# New Opportunities for Seafood Processing Waste

## Appendix 7: Investigation of Biomax Process For Hydrolysing Seafood Waste

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# 1. Background

Biomax is a Singaporean company that has developed a novel enzymatic process for biological waste treatment. The dried product produced by the BIomax process can either be used as fertilizer or as a feed ingredient. The Biomax process had previously been tested on poultry and meat waste and the company were interested to see how waste fish would go in their system. Therefore Curtin worked with BIomax using fish waste as an ingredient in the process.

The Biomax process for fish is described below:

The fish waste material is loaded in a specialized digester along with BM1 enzymes at a ratio of 1ton waste to 1Kg enzymes. A dried waste material was also added (eg coconut coir, sawdust). The digester is a compact and enclosed reactor with sturdy internal mixer that ensures homogenous digestion of waste. BM1 enzymes are a specially formulated cocktail of naturally occurring microbes that break down complex organic compounds inside the waste into simpler organic matter at high speed. This waste/enzyme mix is then mixed, aerated and heated at 80$^{o}$C within the digestor for the next 24 hours. After 24 hours, nutritious animal feed or fertilizer can be produced in powdery form to be discharged from a separate conveyor belt. This environment friendly **zero-waste** process does not produce any solid or liquid by products, only the dried product. This product is cooled for 2-3 days. The resulting product is shelf-stable at room temperature for at least 12 months.

# 2. Trial 1: Methods and Results

### 2.1 Production of Material using Biomax process.

Waste (Fish Frames and Trimmings) were despatched frozen (Patagonian toothfish waste and Atlantic salmon waste) or fresh (snapper waste) to the Biomax plant in Singapore for hydrolysis in their pilot plant and subsequent analysis. Sample and recovery results are shown in Table 1, general analytical results in Table 2 and amino acid results in Table 3. Photos are shown in Figure 1 (toothfish), Figure 2 (salmon) and Figure 3 (snapper).

**Table 1: Sample mix and recoveries.**

| Samples | Sample volume | Mixed with …. | Recovery | Comments |
|---|---|---|---|---|
| **Toothfish trimmings** | 21kg of fish waste | 6kg Coconut coir | | Yield data not collected |
| **White fish trimmings (snapper trimmings)** | 29.26 snapper waste (moisture content 59.38%) | 11.38kg of coco peat | 23.42 kg | Yield is 57.62% |
| **Red fish (Atlantic salmon** | Salmon waste (30 kg) | Sawdust 13.5g) | 25kg | 57.5% yield. |

| | | | | |
|---|---|---|---|---|
| **trimmings)** | | | | |

**Table 2: Analytical Results.**

| **Analysis** | **Toothfish waste (with coconut coir)** | **White fish (snapper waste) with coco peat)** | **Red fish (Atlantic salmon) with sawdust** |
|---|---|---|---|
| **Protein %** | 18.64* | 29.41 | 16.94 |
| **Crude Fat %** | 24.68 | 12.74 | 23.93 |
| **Moisture %** | 5.54 | 8.67 | 5.18 |
| **Fibre** | 17.12 | Acid detergent 46.21<br>Neutral detergent 69.31 | |
| **Energy kcal/g** | 4.27 | 2.4 | 4.70 |
| **Ash** | | 31.75 | |
| **Carbohydrate %** | | | 46.62 |
| **TPC (cfu/g)** | | | |
| **Salmonella (/25g)** | | | Not detected |
| **E.coli (cfu/g)** | | | <10 |
| ***Clostridium perfringens (cfu/g)*** | | | <10 |

* Amino acid breakdown (%) below

**Table 3: Amino acid Breakdown results.**

| | **Toothfish** |
|---|---|
| **Aspartic acid** | 1.686 |
| **Threonine** | 0.743 |
| **Serine** | 0.918 |
| **Glutamic acid** | 2.794 |
| **Glycine** | 1.969 |
| **Alanine** | 1.212 |
| **Cystine** | 0.254 |
| **Valine** | 0.973 |
| **Methionine** | 0.405 |
| **Iso-leucine** | 0.721 |
| **Leucine** | 1.378 |
| **Tyrosine** | 0.589 |
| **Phenylalanine** | 0.711 |
| **Histidine** | 0.49 |
| **Lysine** | 1.192 |
| **Arginine** | 1.237 |
| **Tryptophan** | 0.234 |
| **Proline** | 1.035 |
| **TOTAL** | 18.541 |

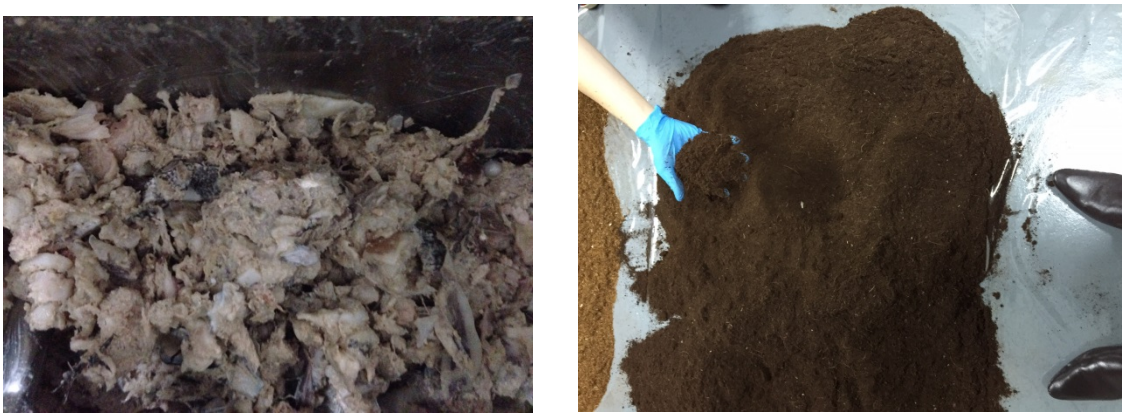


***Figure 1: Toothfish waste before and after Biomax processing.***

***Figure 2: Atlantic salmon waste after Biomax processing.***

| Input | | |
|---|---|---|
|  |  |  |
| Fish head 10kg | Fish bone | Fish stomach & flakes |

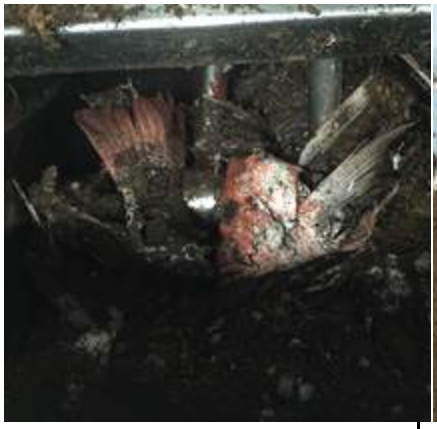
| | | |
|---|---|---|
|  |  | |
| Input | Output | |

***Figure 3: Snapper waste before and after Biomax processing.***

**2.2 Assessment of Value of product as feed ingredient**

A national database of Australian feed suppliers for the pig, poultry and aquaculture markets was developed at Curtin and the analytical results from the Biomax trials were despatched to various feed manufacturers for comment.

Comments were generally that the protein content was too low for a fish meal replacement use, but were comparable with grain based fed ingredients (but with potential additional nutritious value from the fish component). The fat level was considered too high. The dry carrier was considered to have no nutritional benefit.

Specific comments:

Supplier 1

*The inclusion of the sawdust and coconut husk substantially diminishes the value of these products for us. If they could run the process without these plant additions we might be interested. We also couldn't use the salmon based product in the mill as we don't feed like-to-like*

*We use a fair bit of lupin kernel meal so that'd be a safe option (as replacement for sawdust/coconut coir). Though lupin seed meal is cheaper and what needs more value adding.*

Supplier 2

*A few things you will need to ask.*

1. *How much product will you have to work with*
2. *How much finished product will be made*
3. *What form will the product be in as you have to make allowance for existing machinery exist at the mills.*
4. *The bug count of the product (if your feeding young or lactating or dry )how your product will perform.*

*Looking at what you have got, May be putting them all together and drying as one with no carrier would be your best option.*

*Supplier 3*

*I might be missing something here, but to me this looks like a really low grade animal protein. Currently Fishmeal that we buy is around 60% protein, and 8% fat and 14 MJ/kg (3,400 Kcal/kg). It has a lot of carrier in it – could this be removed/diluted to increase the nutritional aspect of the product?*

*A typical Monogastric diet is 18% protein, and 14 MJ, so I would see the below as Nutrient depleting the formulation. Unless there is a lot of Omega 3 etc, it would need be relatively cheap – I'd suggest lining up the specifications against Peas, Canola meal rather than fishmeal and maybe it's got a place. If that's the case it might be worth more like $400/t than $1,500 for good quality fish or $800 for Meatmeal.*

## 3: Trial 2: Method and Results

Based on the various comments a new trial was run with lupin kibbings and snapper trimmings to try and increase the protein content and nutritional benefit. As Dr Howieson was in Singapore on other business she attended the trial and met with the Biomax executive in Singapore to discuss progress/opportunities. Figure 4 shows photos of the process and Table 4 the analytical results. .

**Test date: 2015.08.20**

| Snapper trimming waste content | Composition | Visuals |
|---|---|---|
| • Fish bone<br>• Fish head<br>• Fish belly<br>• Fish scale<br>• Fish gut | 50 % |  |
| Lupin meal | 25 % |   |
| Coco peat | 25 % |  |
| Water | 20 Litre | |

***Figure 4: Lupin trials components.***

*Table 4: Results of Analysis of Lupin Trial*

| Analysis | Snapper Waste (with lupin kibbings and coconut coir) |
|---|---|
| **Protein %** | 22.64 |
| **Crude Fat %** | 5,82 |
| **Moisture %** | 11,65 |
| **Fibre** | 18.08 |
| **Energy kcal/g** | 2.35 |
| **Ash** | 18.83 |
| **Carbohydrate %** | |
| **TPC (cfu/g)** | |
| **Salmonella (/25g)** | |
| **E.coli (cfu/g)** | |
| ***Clostridium perfringens (cfu/g)*** | |

## 4. Discussion

**4.1 Given the low protein content and the high fat the following possible uses for the Biomax product have been suggested**

a. Palatability additives in aquaculture feed
b. Protein replacement in aquaculture feed. However although the amino acid mix is excellent, the fat content is too high. The protein is also too low, there is the potential for increasing protein to ~28% if the dry ingredient is something like corn grain or other higher protein material instead of coconut coir. There may also be the possibility to further increase protein via fermentation (Fotedar* pers comm).
c. For pig feed the product cannot be considered for fish meal replacement as protein too low, but may be considered as grain meal replacement pending input into nutritional calculator/formulae.

**4.2 Cost Benefit Considerations.**

a. Estimated cost of production needs to be calculated by Biomax to assist in options for use.
b. Understanding if there are sufficient volumes of waste in Aust given current Biomax digestor capacities. At present Biomax have two units:

1) 22,000 Litre Unit. This unit can handle up to 15 ton waste per 24 hours. Yield and output from every batch is approx. 10 ton
2) 80,000 Litre Unit. This unit can handle up to 50 ton waste per 24 hours. Yield and output from every batch is approx. 35 ton

**4.3 Next Steps**

The project has been ceased but suggested next steps would include devising strategies to increase the protein to around 40%, this could include adding higher value products such as lupin meal, microalgae, rather than sawdust etc. Trialling fermentation to increase protein may also be attempted. These strategies may increase the production cost but would make a more sellable

product (at least for aquaculture). It would also be necessary to undertake feed trials to see how the product performs. Also to undertake cost benefit analyses of the production costs versus the selling price.

There is a need to devise strategies to decease ash component (this may be around varying the type of waste going in).

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