Black Soldier Fly Larvae – A Sustainable Protein Source?

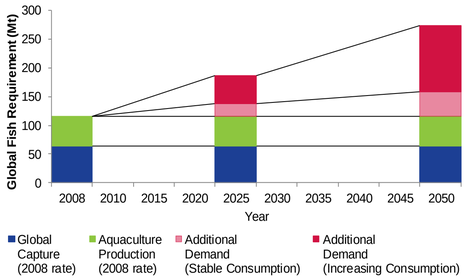
AUTHOR DETAILS: Ian Banks is currently studying a PhD in Entomology and Sanitation at the London School of Hygiene and Tropical Medicine. The project aims to evaluate the potential of black soldier fly (*Hermetia illucens*) larvae, as agents to digest pit latrine contents, and discuss the impact of this approach on sanitation in developing countries.

AQUACULTURE & FISHMEAL

Aquaculture

- Aquaculture is a growing source of food for the human race
- In 2008, aquaculture produced 43%, 52.5 million tonnes (Mt)[1], of the total fish globally caught and produced
- Estimates predict that by 2050, between 95 and 167 Mt of fish will need to be produced using aquaculture, depending on consumption, and assuming global capture remains at 2008 levels[2]

Predicted Aquaculture Production 2008 - 2050

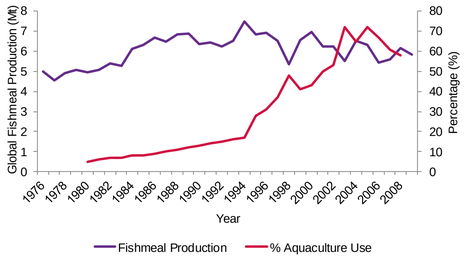


- The production of aquaculture fish is highly dependent on a sufficient supply of nutrients, with up to 80% being fishmeal[3]

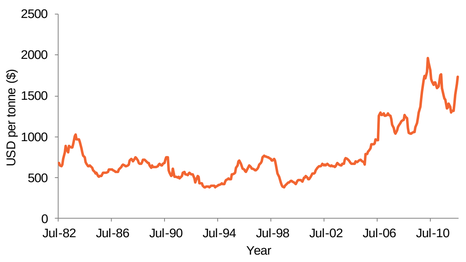
Fishmeal

- Fishmeal is a brown powder produced by cooking, pressing, and drying fish and fish trimmings
- Fishmeal contains high levels of protein (60 - 72%) and fat (5 - 12%), with a high content of health promoting omega-3 fatty acids[4]
- In 2008, 20.8 Mt of fish were caught and used to produce 4.8 Mt of fishmeal[1,5], with 58% used in aquaculture

Global Fishmeal Production & Use in Aquaculture 1988 - 2008



- The cost of fishmeal has increased dramatically since 2000, due to static global supplies and strong market demand[3]



Cost of Fishmeal 1982 - 2012

- Therefore, alternative sources of nutrients used in aquaculture will be required to replace, partially or fully, fishmeal

Fishmeal Alternative

- There is a large variety of alternative protein sources available that could be used to replace fishmeal, including; plant by-products, animal by-products, and invertebrates (Table 1)

Table 1 - Typical Composition of Fishmeal Replacements

Origin	Ingredient	Protein (%)	Lipid (%)	Lysine (%)	Methionine (%)	Cysteine (%)	Advantages	Disadvantages
Plant	Soybean meal (SBM)[6]	48.5	0.9	3.08	0.68	0.75	Economical, nutritious, high crude protein	Concentrations of 10 essential amino acids (EAA), fat, ash and phosphorous are low
	Canola meal[6]	38	3.8	2.27	0.7	0.47	Not widely used in aquafeed, similar protein content to SBM	Similar price to SBM, low in phosphorous
Animal	Poultry by-product meal[7]	66	13	3.10	0.99	0.98	High crude protein and Lysine	Deficient in Lysine, Methionine and Histidine
	Fish by-product meal[8]	Varies depending on species					Best nutritional substitute	Potential pathogens and contaminants harmful to both fish and humans
Inver-tebrate	Earthworm meal[9]	63	18.5	1.43	1.72	0.39	High crude protein, and fat	Low Lysine and Cysteine
	Housefly pupae meal[10]	41	8.5	6.04	2.28	0.52	High crude protein, Lysine and Methionine	Low Cysteine and fat, disease spreading vector,
	Black soldier fly meal[11]	52.5	19.2	2.16	0.32	0.31	High crude protein, fat and Lysine, can alter EAA concentrations with different diets	Low Methionine and Cysteine

AQUACULTURE & FISHMEAL

- The black soldier fly (BSF) (*Hermetia illucens*) is a non-disease spreading, non-pest fly that is found around the world[12]

Adult black soldier fly (*Hermetia illucens*)

- The first five larval instars are voracious consumers of organic matter, the sixth larval instar is known as the prepupae and does not feed[13]
- These prepupae are high in fat and protein, and when used as a component of a complete diet support good growth in chickens[14], swine[15], rainbow trout[16], and catfish[17]

Black soldier fly prepupae

- It is possible to enhance BSF meal with Omega-3 fatty acids[16], and essential amino acids[11], by altering what the black soldier fly larvae feed on, this meal can replace up to 50% of fishmeal without affecting fish growth[11]
- It is estimated that with a feed conversion rate (FCR) of 16%, BSF feeding on swine manure in the United States could produce 1.8 Mt of prepupae per year
- Research is being conducted on the efficiency of BSF's converting fresh human faeces and pit latrine waste into prepupal biomass, with preliminary results producing an FCR of at least 16%[18]
- With 1.7 billion people using latrines, and a further 2.7 billion with no access[19], it is estimated that 25 Mt of prepupae could be produced per year from the waste created

CONCLUSION

- Aquaculture is set to grow greatly over the next 40 years, while its main source of nutrition is unsustainable and increasing in price
- Black soldier fly larvae offer a suitable fishmeal alternative, while at the same time providing a way to effectively manage human and animal waste

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