

# Bioconversion of a meat industry side-stream into added-value products and ingredients

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# Objectives

Investigation if sheepskin could be used as a substrate to rear Black soldier fly larva (BSF) and then produce BSF larva meal to be used as an ingredient in the formulation of animal feed.



# Background



## Putrid unwanted sheep pelts being dumped in huge numbers, causing stink for neighbours

Marty Sharpe · 13:38, Mar 23 2021

HAWKES BAY TODAY

## Hawke's Bay's rotting landfill problem

By [Patrick O'Sullivan](#)

25 Jun, 2021 02:58 PM

Low grade hides and skins are uneconomic to process and are sent to landfill instead.

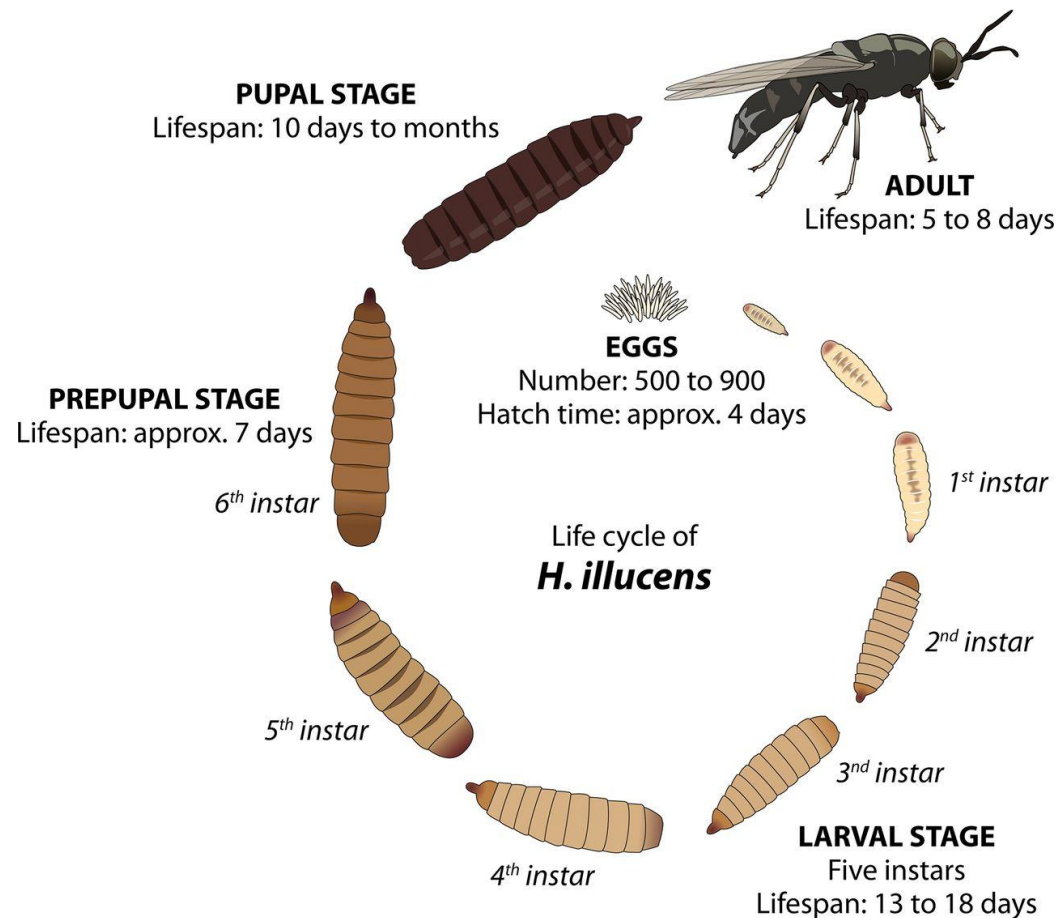
*Meat Industry Association*

Alternative uses for sheepskin, which is a side stream from the lamb meat industry, with an annual volume of approximately 28,000 ton/year.





# Black Soldier Fly larvae



## Breeding better waste-munching flies

LISA KORYCKI

September 2, 2022, 10:51 AM



JCU's Professor Kyall Zenger is the leader of a project in collaboration with Flyfarm Queensland to solve the challenges facing the industrial scale-up of Australian Black Soldier Fly (BSF) farming.

**European based ingredient and technology suppliers, feed formulation experts and farmers have collaborated on the development and launch of a new shrimp feed.**

The partners including Protix, Förde Garnelen, Aquafeed Germany, neomar and Crusta Nova outlined how they worked closely together to develop the product, branded as SHR EX.

The new feed has been exclusively designed for the needs of European land-based shrimp farms.

By Jane Byrne [↗](#)

09-Sep-2022 - Last updated on 09-Sep-2022 at 12:38 GMT

## Brief: Nutrition Technologies lands \$20m to expand insect-protein operation across Asia

September 20, 2022 Lucy Ngige

- Singapore-based insect protein producer [Nutrition Technologies](#) has closed a \$20 million equity round.
- The biotech company's production system leverages black soldier fly larvae to produce proteins for animal feed and fertilizers.

Vienna's LIVIN Farms Receives €6 million to Upcycle Food Waste Into Insect-Powered Protein

# Objectives



Investigation if sheepskin could be used as a substrate to rear Black soldier fly larva (BSF) and then produce BSF larva meal to be used as an ingredient in the formulation of animal feed.

- Characterization of the nutritional profile of different skin materials
- Insect dynamics and life history parameters
- Nutritional profile of the insects reared on different diets
- Feasibility study



# Trial Design



**Standard diet (S)** broll, typical chicken diet based on wheat residues

Sheepskin with partially shearing **(SW) short wool**

Sheepskin without shearing **(LW) long wool**

Sheepskin **chemically treated (CT)** to remove wool

Sheepskin **enzymatically treated (ET)** to remove wool

- BSF larvae were feed with broll for 7 days after hatching
- moved to the different diets for 15 days
- 2 different larval density 200 and 400
- Larvae and Larvae meal composition analysed



# Trial Design





# Different life stages of BSF larvae and survival rate





# Amino acid profile of Sheep skin and BSF larvae meals

Amino acids Diet composition	Crude Protein %	Alanine	Arginine	Aspartic acid & asparagine	Cystine	Glutamic acid & glutamine	Glycine	Histidine	Hydroxylysine	Hydroxyproline	Isoleucine	Leucine	Lysine	Methionine	Phenylalanine	Proline	Serine	Threonine	Tryptophan	Tyrosine	Valine	Total
Broll Diet		31	44	43	9	129	32	19	0	0	19	38	28	7	25	44	26	21	2	21	27	563
Chemical treat Diet		57	68	49	9	96	117	10	5	58	19	42	34	7	23	73	34	25	0	20	27	773
Enzyme treat. Diet		63	72	51	16	99	130	12	5	66	19	41	33	7	23	86	37	28	0	21	28	838
Long wool Diet		40	90	65	53	141	50	12	0	5	30	74	32	6	34	58	75	53	0	50	46	917
Short wool Diet		65	76	56	18	109	131	12	5	62	20	46	36	6	25	86	42	30	0	24	29	877
Larvae meal composition																						
Broll BSF	54.6	56	27	69	3	81	38	18	0	0	29	47	41	8	28	40	30	28	4	50	42	639
Chemical treat. BSF	42.9	56	28	56	5	87	35	14	0	0	27	43	36	5	24	41	27	25	2	40	38	589
Enzyme treat. BSF	49.8	63	29	61	5	92	38	19	0	0	30	48	43	6	28	43	29	28	5	49	42	656
Long wool BSF	53.3	56	34	72	5	85	40	20	0	0	32	52	43	9	33	44	31	29	6	60	46	699
Short wool BSF	47.4	59	33	77	5	90	41	22	0	0	33	54	48	8	35	45	32	31	6	62	47	727

Taurine not detected

# Amino acid profile of Sheep skin and BSF larvae meals

Fatty acids % Diet composition	Crude Protein %	Amino acid profile																				Total
		Alanine	Arginine	Aspartic acid & asparagine	Cystine	Glutamic acid & glutamine	Glycine	Histidine	Hydroxylysine	Hydroxyproline	Isoleucine	Leucine	Lysine	Methionine	Phenylalanine	Proline	Serine	Threonine	Tryptophan	Tyrosine	Valine	
Broll Diet		31	44	43	9	129	32	19	0	0	19	38	28	7	25	44	26	21	2	21	27	563
Chemical treat Diet		57	68	49	9	96	117	10	5	58	19	42	34	7	23	73	34	25	0	20	27	773
Enzyme treat. Diet		63	72	51	16	99	130	12	5	66	19	41	33	7	23	86	37	28	0	21	28	838
Long wool Diet		40	90	65	53	141	50	12	0	5	30	74	32	6	34	58	75	53	0	50	46	917
Short wool Diet		65	76	56	18	109	131	12	5	62	20	46	36	6	25	86	42	30	0	24	29	877
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Short wool BSF	47.4	59	33	77	5	90	41	22	0	0	33	54	48	8	35	45	32	31	6	62	47	727

Taurine not detected



# Mineral profile of Sheep skin and BSF larvae meals



Diet composition (mg/kg)	Cu	Fe	Ni	Zn
Broll Diet	11.9	169.0	2.14	92.2
Chemical treat Diet	2.7	547.4	0.90	55.7
Enzyme treat. Diet	3.0	216.8	0.39	60.6
Long wool Diet	3.5	179.3	0	72.2
Short wool Diet	2.9	153.7	0	65.0

Larvae meal composition	Total Nitrogen (g/100g)	Crude Protein (g/100g)	Crude Fat (g/100g)	Calcium (g/100g)	Magnesium (g/100g)	Potassium (g/100g)	Sodium (g/100g)	Phosphorus (g/100g)	Sulphur (g/100g)	Iron (mg/kg)	Boron (mg/kg)	Copper (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
Larvae feed on different diets														
Broll Diet	8.7	54.6	29.5	0.68	0.32	1.48	0.07	0.93	0.44	229.3	1.31	17.6	480.4	161.6
Chemical treat Diet	6.8	42.9	41.8	2.30	0.26	0.91	0.11	0.69	0.30	120.3	1.57	11.7	209.2	93.1
Enzyme treat. Diet	7.9	49.8	39.2	0.67	0.26	1.01	0.10	0.80	0.34	177.9	0.74	44.5	211.8	114.3
Long wool Diet	8.6	53.3	32.0	0.59	0.27	1.12	0.12	0.73	0.41	309.3	0.85	12.3	288.0	177.1
Short wool Diet	7.6	47.4	35.8	0.41	0.21	0.98	0.10	0.61	0.37	180.1	0.95	9.6	210.6	111.6

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Enzyme treat. Diet	7.9	49.8	39.2	0.67	0.26	1.01	0.10	0.80	0.34	177.9	0.74	44.5	211.8	114.3
Long wool Diet	8.6	53.3	32.0	0.59	0.27	1.12	0.12	0.73	0.41	309.3	0.85	12.3	288.0	177.1
Short wool Diet	7.6	47.4	35.8	0.41	0.21	0.98	0.10	0.61	0.37	180.1	0.95	9.6	210.6	111.6



# Fatty acid profile of Sheep skin and BSF larvae meals



Fatty acids % Diet composition	Crude fat %	C10:0	C12:0	C14:0	C14:1	C15:0	C15:1	C16:0	C16:1	C17:0	C17:1	C18:0	C18:1 trans	C18:1 cis Oleic	C18:2 trans	C18:2 cis LA	C18:3 cis ALA	C20:3 cis	C20:4 cis	C20:5 cis EPA	C24:0
Broll Diet	29.5	0.01	0.18	0.1		0.07		17.2	0.1	0.06	0.02	1.0		19.1		57.7	3.7		0.04		
Chemical treat Diet	41.8	0.21	0.21	2.3	0.09	0.24	0.24	25.7	1.7	0.73	0.35	14.4	0.1	50.3	0.37	0.8	0.54	0.74	0.13	0.44	0.15
Enzyme treat. Diet	39.2	0.09	0.08	1.6	0.15	0.17	0.16	23.3	3.3	0.49	0.69	8.3	0.11	59.1	0.25	0.94	0.43	0.39	0.12	0.14	0.05
Long wool Diet	32.0	0.12	0.12	1.7	0.05	0.31	0.16	23.1	1.3	0.99	0.45	17.2	0.21	49.9	0.55	1.6	0.95	0.4	0.13	0.25	0.2
Short wool Diet	35.8	0.11	0.11	2.1	0.16	0.28	0.14	24.8	3.2	0.68	0.6	9.6	0.14	54.7	0.51	0.98	0.48	0.52	0.06	0.3	0.13
Larvae meal composition																					
Broll BSF	21.0	1.7	43.34	9.7	0.09	0.21		14.9	2.3	0.18		1.9		9.8		12.8	0.75				
Chemical treat. BSF	28.7	0.79	19.16	5.5	0.17	0.57		20.7	5.5	0.47		2.8	0.13	32.8	0.21	4.8	0.5		0.08	0.23	
Enzyme treat. BSF	29.4	1.16	23.43	5.6	0.19	0.72		18.1	5.8	0.38		2.6	0.13	29.7	0.23	5.1	0.55		0.1	0.26	
Long wool BSF	21.5	1	28.62	6.5		0.86		19.7	2.5	0.45		3.7		26.6	0.16	6.4	0.75			0.39	
Short wool BSF	27.6	0.86	21.5	6.7	0.08	0.95		21.6	2.8	0.68		5.0	0.1	31.2	0.33	4.2	0.7		0.1	0.29	

# Fatty acid profile of Sheep skin and BSF larvae meals



Fatty acids % Diet composition	Crude fat %	C10:0	C12:0	C14:0	C14:1	C15:0	C15:1	C16:0	C16:1	C17:0	C17:1	C18:0	C18:1 trans	C18:1 cis Oleic	C18:2 trans	C18:2 cis LA	C18:3 cis ALA	C20:3 cis	C20:4 cis	C20:5 cis EPA	C24:0
Broll Diet	29.5	0.01	0.18	0.1		0.07		17.2	0.1	0.06	0.02	1.0		19.1		57.7	3.7		0.04		
Chemical treat Diet	41.8	0.21	0.21	2.3	0.09	0.24	0.24	25.7	1.7	0.73	0.35	14.4	0.1	50.3	0.37	0.8	0.54	0.74	0.13	0.44	0.15
Enzyme treat. Diet	39.2	0.09	0.08	1.6	0.15	0.17	0.16	23.3	3.3	0.49	0.69	8.3	0.11	59.1	0.25	0.94	0.43	0.39	0.12	0.14	0.05
Long wool Diet	32.0	0.12	0.12	1.7	0.05	0.31	0.16	23.1	1.3	0.99	0.45	17.2	0.21	49.9	0.55	1.6	0.95	0.4	0.13	0.25	0.2
Short wool Diet	35.8	0.11	0.11	2.1	0.16	0.28	0.14	24.8	3.2	0.68	0.6	9.6	0.14	54.7	0.51	0.98	0.48	0.52	0.06	0.3	0.13
Larvae meal composition																					
Broll BSF	21.0	1.7	43.34	9.7	0.09	0.21		14.9	2.3	0.18		1.9		9.8		12.8	0.75				
Chemical treat. BSF	28.7	0.79	19.16	5.5	0.17	0.57		20.7	5.5	0.47		2.8	0.13	32.8	0.21	4.8	0.5		0.08	0.23	
Enzyme treat. BSF	29.4	1.16	23.43	5.6	0.19	0.72		18.1	5.8	0.38		2.6	0.13	29.7	0.23	5.1	0.55		0.1	0.26	
Long wool BSF	21.5	1	28.62	6.5		0.86		19.7	2.5	0.45		3.7		26.6	0.16	6.4	0.75			0.39	
Short wool BSF	27.6	0.86	21.5	6.7	0.08	0.95		21.6	2.8	0.68		5.0	0.1	31.2	0.33	4.2	0.7		0.1	0.29	



# Nutritional Feasibility



BSF meals could be used with a 30–40% inclusion in the diet formulation for dogs and cats

BSF meal could be used for fish and poultry diets



# Financial Feasibility



10 year project life time

CAPEX \$10,000,000

OPEX \$350,000 per annum

1000 t Waste per annum = 340 t Dried meal at \$15 per kg

Gross profit \$5,000,000 per annum





# Thank you

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A smart  
green  
future.  
Together.