

Alternative Livestock feed ingredients – How far are we?



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Black Soldier Fly as a Feed Ingredient for Livestock

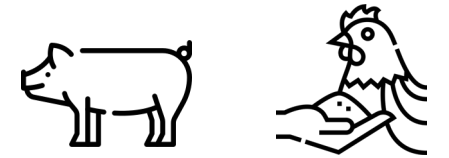
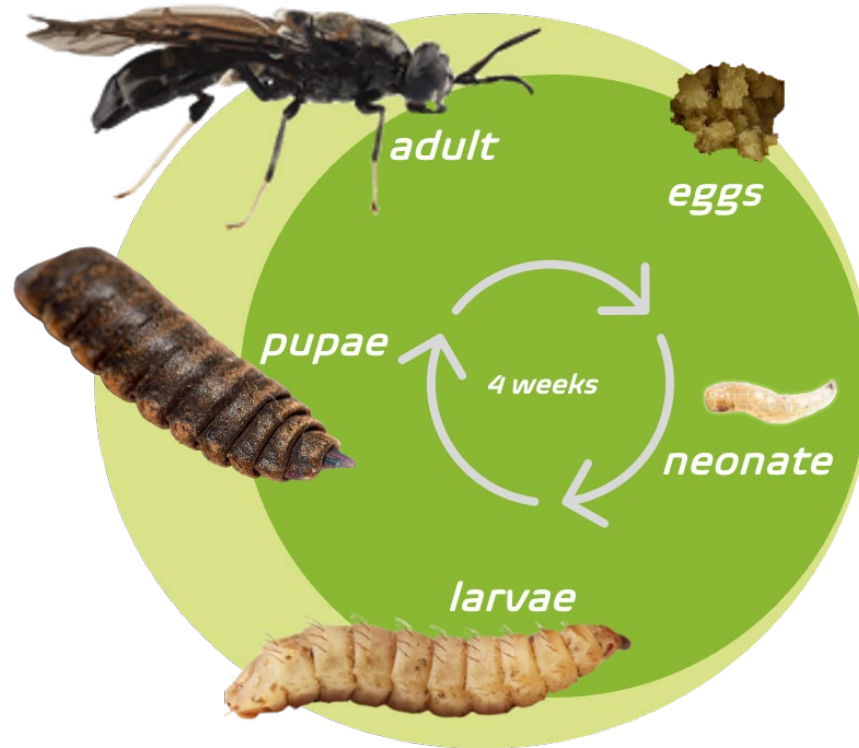




A New Ingredient What is BSF?

Life Cycle of the Black Soldier Fly

A Decomposer



Livestock Feed

A Nutrient Upcycler

**More Than
Just a Protein
Source.
It's A Full Meal.**

Nutrient-	BSFL	FM
g/1000 g of dry matter		
Crude protein	350	618
Crude fat	298	165
Crude fibre	79.0	0
Crude ash	53.0	175
Nitrogen free extract	221	42.0
Amino acid	g/100 g of crude protein	
Aspartic acid	7.30	9.40
Glutamic acid	13.1	14.5
Serine	4.88	4.17
Glycine	6.15	6.41
Histidine	3.25	2.09
Arginine	5.47	6.07
Threonine	4.43	4.10
Alanine	8.21	6.87
Proline	6.68	4.28
Tyrosine	6.71	3.00
Valine	6.79	5.79
Methionine	2.12	2.53
Cystine	0.76	9.59
Isoleucine	4.73	4.24
Leucine	7.83	7.48
Phenylalanine	7.76	3.07
Lysine	6.82	6.63

Role in Animal Nutrition



A modern commercial ingredient but an age old component of swine and poultry balanced diets

Insects are an evolutionarily natural prey for birds - providing a full balanced diet



Insect meal provides pigs with not just protein, but also important fibre and fats which support overall nutrition

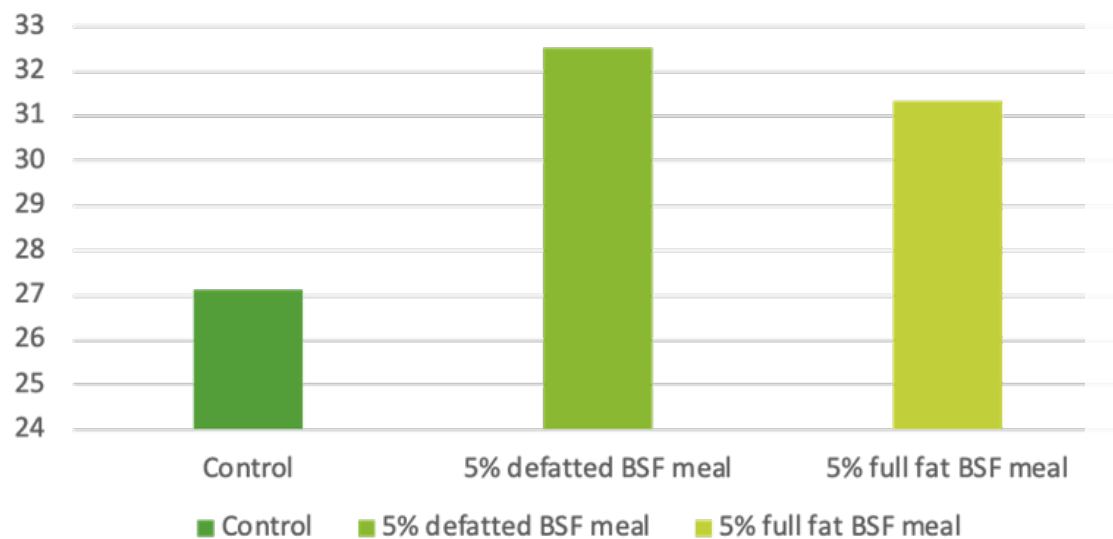




Evidence: Field Trial Applications



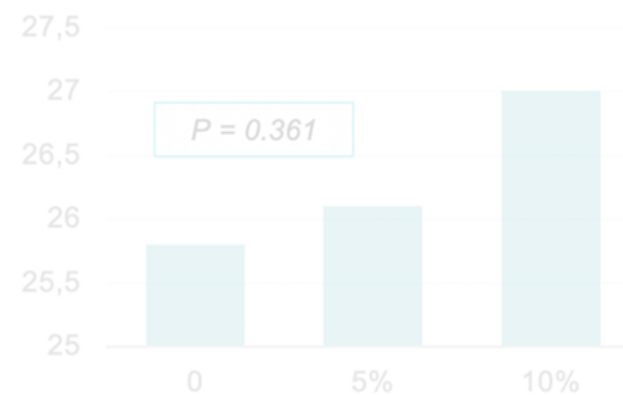
Eggs per Hen



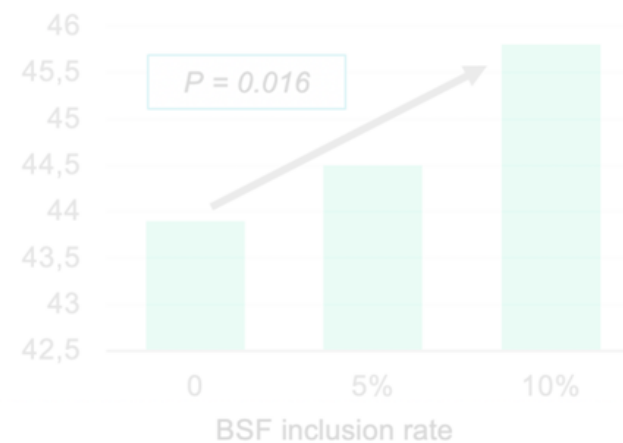
Petkov et al, 2022, *Journal of Insects for Food & Feed*



Weight Gain (kg)



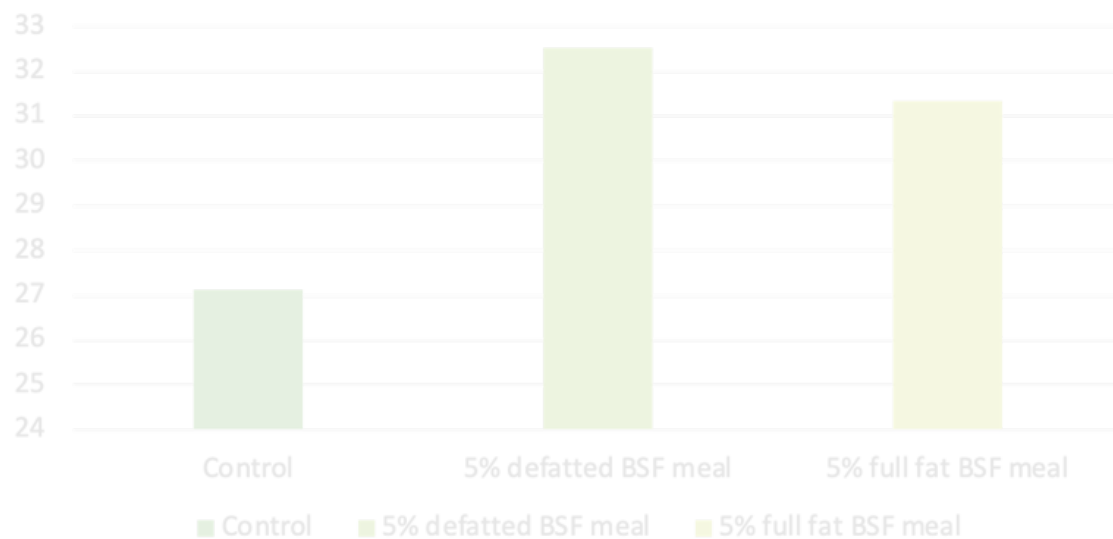
Feed Intake (kg)



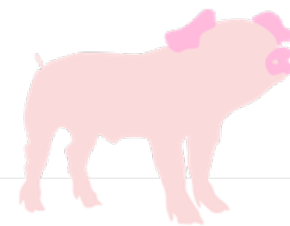
Biasato et al., 2019 –BSF meal effect on piglet performance



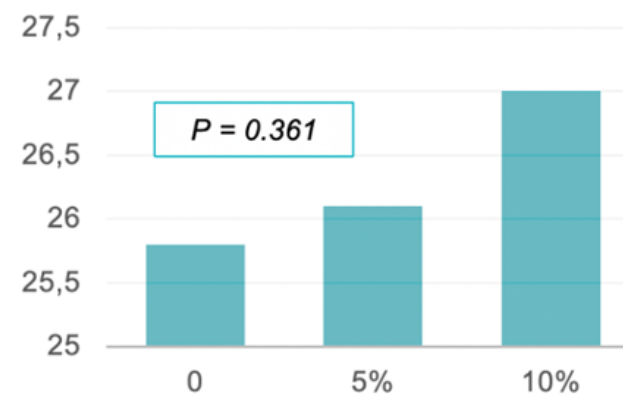
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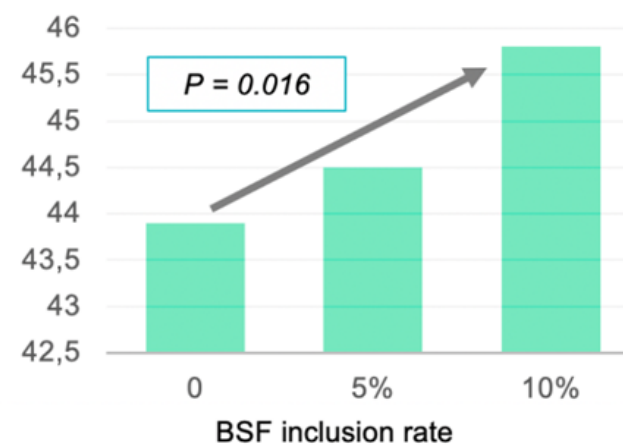
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Weight Gain (kg)



Feed Intake (kg)



Biasato et al., 2019 –BSF meal effect on piglet performance



Beyond Nutrition: Functional Benefits

Benefits of BSF Meal

BSF have diverse components which contribute to animal health, nutrition and growth

1. Palatable
2. Digestible
3. Nutrient Rich
4. Antimicrobial
5. Sustainable
6. Antioxidant
7. Prebiotic
8. Low in undesirables - no mycotoxins, heavy metals, PCBs

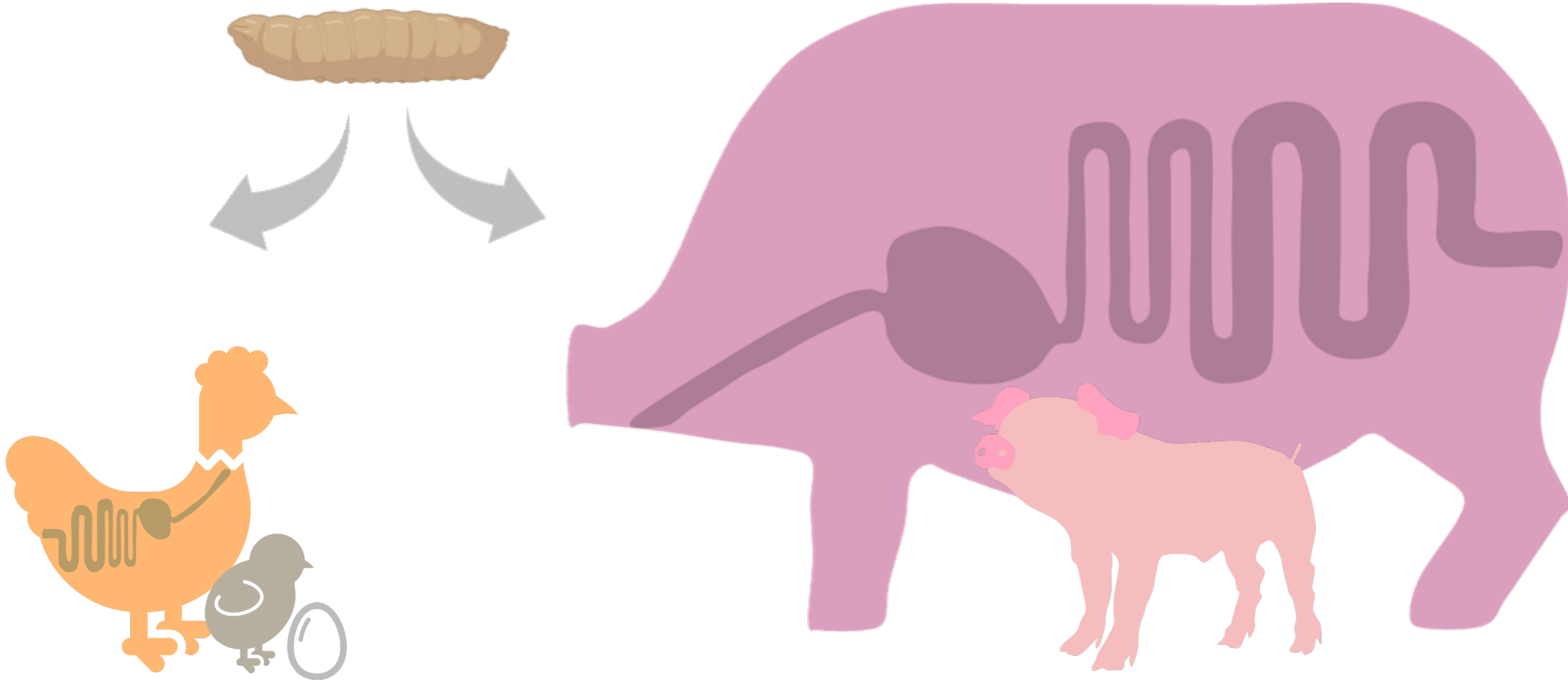


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Disease Resistance

AMPs and Lauric acid in diet will help resistance against pathogens

Boosted Gut Health

Chitin fibre enhancing digestion and AMPs present supporting probiotics proliferation

Enhanced Growth and Nutrition

Overall nutrition and digestive efficiency is improved

Antimicrobial Components: 3-Fold

Antimicrobial peptides (AMPs)

68 AMP's in the *H. illucens* have been identified with antimicrobial, antiviral, and or antifungal activity.

Medium Chain Fatty acids

MCFAs aid numerous metabolic processes such as pathogen control, gut health & immune responses.

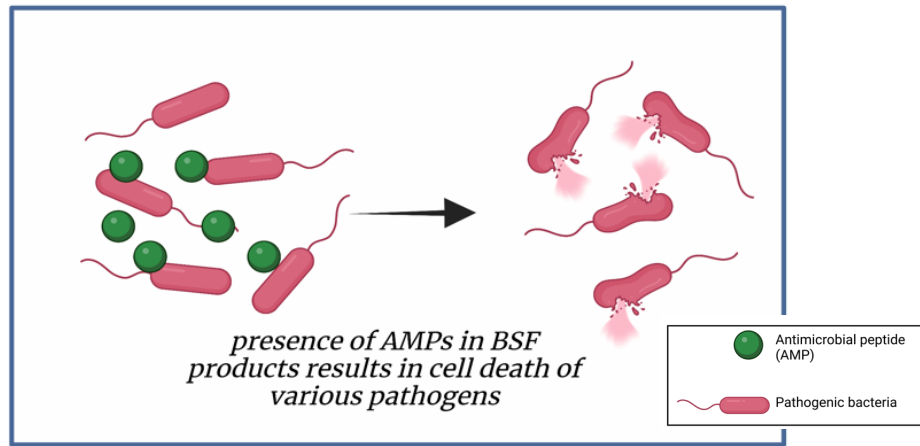
Chitin

Chitin is a natural dietary fibre which is a probiotic for gut bacteria



Antimicrobial Peptides (AMPs)

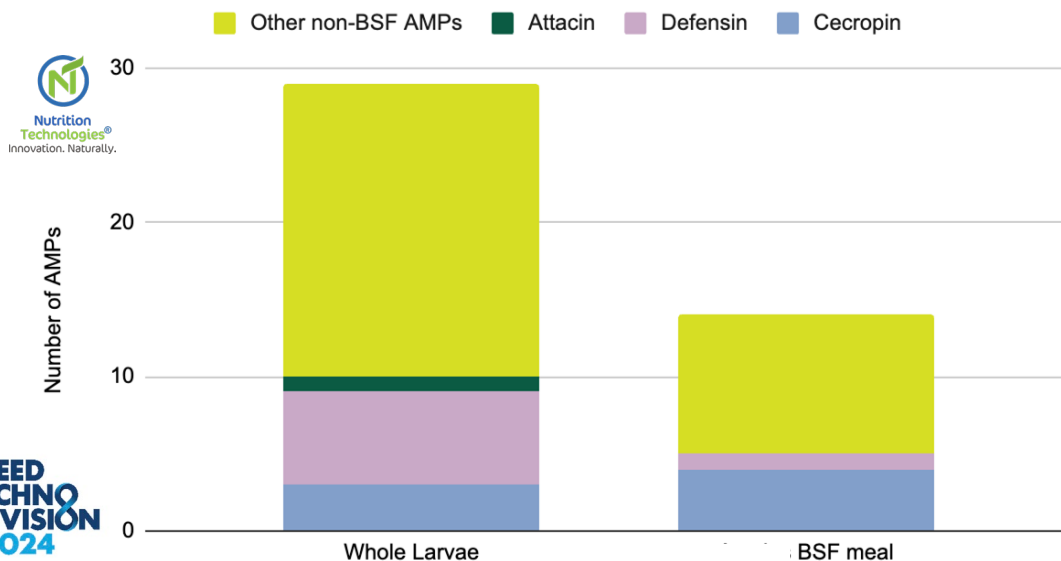
The BSF has the biggest and richest repertoire of AMP genes amongst insects



Antimicrobial peptides (AMPs) small molecules that are produced naturally by living organisms as a defence mechanism against pathogens such as bacteria. AMPs can be the solution to antibiotic resistance, which is a massive threat to livestock farming.

BSF are both a non-carrier of disease, and a source of immunologically beneficial components that can be utilised in feed applications.

Compared to Soybean, which generally lack AMPs, the BSF has over 68 AMPs and provides a natural resistance against bacteria, fungi and viruses.



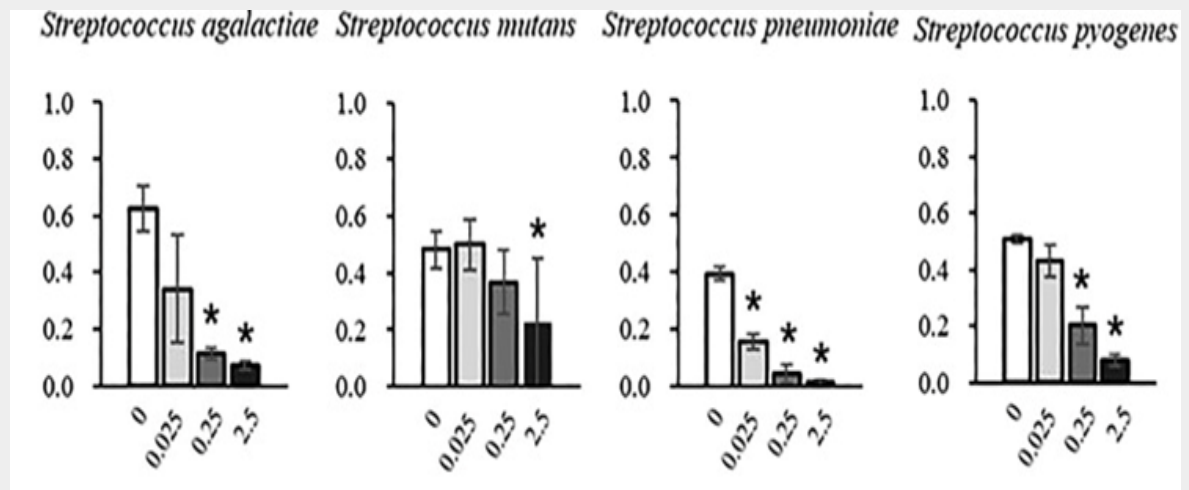
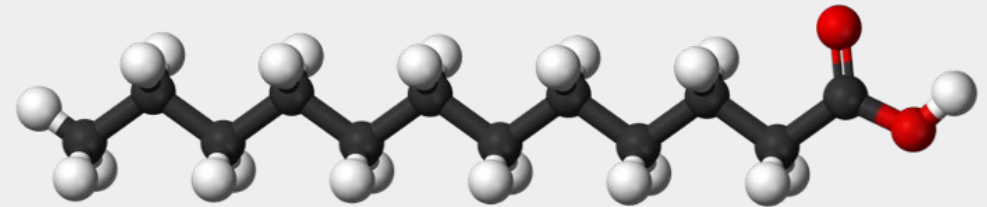
Medium Chain Fatty Acids (MCFA)

The BSF is a catalog of healthy lipids such as Lauric Acid which has antimicrobial effects

Oils from BSF are a palatable ingredient suitable for the diet of poultry, pets & swine, which will help boost your animals' health and performance thanks to its health-promoting fatty acid profile, composed primarily of lauric acid.

MCFAs are natural antimicrobial agents which are particularly active against Gram-positive bacteria (e.g. *Clostridium* and *Streptococcus*).

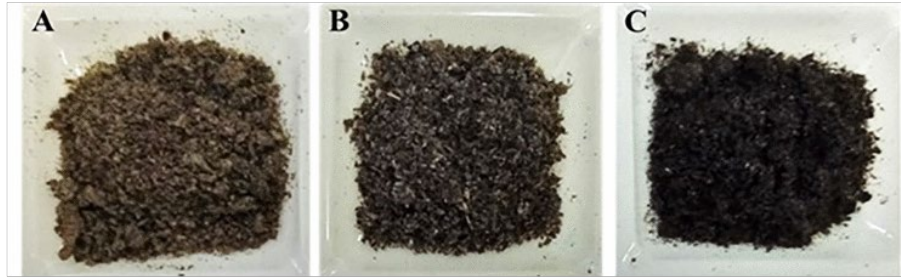
They act by disrupting the bacterial cell walls, as well as stimulating tight junctions in the animal's gut lining.



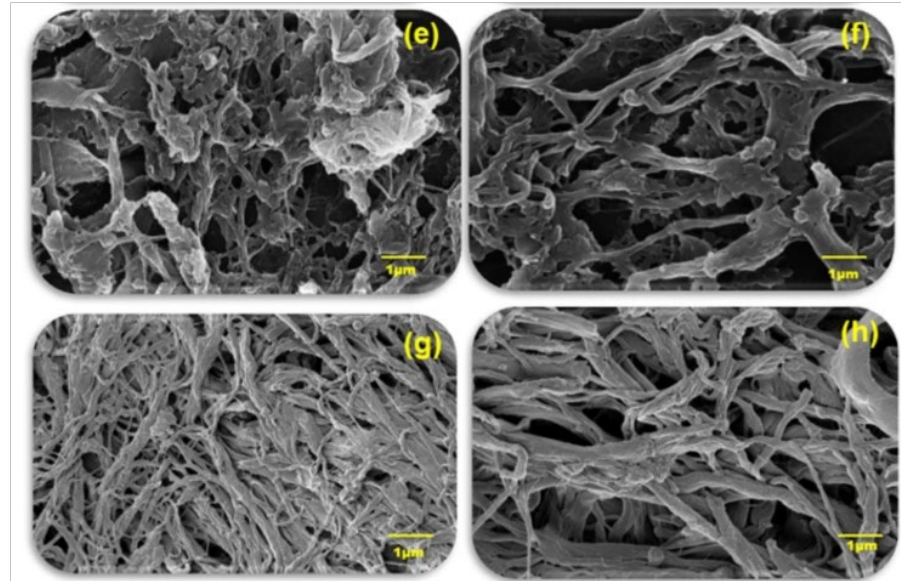
Matsue, Miki et al. (2019): 1528-1541. doi:10.1177/0963689719881366

Chitin

The BSF exoskeleton is rich in chitin which has antimicrobial properties

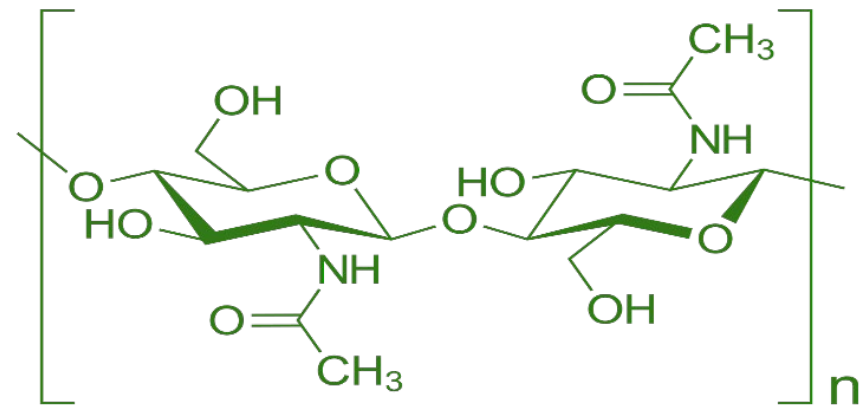


Triunfo, M., Tafi, E., Guarnieri, A. *et al.* Characterization of chitin and chitosan derived from *Hermetia illucens*, a further step in a circular economy process. *Sci Rep* 12, 6613 (2022). <https://doi.org/10.1038/s41598-022-10423-5>



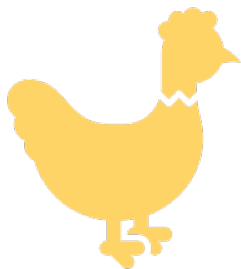
Gopal, J., Muthu, M., Dhakshanamurthy, T. *et al.* Sustainable ecofriendly phytoextract mediated one pot green recovery of chitosan. *Sci Rep* 9, 13832 (2019). <https://doi.org/10.1038/s41598-019-50133-z>

- 1 A great source of fiber
- 2 A source for Glucosamine: which is essential for bone and joint health
- 3 A source for Calcium accumulation: which is an essential nutrient
- 4 Has antimicrobial properties

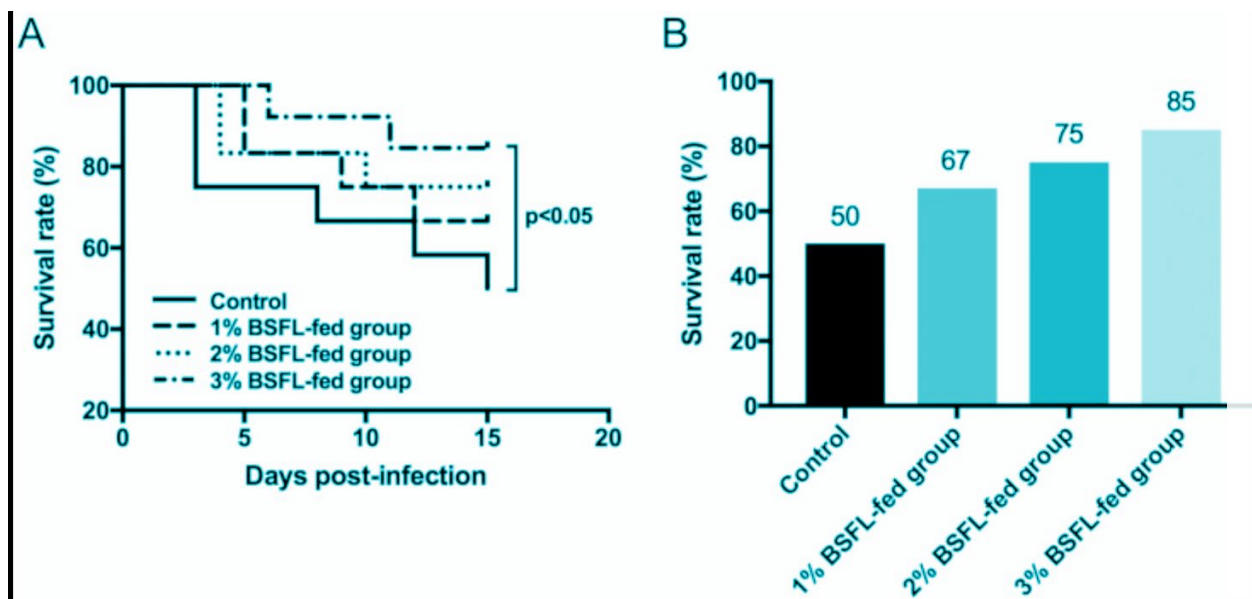




Evidence of Antimicrobial Effect: Field Trial Applications



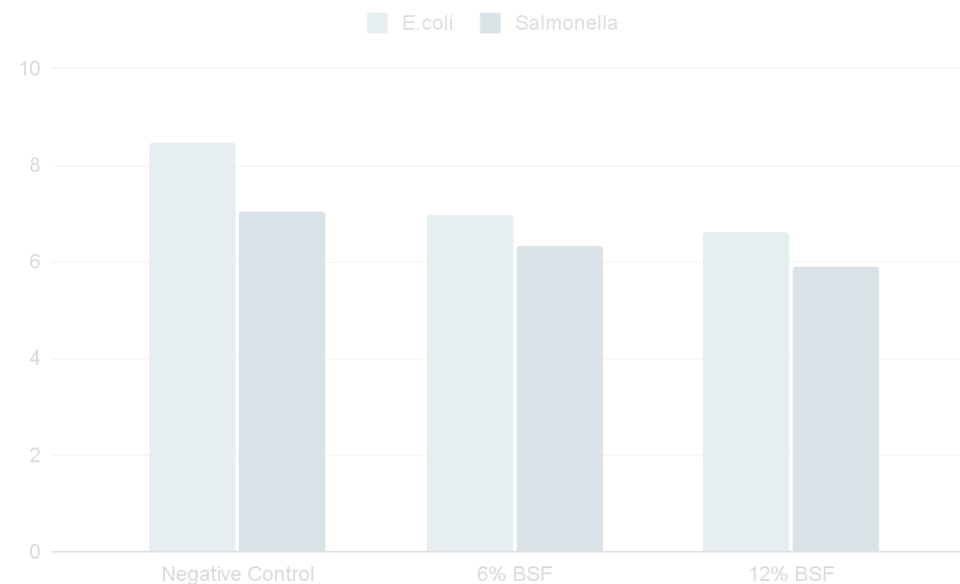
The BSF-fed broiler chickens had significantly higher survival rate against Salmonella infections compared to control diet



Lee, Jina et al. "Black soldier fly (*Hermetia illucens*) larvae enhances immune activities and increases survivability of broiler chicks against experimental infection of *Salmonella Gallinarum*.



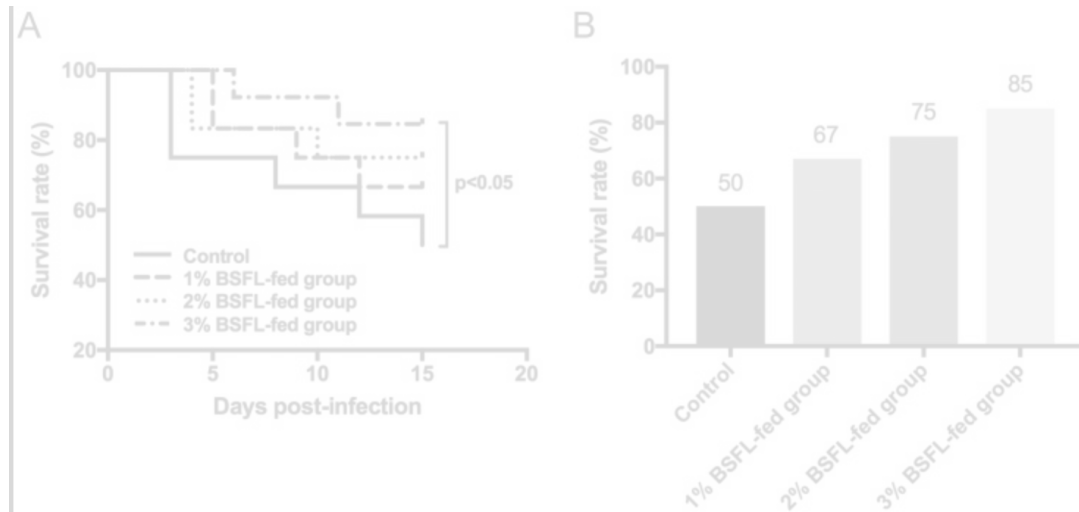
The BSF-fed piglets showed significant reduced diarrhoeal rate, gut inflammation and multiple other health indicators, as well as lower *Escherichia coli* and harmful metabolites (malondialdehyde) concentrations.



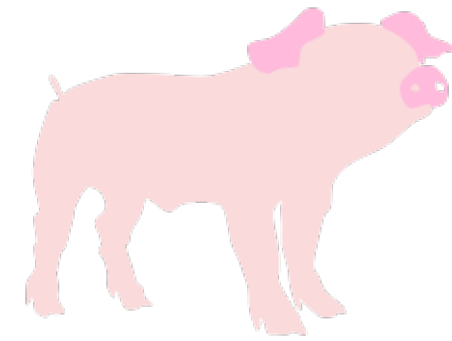
Waewaree 2022, Full-fatted *Hermetia illucens* larva as a protein alternative: effects on weaning pig growth performance, gut health



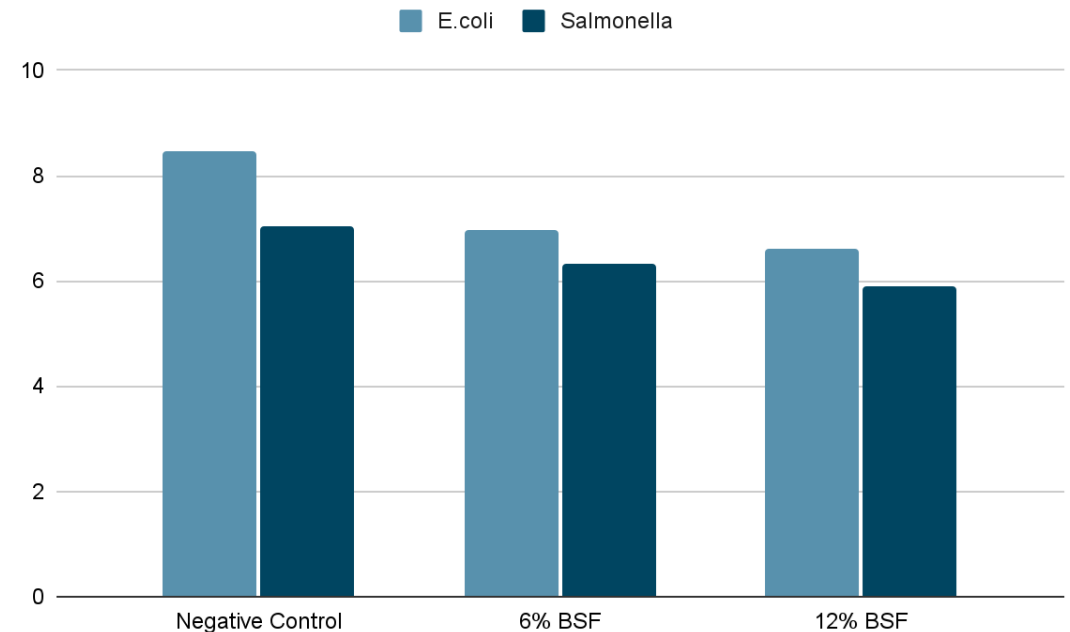
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Commercial Scale: Risk and Acceptance

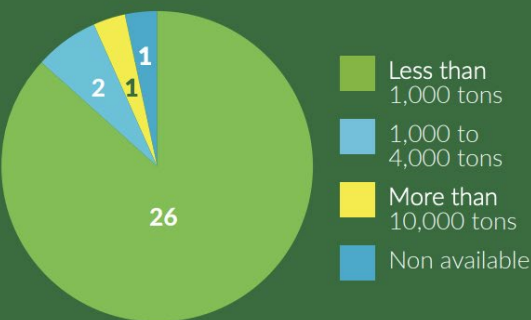


Scale

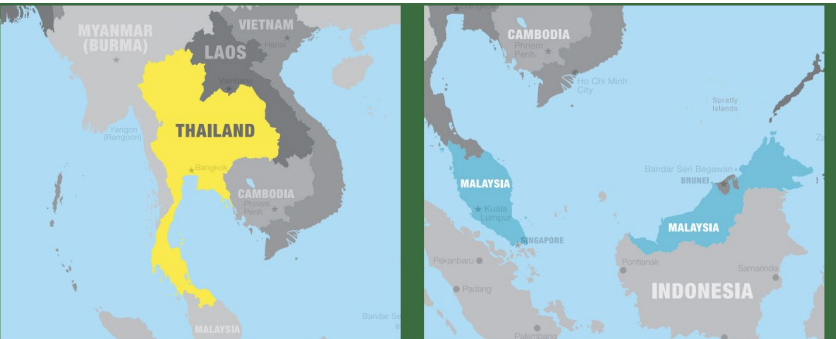
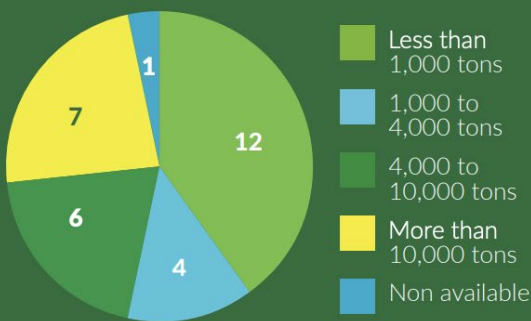
WHOLE INSECTS PRODUCTION (wet weight)

On 30 producers

Annual production in 2021



Targeted production for 2025



THAILAND

Area: 513,120 km²

Population: 68 million people

Insect as feed producers identified in the mapping:
14 BSF producers

MALAYSIA

Area: 329 847 km²

Population: 32,7 million people (2022)

Insect as feed producers identified in the mapping:
8 BSF producers



SINGAPORE

Area: 728,6 km²

Population: 5,6 million people (2022)

Insect as feed producers identified in the mapping:
4 BSF producers

INDONESIA

Area: 1,904,569 km²

Population: 273.5 million (2020)

Insect as feed producers identified in the mapping:
10 BSF producers

Insect meal potential market in Asia (million tonnes per annum)

Application	Inclusion Rate	Total Addressable Market in Asia (million tonnes per annum)	Insect meal potential market in Asia (million tonnes per annum)
Aquafeed	5%	7.6	0.4
Poultry Feed	5%	224	11.2
Swine Fweed	5%	139	6.9
Petfood	20%	4	0.8
Total			19.3

Table 2: Total Addressable Market in Asia data are adapted from Alltech feed data report 2022. Insect meal potential market in Asia assumptions taken from the AFFIA survey.

How to Navigate Risk

- ☑ Quality Certifications e.g. GMP and HACCP
- ☑ Approved plant based feedstock (no animal slaughter waste)
- ☑ No trace of heavy metals
- ☑ No trace of pathogens e.g. Salmonella
- ☑ Region of Sourcing



Sustainability: Case Study:



Nutrition
Technologies®
Innovation. Naturally.

1. Upcycling Factory Waste + Feed Source
2. Tropical Climate Systems
3. Vertical Farming
4. Rearing Waste Repurposing (Frass)

Impact category	Poultry meal	Hi.Protein meal	Lamb meal	Salmon meal
Climate change (kg CO2 eq)	8.87-10.7	0.93	39.72	7.3895
Land usage (m2/yr)	12.22-25.4	Approx 3*	369.81	4.86
Water usage (m3)	0.092- 0.66	0.89	1.803	2



Thank you

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