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Pervasive plasticity: G × E interactions for larval performance & body composition traits in the black soldier fly (BSF)

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Athens, Greece
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What factors influence BSF larval performance & body composition?

Fully crossed factorial design to assess effects of:
feed substrate (3 diets), BSF genetics (4 strains) & their interaction (6 replicates/combination)

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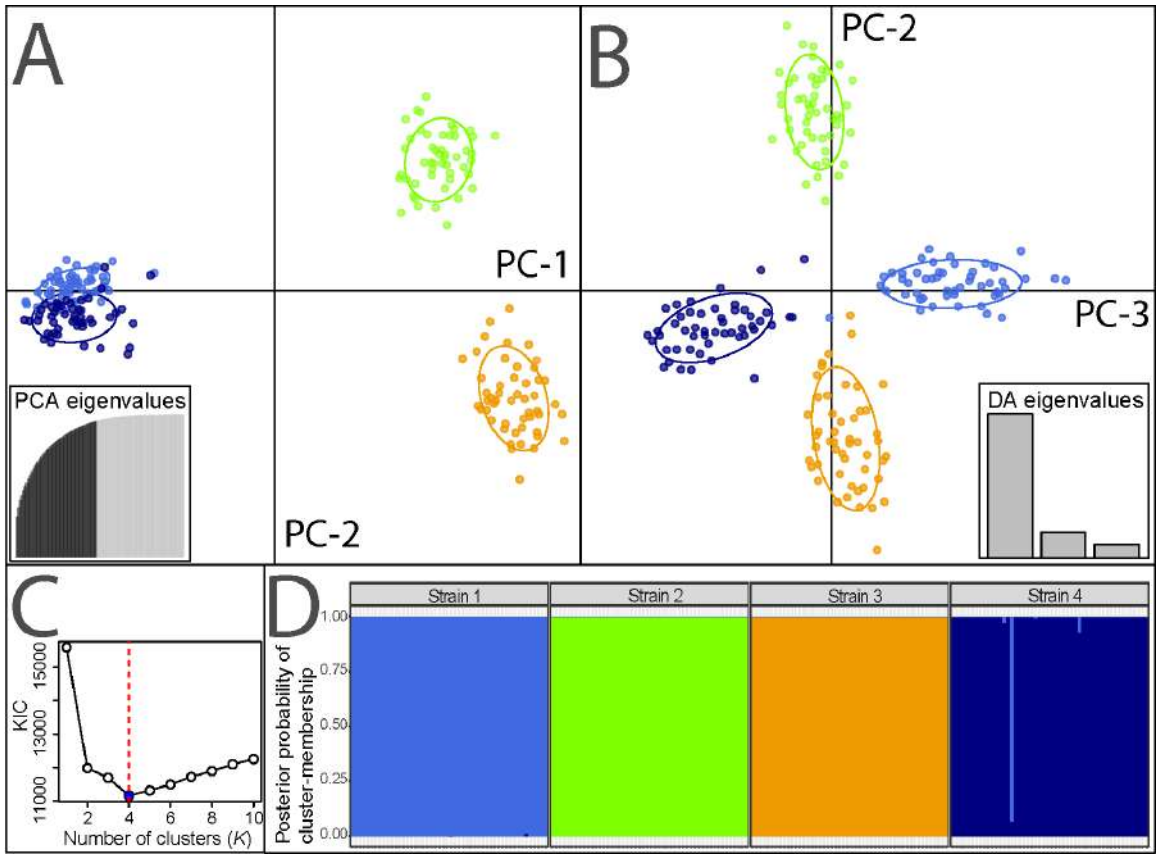
Design: Genetically distinct experimental strains



Microsatellite genotyping of 50 individuals per population (15 loci)

All populations maintained equally
for ≥2 entire generations prior to experiment

Strain	Pairwise F_{ST}			F_{IS}	H_{obs}	H_{exp}	A_R	N_e
	S1	**S2**	**S3**					
S1				**0.13**	0.50	0.56	4.0	110
S2	**0.33**			**0.14**	0.43	0.49	3.9	193
S3	**0.31**	**0.11**		0.02	0.55	0.56	4.5	267
S4	**0.13**	**0.35**	**0.36**	-0.01	0.52	0.52	3.7	147

insects MDPI

Article

Genotype-by-Diet Interactions for Larval Performance and Body Composition Traits in the Black Soldier Fly, *Hermetia illucens*

Insects **2022**, *13*, 424. https://doi.org/10.3390/insects13050424

Design: Nutritionally different experimental diets

Poultry feed (PF)

Food waste (FW)

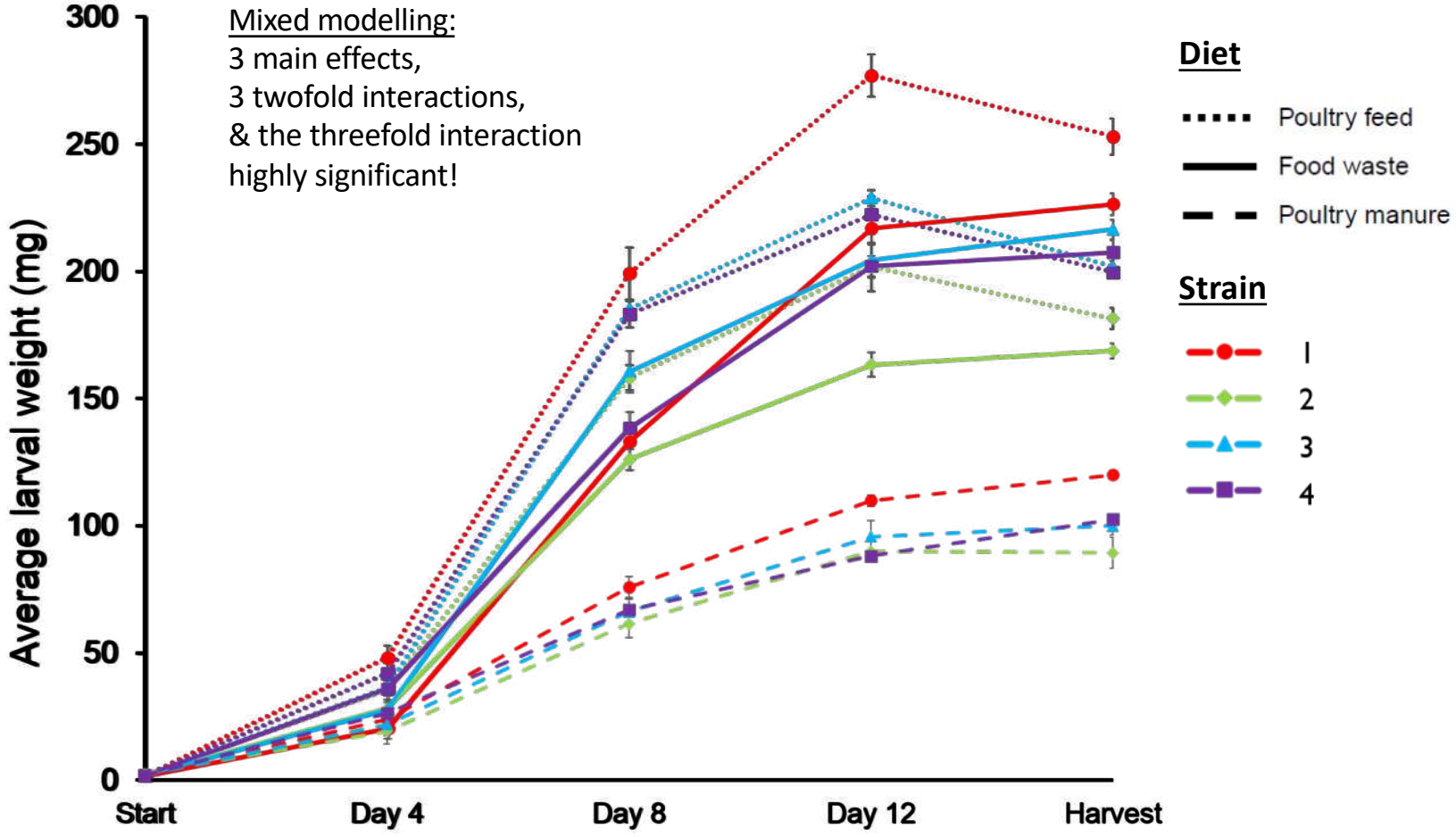
Poultry manure (PM)

- Adjusted dietary dry matter (DM)
- Ventilated vessels (rotated)
- 1100 neonates/box (5 days old; ~2mg)
- Climate cabinet: 28°C, 50% rel. humidity
- equal daily feeding rates (~23mg DM per larva) provided every other day
- Daily inspections; harvest: one day after observing first prepupae were

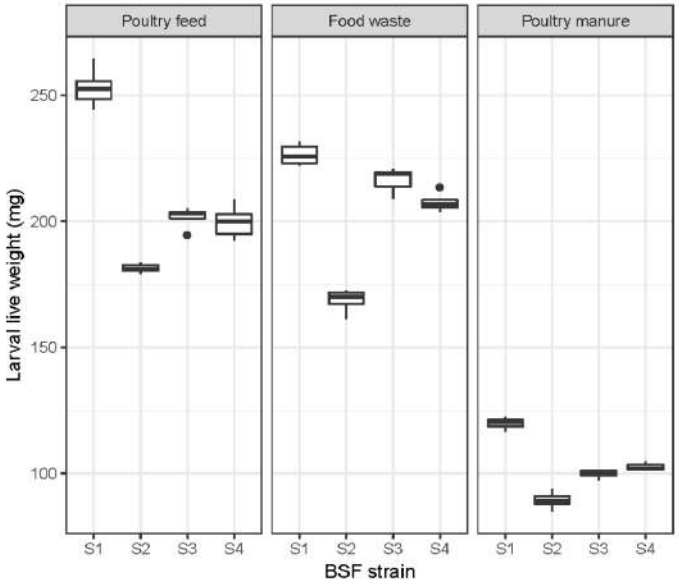
(g/kg DM)	PF	FW	PM
Protein	196	140	94
Fat	50	52	23
Ash	132	35	258
Fibre	299	317	399

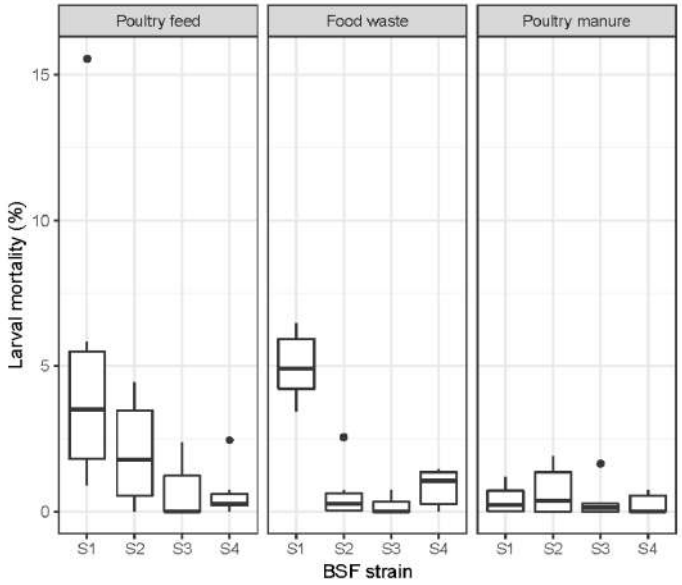
- Growth-tracking
- Survival rate
- Composition of diets, larval biomass & frass
- Relevant (conversion) parameters
- Larval amino acid profiling

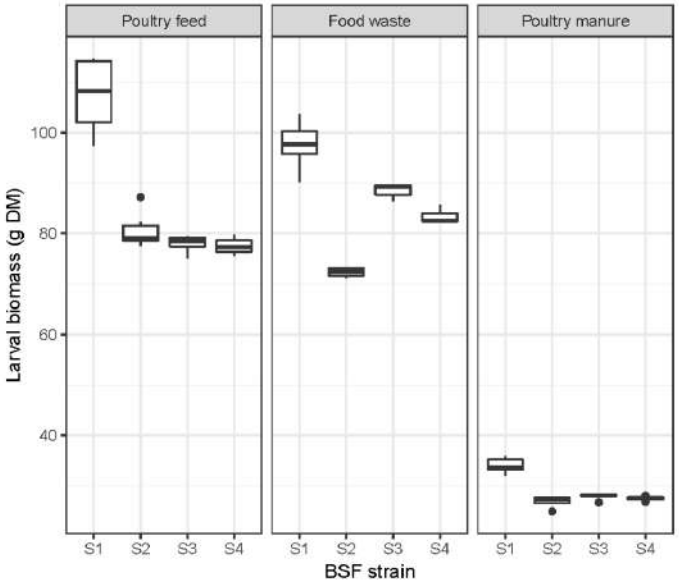
Results: Larval growth dynamics over time



Results: larval live weight, mortality rate and total biomass (DM)

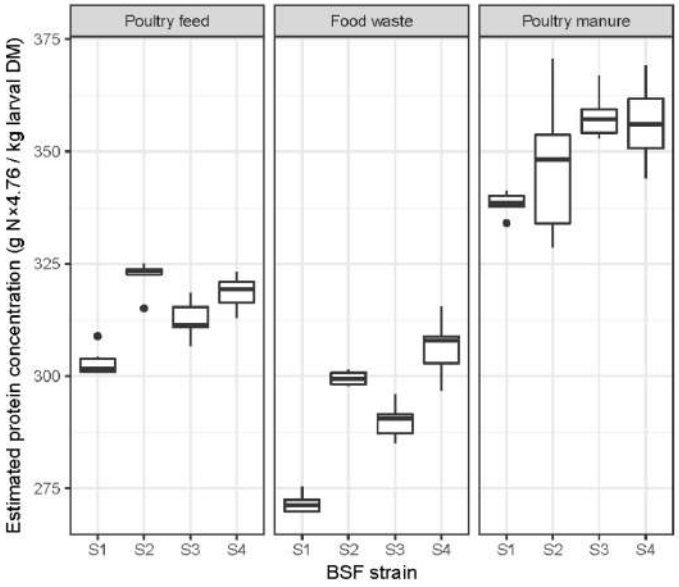


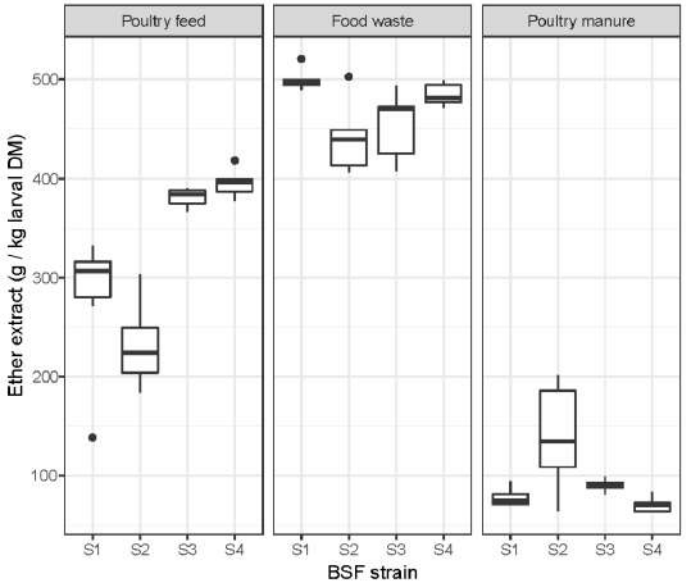


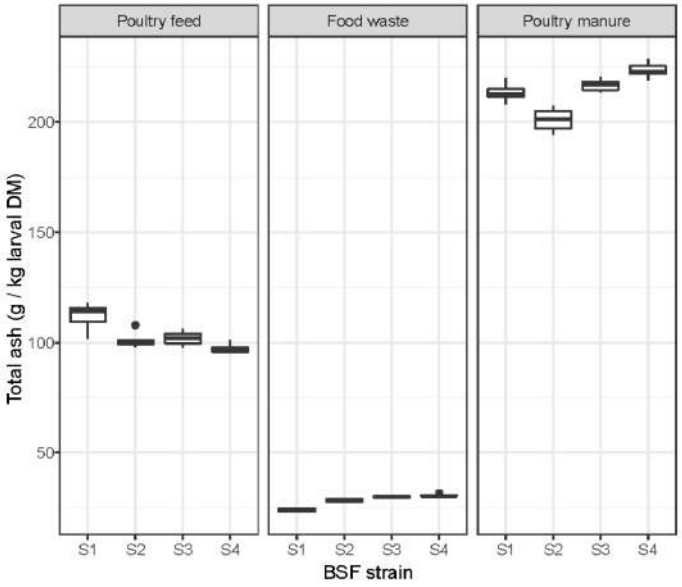


	Strain	Diet	S × D
Mortality (%)	***	***	***
Larval live weight (mg)	***	***	***
Larval biomass (g DM)	***	***	***

Results: crude protein, lipid and ash

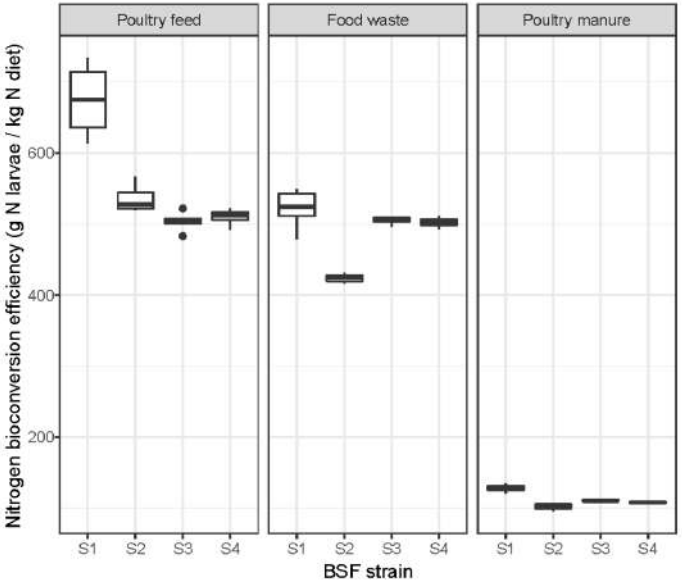


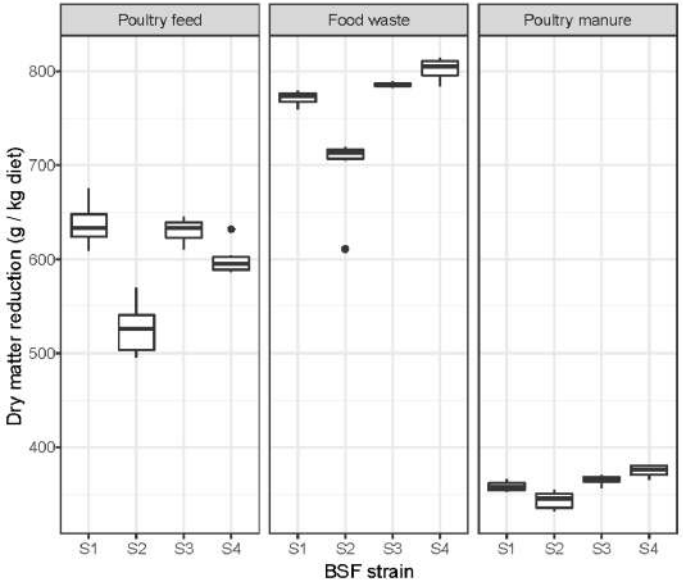


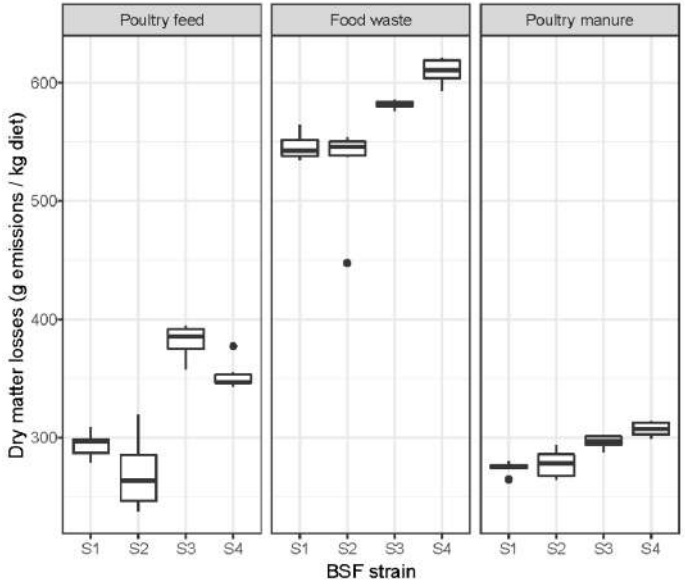


	Strain	Diet	S × D
Protein (% of DM)	***	***	***
Lipids (% of DM)	***	***	***
CP/EE ratio	***	***	***
Ash (% of DM)	***	***	***

Results: conversion efficiency, waste reduction and emissions

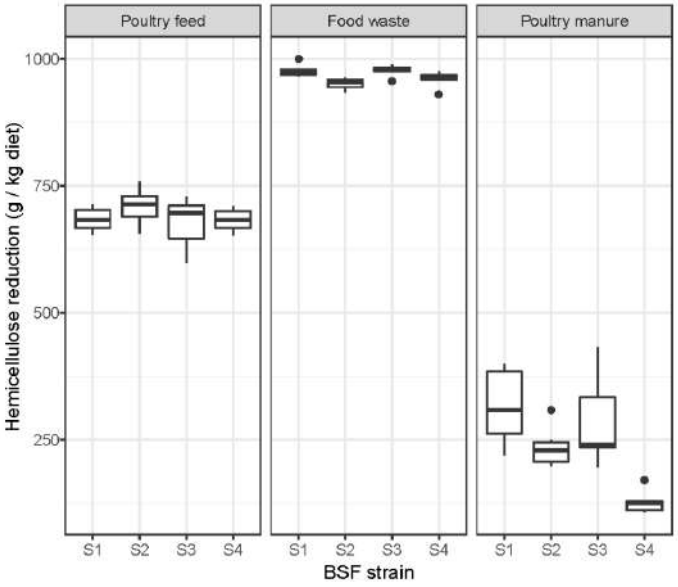


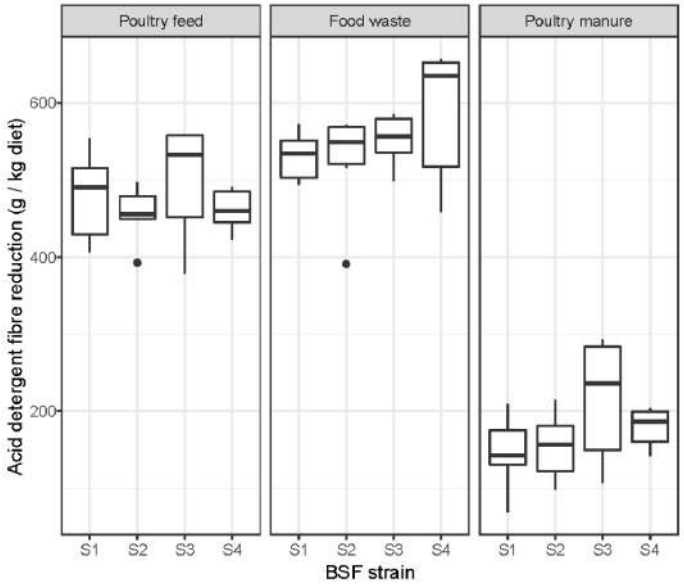




	Strain	Diet	S × D
Nitrogen and overall bioconversion efficiency (g/kg DM)	***	***	***
DM reduction (%)	***	***	***
Emissions of DM (g/kg)	***	***	***

Results: dietary fiber reduction



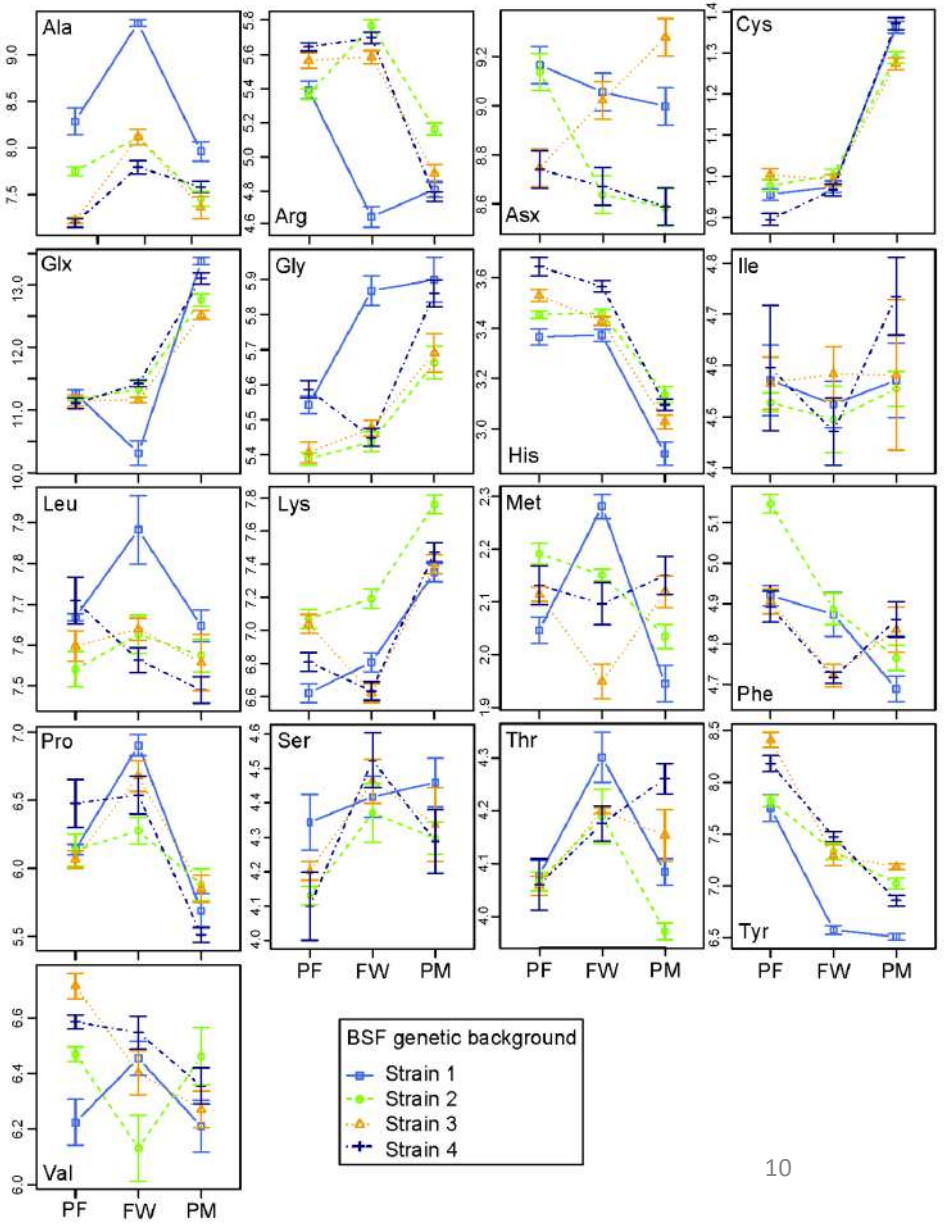


	Strain	Feed	S × D
Hemicellulose reduction (g/kg diet)	***	***	***
Acid detergent fiber reduction (g/kg diet)	***	***	

Results: Larval amino acid profiles (g/100g Protein)

	Strain	Diet	S × D
Ala	***	***	***
Arg	***	***	***
Asx	***		***
Cys		***	***
Glx	***	***	***
Gly	***	***	***
His	***	***	***
Ile			
Leu	***	*	*
Lys	***	***	***
Met	*	***	***
Phe	***	***	***
Pro	***	***	***
Ser		***	
Thr	***	***	***
Tyr	***	***	***
Val	***	***	***

Essential
Non-essential



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Conclusions & implications

Overarching diet effects expected – prevalent & significant BSF genotype effects were new

Omnipresent genotype-by-diet interactions across virtually all target traits

Dietary specialists > moderate generalists within certain dietary ranges > general superiority

Comparative geno-/phenotyping highlights variation for (heritable) traits & breeding potentials

Screening diverse wild populations to discover novel phenotypes

More complex of interactions – e.g. including microbiota - requires further research

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BSF strain sources:
1) FiBL house strain;
2) Emilie Devic / Entofood, Malaysia;
3) Claire Leach / Hatch Biosystems, Australia;
4) Heather Fallquist & Mohammed Gastli / nextProtein, Tunisia