

# Optimizing nutrition of black soldier fly larvae



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26/08/2019

# **VIVES**



Entomofood (Cornet: 2015-2017)





(2017-2020)



Entomatisation (TETRA/VLAIO: 2016-2018)







# INSECTLAB





#### Goal

# Rearing of two species: T. molitor and H. illucens





#### Goal

**BSF** 

Assessing the value of different side streams → most promising substrates or mixtures are being tested on larger scale

Nutritional requirements are being assessed in order to select promising side streams to combine

Laboratory standard feed: chicken feed mixed with water (30/70) 5.4% protein (21% on DM)

Larvae grow to maximum weight in 18 days (egg hatch-harvest)

Resulting larvae contain 41% protein and 36% fat on DM Feed Conversion Ratio (Dry feed/Live insects) of 1.2

#### Nutritional requirements

Optimal nutrient composition of BSF feed

Nutritional requirements for BSF larvae are not well known

Protein content in the chicken feed standard is too high -

ammonia emissions

Most side streams of plant origin contain lower protein levels



#### Nutritional requirements

Optimal nutrient composition of BSF feed

Testing of diets with different protein levels and comparing to chicken feed

Per diet: 100 larvae receive 110 g wet feed (28 g DM) over 2 week period,

3 times replicated

Using pure ingredients (artificial diets)

Iso-energetic substrates:

All substrates are high in starch (75-95% DM) → only protein is limiting Decrease in protein is compensated by starch (gross-energy)



## Nutritional requirements: protein and starch

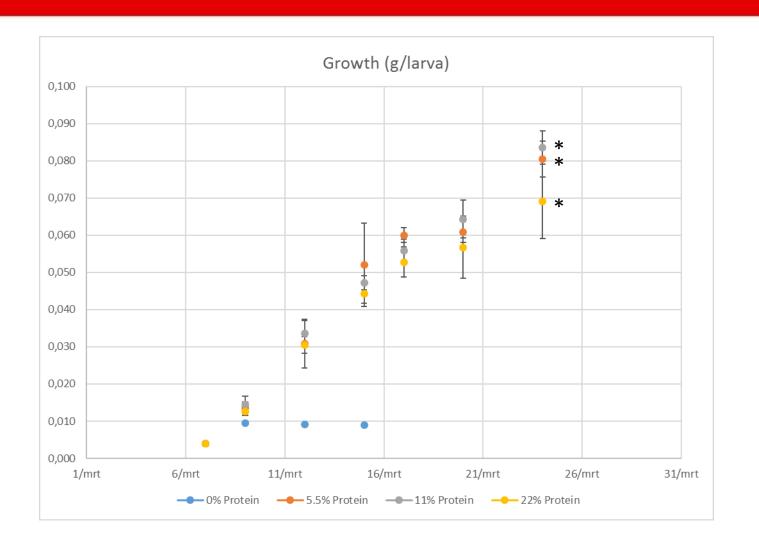


of t	Average nutritional values / gemiddelde voedingswaarden / valeurs nutritionelles moyennes / Durchschnittlicher Nährwert	/ 100g
ed s.	energy/energie/valeur énergétique/ Brennwert	1635 kJ 390 kca
	fat/vetten/matières grasses/Fett of which/waarvan/dont/davon	1.63 g
	saturated fatty acids/verzadigde vetzuren/ acides gras saturés/gesăttigt	0 g
	carbohydrates/koolhydraten/glucides/ Kohlenhydrate	0 g
	of which/waarvan/dont/davon sugars/suikers/sucres/Zuckerarten	0 g
	fibers/vezels/fibres/Ballaststoffe	1.09 g
	protein/eiwitten/protéines/Eiweiß	92.60 g
		0.22 g
	salt/zout/sel/Salz	3.85.g
	alanine	7.04 g
	arginine	10.10 g
	aspartic acid	0.75.9
	cystine	17.50 g
	glutamic acid	3.68 g
	glycine	2.65 g
	histidine	4.32 9
	isoleucine	7.17 9
	leucine	5.38 9
er	lysine	1.07 9
tot -	methionine	59
	phenylalanine	4,86 9
	proline	4.30 9
	serine	3.04 9
	threonine	3.41 0
	tryptophane	4.399
nt	tyrosine	4.00
éal	Valine	



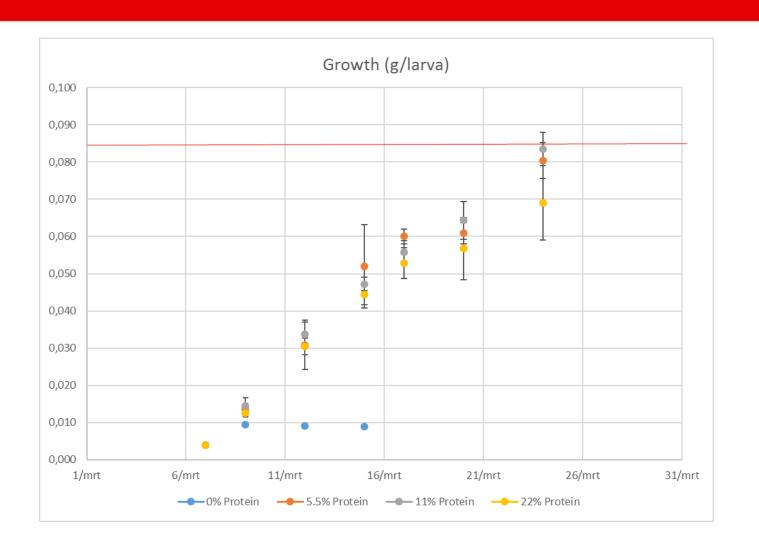


#### Nutritional requirements: protein and starch





# Nutritional requirements: protein and starch





#### Nutritional requirements: protein, starch and vitamins + minerals





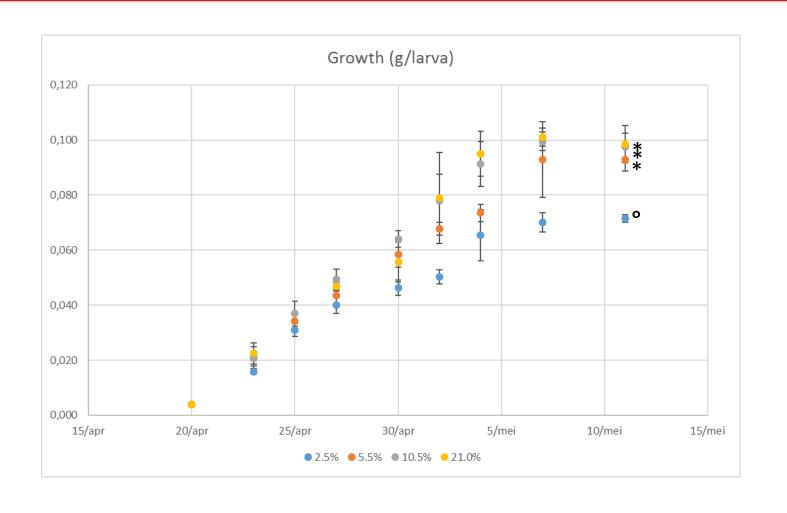




COMPOSITION / SAMENSTELLING / COMPOSITION / ZUSAMMENSETZUNG / SKŁAD: Calcium carbonate / Calciumcarbonaat / Carbonate de calcium / Calciumkarbonat / Weglan wapnia, Monodicalcium phosphate / Monodicalciumfosfaat / Phosphate monobicalcique / Monodicalciumphosphat / Fosforan jedno-, dwuwapniowy, Sodium chloride / Natriumchloride / Chlorure de sodium / Natriumchlorid / Cklorek sodu, Sodium bicarbonate / Natriumbicarbonaat / Bicarbonate de sodium / Natriumbicarbonat / Wodoroweglan sodu ANALYTICAL CONSTITUANTS / ANALYTISCHE BESTANDDELEN / CONSTITUANTS ANALYTIQUES / ANALYTISCHE BESTANDTEILE / SKŁADNIKI ANALITYCZNE: Lysine / Lysin / Lizyny: 0.12%, Methionine / Méthionine / Methionin / Metioniny: 0.001% NUTRITIONAL ADDITIVES / NUTRITIONELE TOEVOEGINGSMIDDELEN / ADDITIFS NUTRITIONNELS / ERNÄHRUNGSPHYSIOLOGISCHE ZUSATZSTOFFE / DODATKI ŻYWIENIOWE: Calcium-D-pantothenate (3a841); 21.7 mg/kg, Vitamin A (3a672a): 202500 IU/kg, Vitamin D3 (E671): 25500 IU/kg, Vitamin E (All-rac-alfatocopheryl acetate) (3a700): 140 IU/kg, Vitamin K3 (Menadione Nicotinamide bisulfite) (3a711): 16 mg/kg. Vitamin B2 (Riboflavin): 40 mg/kg, Niacinamide (3a315): 40 mg/kg, Vitamin B6 (Pyridoxine hydrochloride) (3a831): 5 mg/kg, Folic acid (3a316): 2 mg/kg, Vitamin B12 (Cyanocobalamin): 300 µg/kg. Vitamin B1 (Thiamine mononitrate) (3a821): 2 mg/kg, E1 Iron, Iron(II)sulphate, monohydrate: 438 mg/kg, Iron(III) oxide, Iron (E1): 1561.1 mg/kg, Calcium iodate, anhydrous (3b202): 4 mg/kg, E4 Copper, Copper(II) sulfate pentahydrate: 5 mg/kg, Manganese (II) - oxid, Manganese (E5): 298 mg/kg,

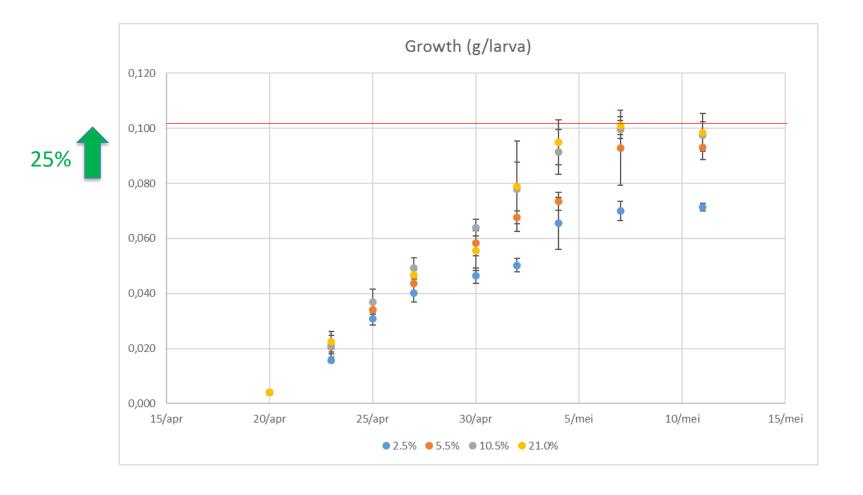
Zinc sulfate, monohydrate, Zinc (3b605): 153 mg/kg

#### Nutritional requirements: protein, starch and vitamins + minerals





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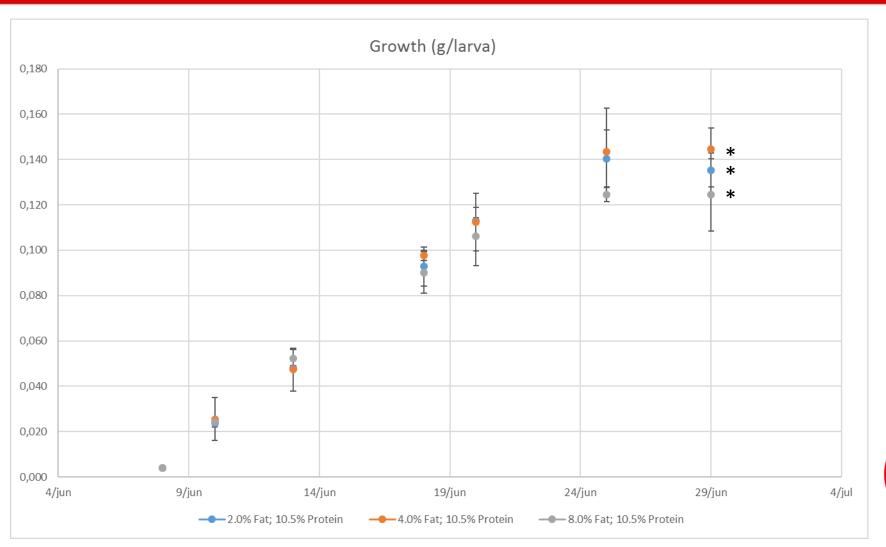
#### Nutritional requirements: protein, starch, vitamins+minerals and fat





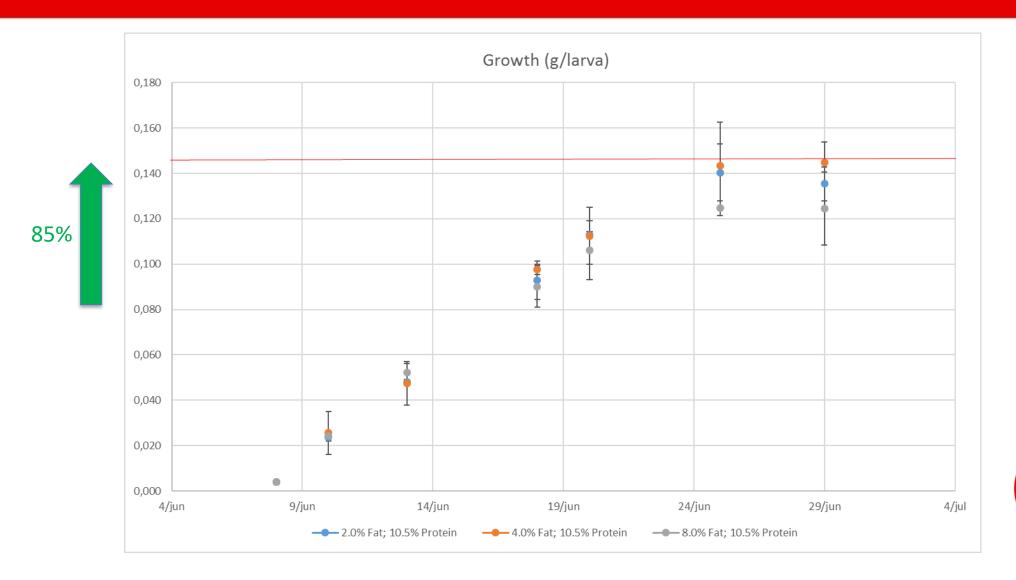


#### Nutritional requirements: protein, starch, vitamins+minerals and fat



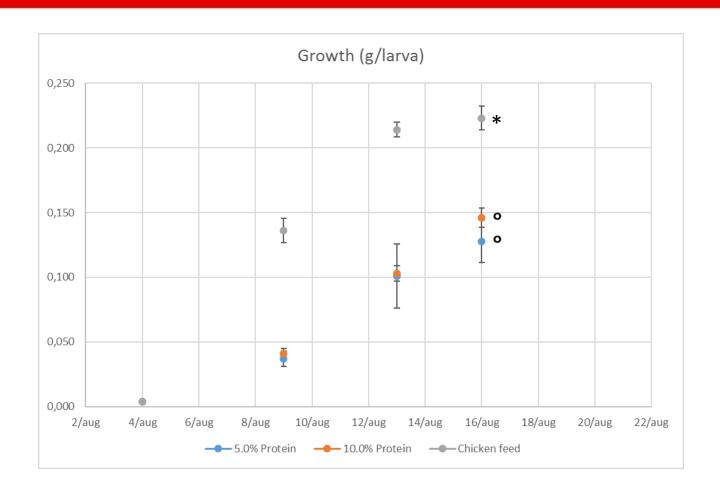


#### Nutritional requirements: protein, starch, vitamins+minerals and fat



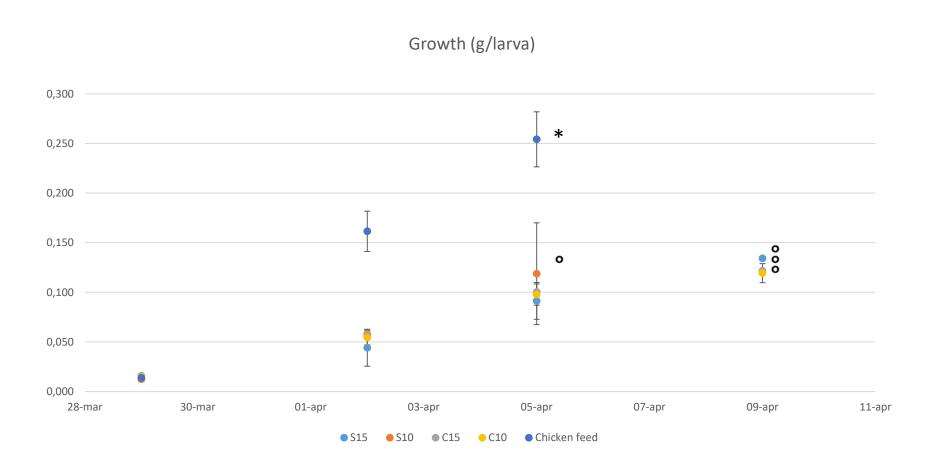


#### Nutritional requirements: one time feeding





#### Nutritional requirements: different protein sources





#### Nutritional requirements: discussion

BSF larvae require only 25 – 50% of the protein level in chicken feed

#### Restrictions artificial diets:

Larvae grow maximum until 75% compared to chicken feed diet, despite all (macro)nutrients being present and high energy levels

Shortage of micronutrients?

Cholesterol? (Barragán-Fonseca, 2018)

Digestibility of carbohydrates (resistant starch)?

Structure and other properties of the substrate?



# Nutritional requirements: discussion









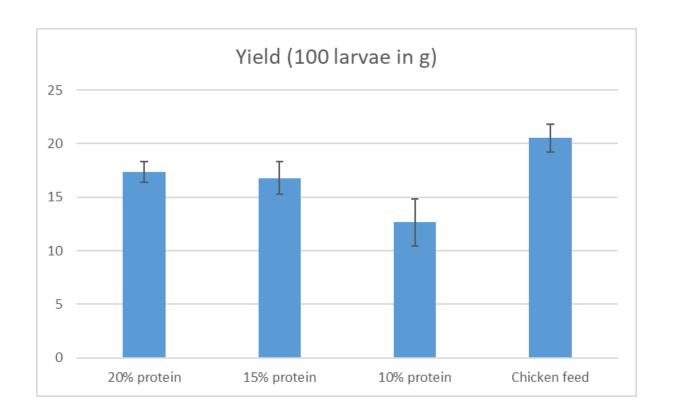


## Nutritional requirements: semi-artificial diets

20% Protein	15% Protein	10% Protein	Chicken feed
50 g Chicken feed/water	50 g Chicken feed/water	50 g Chicken feed/water	100 g Chicken feed/water
6.85 g Sugar	8.30 g Sugar	9.75 g Sugar	
3.00 g Protein	1.50 g Protein		

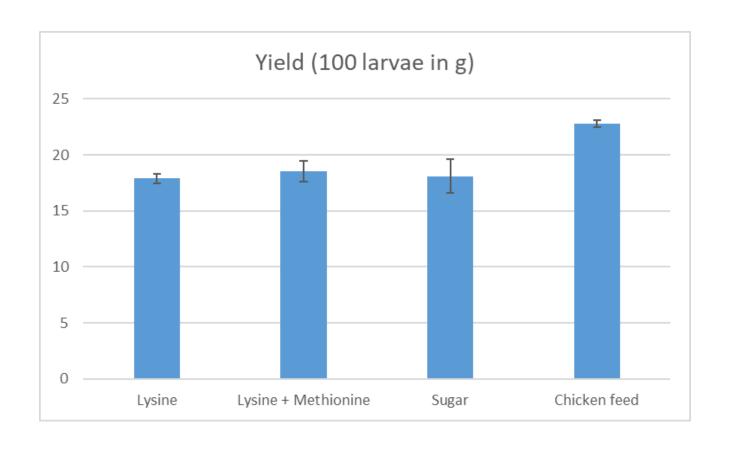


#### Nutritional requirements: semi-artificial diets





#### Nutritional requirements: semi-artificial diets





#### Nutritional requirements: future perspectives

Further testing different mixtures with synthetic amino acids 

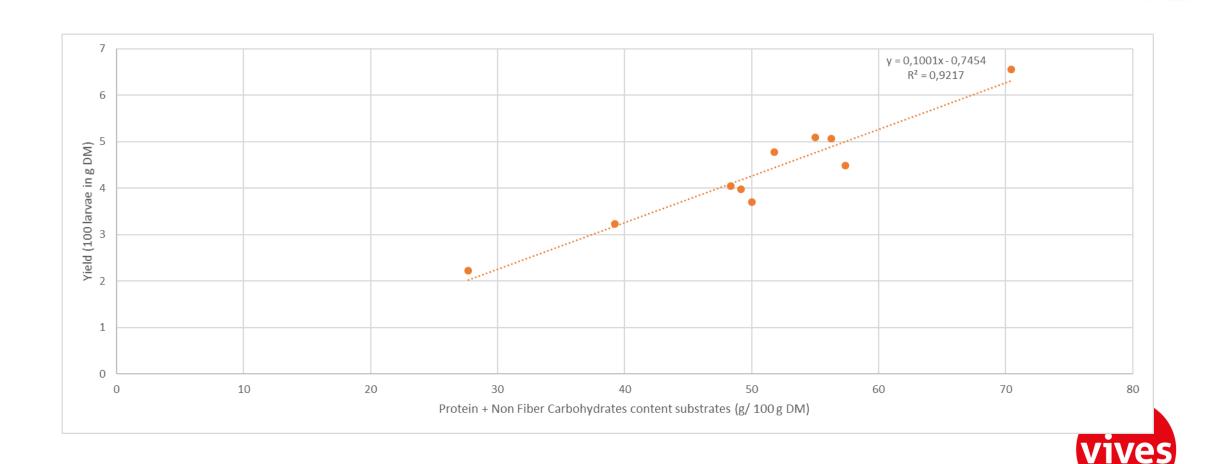
identifying essential amino acids

Identifying other essential nutrients (fatty acids, sterols, vitamins and minerals)

Assessing the digestibility of nutrients and trying to improve it (enzymes, microorganisms,...)



# Nutritional requirements: future perspectives



#### Thank you for your attention!

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