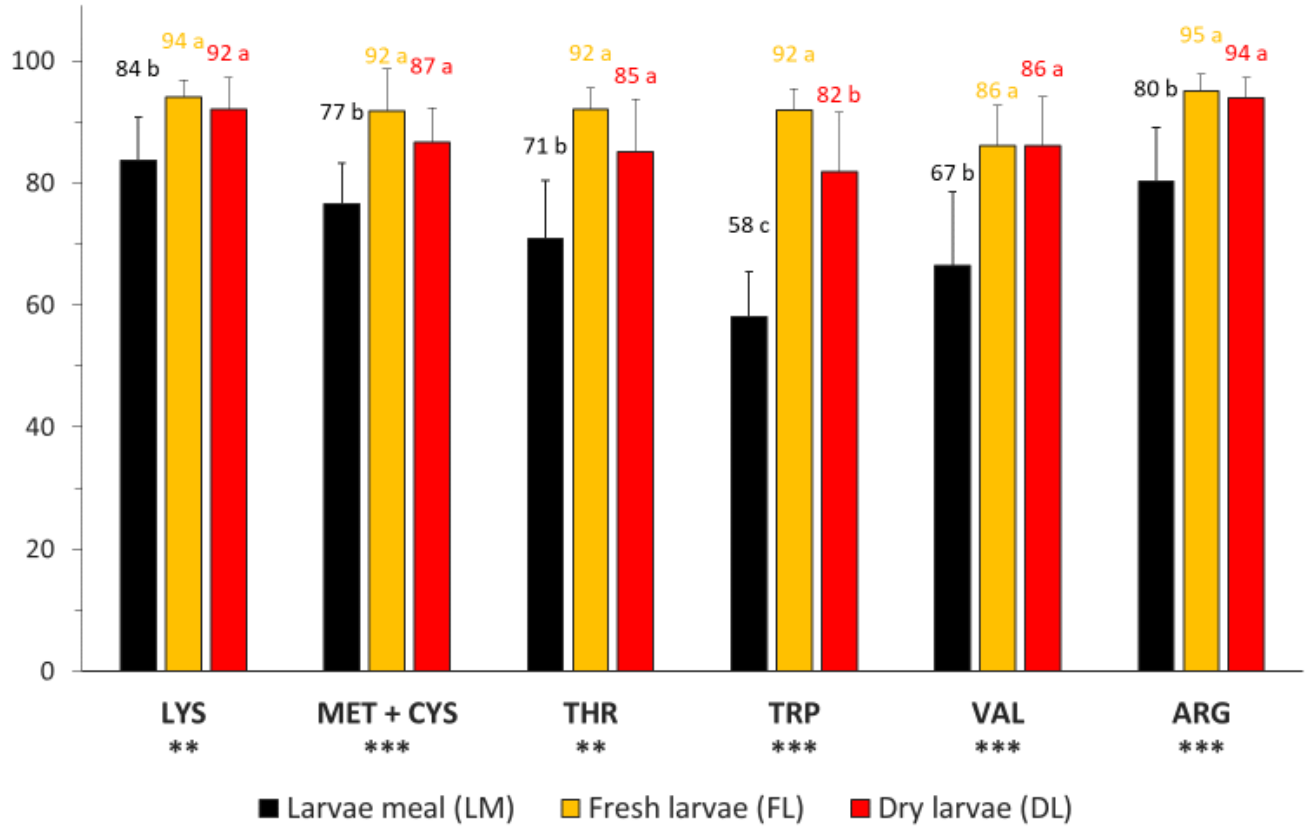
Apparent Metabolizable Energy (AMEn, kcal/kg)



- **Consistent ranking of as-fed values: FL < LM < DL**
  (cf. protein & fat contents)
- **Close values for FL & DL on a DM basis**
  (despite a significant effect)

Standardized ileal digestibility of amino acids (%)





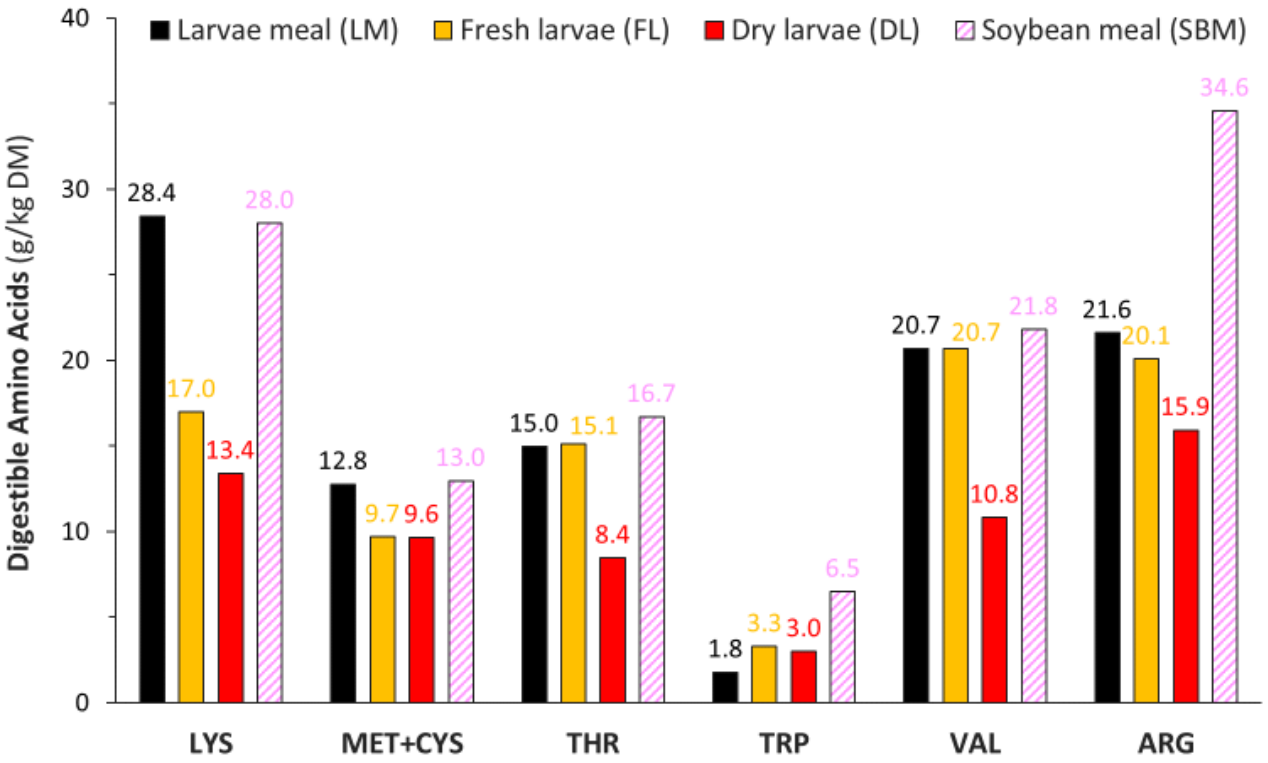
- **Lower digestibility in LM** *vs.* FL/DL (-9 to -29 pts)

⇒ **Chitin effect?** (Marono *et al.*, 2015; Schiavone *et al.*, 2017)

- **Excellent digestibilty for FL & DL** (77-96%; 85-98%)

- **No difference FL *vs.* DL** for most AAs (15/19)

Digestible amino acids content & AA profile



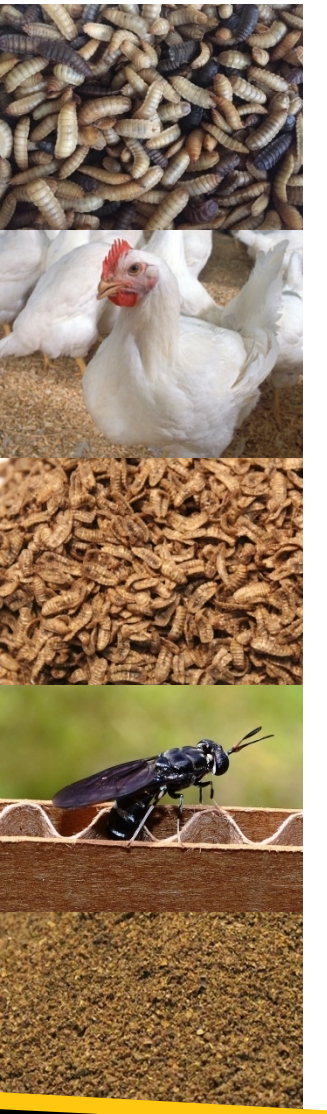
- **Dig. AA levels in LM ≈ SBM** despite ↘ digestibility
- **Variability for some AA** between **FL** & **DL** + **AA profile closer to ideal prot.** (Met+Cys, Trp…)

⇒ **Effect of rearing substrate?**

(Tschirner & Simon, 2015; Fuso et al., 2021)

Ideal profile (% dig LYS)	LM	FL	DL	SBM	Rostagno (2017)
dig MET+CYS	45	57	72	46	74
dig THR	53	89	63	60	66
dig TRP	6	19	22	23	18
dig VAL	73	122	81	78	77
dig ARG	76	118	119	123	107

Conclusions



- **FL & DL = promising energy/protein sources ⇒ Max. inclusion rate?**
  - Chitin? Gut capacity?
  - Fatty acid profile of meat? (*cf.* lauric acid)
  - Gut & microbiota effects? (*cf.* chitin, antimicrobial peptides, lauric acid)
- **Variability in digestibility** (LM vs. FL/DL) ⇒ **Chitin effect?**
  (25% of LM in our study vs. ≈10% max for Moula & Detilleux, 2019)
- **Variability in BSF composition ⇒ Tailored BSF nutrition for poultry?**
  - ↗ content for specific nutrients?
  - Modification of AA profile according to final use?

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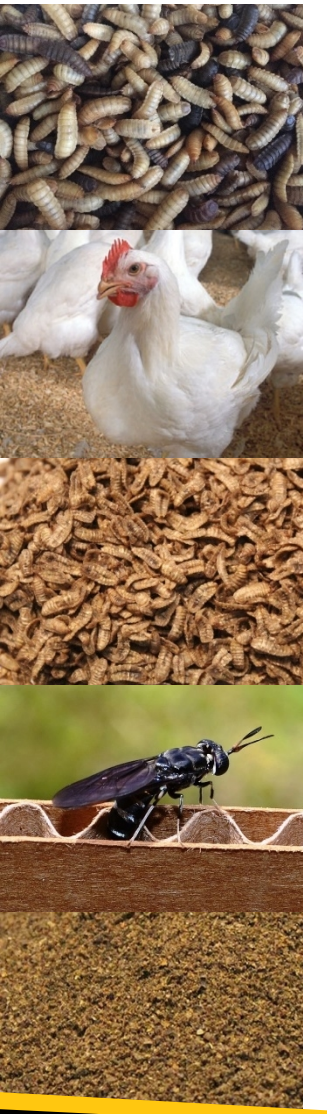

Thank you! / Merci !

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