New Opportunities for Seafood Processing Waste

Appendix 6: Strategies for Potential Utilisation of Aquacultured Abalone Waste

Dr Janet Howieson

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1. Background

Abalone, also known as *Haliotis* in the family Haliotidae, is found worldwide and is classified into the class Gastropoda of the phylum Mollusca (Anderson, 2003). It is one of the most expensive seafoods especially amongst Asian countries like Thailand, Singapore, China, and Hong Kong. In Australia, the legal areas of wild fishery include all coastal waters of Southern Ocean, Indian Ocean, Timor Sea between the Western Australia/ Northern Territory Border and Western Australia/ Southern Australia Border (Department of Fisheries Government Western Australia, 2002). There are four types of species commonly known, the Greenlip, Brownlip, Blacklip and Roeii. Abalone aquaculture also occurs in Australia, in Western Australia, South Australia, Victoria and Tasmania. The common aquaculture species is greenlip abalone.

A nutrition information panel for Abalone can be seen in Table 1 below. The information is based on analysis conducted by Silliker Microtech Pty Ltd (2012):

Table 1 Nutrition Information Panel for dried abalone shuckings:

	Sample 2: Lab No. 0205380F Dried Abalone Gut
	Average Quantity Per 100g
ENERGY	1656kJ
PROTEIN	52.9g
FAT - TOTAL SATURATED	13.1g 4.2g
CARBOHYDRATE - TOTAL SUGARS	13.9g 7.1g
SODIUM	4270mg
DIETARY FIBRE	4.5g
	Sample 3: Lab No. 0211245M Dried Abalone Gut
CHOLESTEROL	439.6 mg / 100g

1.1 Abalone Waste.

Wild harvest abalone are generally shucked and the edible portion is what is traded. In wild abalone production most of the production wastes, following shucking, are discarded into the sea. The shucking wastes serves as a food source to other animals that would not naturally have the opportunity to feed on abalone (Banumathy, 2002). The edible portion of an abalone is around 33% of the total weight, inedible parts include the shell (~34%) and the soft waste (stomach, mouth, gills, tissues, head, frills) (33%) making up the rest of the weight (Howieson pers comm).

By contrast aquacultured abalone is generally shucked on land and the waste generated is then frozen for later disposal. This frozen product and the shell is therefore considered an opportunity for value-adding. However there has been not a great deal of research performed into the potential uses for abalone waste. Currently policies and principles of abalone aquaculture in Western Australia are mentioned only in terms of production, economy and financial factors.

1.2 Potential Uses of Abalone Waste

Hydrolysis

Hydrolysis is a chemical reaction which breaks down complex proteins into smaller simpler subunits via acid or enzyme addition. The hydrolysed products can be used as amino acid sources combined with reducing sugars for various applications dependent on the hydrolysis products. Hydrolysis of seafood waste has been commonly reported, with the hydrolysate product then used as fertiliser or as a feed supplement. In this research study, abalone waste will be hydrolysed to determine what useable by-products could potentially be are produced. Two different processes of hydrolysis are commonly reported: acid and enzyme.

Collagen and Gelatin

One use of abalone shucking waste which has been explored is the extraction of collagen from abalone flesh. Collagen has traditionally been been obtained from the joints and meat of cattle feed for pharmaceutical, medical and cosmetic industries. However, there has been some concern by manufacturers over the safety of using collagen derived from a bovine source due to the existence of Bovine Spongiform Encephalopathy (BSE), commonly known as Mad Cow Disease. It is an infectious disease originating from infected meat and bone meal, with no treatment available and difficult to identify. To prevent the spread of this disease to humans, manufacturers from Japan, UK and Europe and other countries have stopped using British beef and beef products Manickavasagam (2013).

The type of collagen utilised in foods and beverages, cosmetics and medical materials is called Type 1 Collagen, especially bovine skin collagen (Manickavasagam, 2013). In Abalone, Type 1 collagen is present between the shell and the tentacles, and potentially can be extracted and utilised for pharmaceutical purposes.

Collagen is converted to gelatin as denaturation of collagen at temperatures above body temperature are reached (Banumathy, 2002). Gelatin is used in medicinal purposes or can be used to produce collagen masks. It is also commonly used in transparent dessert jelly, and also widely used in confectionery, jellied meats and chilled dairy products (Manickavasagam, 2013). When collagen is heated, the helix unfolds and collagen is readily soluble and denatures. The temperature used for bovine collagen is usually 40 C. This could

be due to the proportion of amino acids, proline and hydroxyproline present in collagen, which determines the melting and gelling temperature of gelatin (Manickavasagam, 2013).

Anti-Cancer components

Isatin is a synthetically versatile molecule, its derivatives possess diverse biological and pharmacological properties: antifungal, antiviral, antibacterial, and anticonvulsant and anticancer (Benkendorff et al. 2013). A range of mono-substituted isatins have been studied, showing it being five to ten times more effective in killing cancer cells than the unsubstituted isatins (Benkendorff et al, 2013). Various substituted isatins are also naturally found in nature including plants, fungi and marine molluscs (Benkendorff et al, 2013). Recent studies have shown extracts of 6-bromoisatin from the marine molluscs have anticancer properties. It is presumed that such brominated compounds would be present in abalone.

Shells

Abalone shells, if cleaned of shuckings and unmarked can potentially be used for decorative work

2. Objective

Determine options for potential utilisation of farmed Greenlip Abalone waste (gonads and stomach/ intestines with or without shells atttached) supplied by Southseas Abalone.

3. Methods, Results, Discussion

Following discussion with the industry partner three separate experimental trials were performed.

These trials were:

1. Determine the effectiveness of acid and enzyme hydrolysis of abalone waste (with and without shell).

2. Drying of hydrolysed and unhydrolysed waste in a freeze dryer.

3. Oven drying of untreated hydrolysed waste to develop a shelf-stable powder.

Each trial will be reported separately.

3.1 Acid and Enzyme Hydrolysis of Abalone waste.

3.1.1 Methods

The following experimental treatments were prepared.

a. **Addition of water and heating to Abalone shuckings with shell attached (control)**

- ~190g of abalone shuckings with shells were placed in a Sunbeam Sous Vide/ Slow Cooker.
- 1.5 L of water was added and incubated for 1.5-2 hours at 70˚C.

b. **Acid Hydrolysis of Abalone shuckings with shell attached**

- 258.33g of Abalone Shuckings with shells were placed in a Sunbeam Sous Vide/ Slow Cooker
- 3.5% by volume of phosphoric acid was added to the Abalone Shuckings
- The shuckings were incubated for 2 hours at 50˚C and further incubate overnight.

c. **Enzyme Hydrolysis of Abalone shuckings with shell attached:**

- 258.47g of Abalone shuckings with shells were placed in a Sunbeam Sous Vide/ Slow Cooker.
- 0.57g of Protamex was added to mL tap water (850mL) to dissolve and then added to the shuckings with shells attached and incubate for 2 hours at 55˚C
- Abalone shuckings with shells were then further incubated overnight.

d. **Acid Hydrolysis of Abalone shuckings (no shell):**

- 756g of Abalone Shuckings were placed in a Sunbeam Sous Vide/ Slow Cooker
- 3.5% by volume of phosphoric acid was added to the Abalone Shuckings
- The shuckings were incubated at 4 hours at 40˚C and incubated further overnight
- Batches were stirred daily until liquified
- The liquified remains were transferred into 800 g batches and refrigerated for lipid yields
- Centrifuged for 10 min at 5000 rpm to exstract oil

e. **Enzyme Hydrolysis on Abalone shuckings (no shell):**

- 754.81g of Abalone shuckings were placed in a Sunbeam Sous Vide/ Slow Cooker (the frames were cut into small pieces using shears).
- 1.5 g / kg Protamex (4.4g) was added to mL tap water (75.84mL) to dissolve and then added to the shuckings
- The shuckings were incubated for 4 hours and further incubate overnight at 55˚C, stirring occasionally through the digestion process every 20-minutes.
- The liquified remains were transferred into 800 g batches and refrigerated for lipid yields

Analyses

Following visual observation and comment, recoveries of the different hydrolysis products were determined. Shell integrity and form was observed.

3.1.2.Results

a. Addition of Water to Abalone shuckings with shell attached

Abalone shells with waste attached were placed in water at a temperature of 70˚C. The waste was easily removed after an hour and a half to two hours. The high temperature of the water denatured the collagen present and so the waste was able to be easily detached from the shell. Shells were clean and unaffected (Figure 1).

Figure 1: Shells after addition of Water

b. Acid and Enzyme Hydrolysis on Abalone Shuckings with shell attached

There was an obvious discolouration of the abalone shells in acid hydrolysis. Also, there were little cracks formed by the edge and this could be due to the fact that 3.5% phosphoric acid was too concentrated, causing the cell structures of abalone shell to break down and crack (Figure 2). All waste from the shell was removed by the acid hydrolysis.

Enzymatic hydrolysis retained the shell integrity and colour at the optimum temperature of 55˚C (Figure 2). However, there was still some waste attached to the shell and this might be due to the incomplete breakdown of the collagen present in abalone.

Figure 2: Shell damage with Acid and Enzyme Hydrolysis

c. Acid and Enzyme Hydrolysis (no shell)

After four hours the abalone waste broke down more efficiently using enzyme hydrolysis in comparison to acid hydrolysis (Table 1 and Figures 3 and 4). However there was significant undigested solid in both treatments. There was no change in the hydrolysis from 4 hours when compared to overnight incubation.

Table 2: Results from acid and enzyme hydrolysis of abalone shuckings

	Initial Weight (g)	Post hydrolysis Solid (g)	Post hydrolysis liquid (g)	Final combined Weight (g)	% left unhydrolysed	
Acid	756	186.66	430.5	617.16	30.2	
Enzyme	754.81	144.19	505.21	649.40	22.2	

Figure 1: Acid Hydrolysis after 4 hours

Figure 2: Enzyme Hydrolysis after 4 hours

3.1.3 Discussion

Acid and enzyme hydrolysis did not result in complete breakdown of the abalone shuckings. This may indicate non-protein components. Enzyme hydrolysis was more effective then acid hydrolysis and did not impact on the shell integrity.

3.2 Drying of hydrolysed and unhydrolysed waste in a freeze dryer

The aim of this trial was to dry the partial hydrolysed waste and the un-hydrolysed waste using a freeze and vacuum vacuum dryer. However following consultation with laboratory staff the room temperature vacuum dryer was not recommended for the liquefied samples due to the possibility of the waste emitting "off" smells before the samples had completely dried. A heated rotating vacuum was therefore used.

3.2.1 Methods

Enzyme hydrolysis

Abalone waste was enzymatically hydrolysed by the addition of 0.8g Protamex (). A total of 536.4g of Abalone waste was defrosted and placed in an incubator (Sunbeam Sous Vide). The incubator was set to 55C and 50ml of water was added to ensure optimum conditions for the enzymes to function. The hydrolysis process continued for 24 hours, after which samples were removed from the incubator and solids and liquids separated. Samples were then frozen at -18˚C until further analysis.

Acid hydrolysis

Abalone waste was also hydrolysed with acid. A total of 488.44g of Abalone waste was defrosted and placed in an incubator (Sunbeam Sous Vide). The incubator was set to 55C and 17ml of phosphoric acid was added. The hydrolysis process continued for 24 hours, after which samples were removed from the incubator and solids and liquids separated. Samples were then frozen at -18 until further analysis.

Freeze drying

Frozen liquid (hydrolysed) and solid (unhydrolysed) samples were freeze dried using the Alpha 1-2 LD plus model (John Morris Scientific) at 2.5mbar (Figure 5). The samples were dried for 46 hours in total. The liquid samples took longer to dry and the samples were adjusted several times to ensure a larger surface area was exposed to decrease drying time.

Figure 5: Freeze dryer used in the experiments.

Heated rotating vacuum

Frozen liquid samples were defrosted and placed in the heated rotating vacuum. The samples were dried for 46 hours.

3.2.2 Results

As in the previous trials (3.1) the hydrolysis of the waste was incomplete after 24 hours (see Figures 6-8 and Table 3)

Table 3: Results of enzyme and acid hydrolysis.

	Liquid waste (hydrolysed)	Solid waste (unhydrolysed)	Total
Enzyme hydrolysis	235.53g	112.45g	347.98

Acid hydrolysis	254.92g	124.32g	379.24g
Total	490.45	236.77	

Figure 6: Abalone waste before hydrolysis

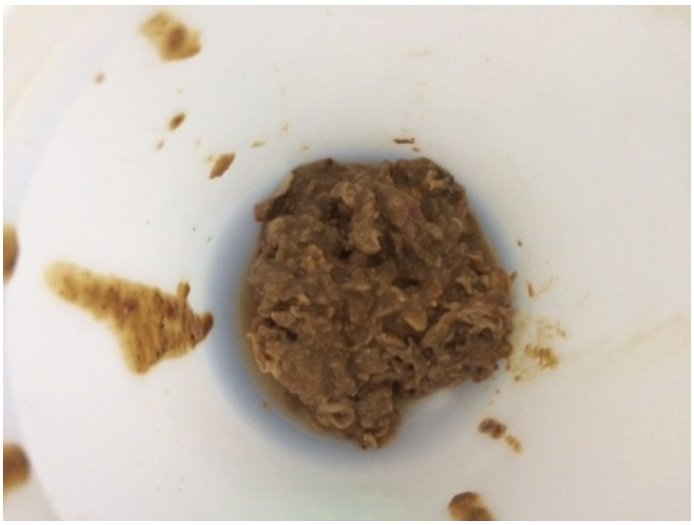

Figure 7: Solid abalone waste extracted after hydrolysis (unhydrolysed)

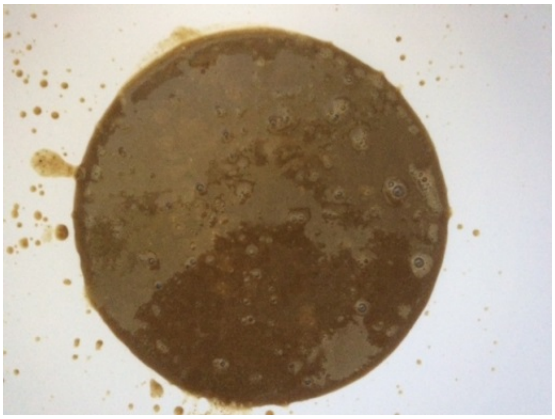

Figure 8: Liquid abalone waste extracted after hydrolysis (hydrolysed waste)

In the freeze dryer the drying was ineffective after 20 hours (Figure 9) taking 46 hours to be effective (see Table 4) with moisture levels below 10%. The vacuum dryer did not dry the samples effectively after 46 hours. See Figure 10 for final samples.

Figure 9: Solid waste (left) and liquid waste (left) after 20 hours of freeze drying

Table 4: Moisture Analysis after drying.

Sample	Moisture content (%)
Abalone acid hydrolysis- freeze dried	6.27
Abalone- enzyme hydrolysis- freeze dried	3.95
Abalone acid hydrolysis- vacuum rotator	13.32
Abalone enzyme hydrolysis- vacuum rotator	21.53

Figure 10: Samples before being tested for moisture content, labelled from Right hand top corner in a clockwise direction; (1)Abalone- enzyme hydrolysis- freeze dried, (2) Abalone acid hydrolysis- vacuum rotator, (3) Abalone acid hydrolysis- freeze dried, (4) Abalone enzyme hydrolysis- vacuum rotator.

3.2.3 Discussion

The results showed that hydrolysis of the abalone shuckings followed by freeze or vacuum drying was not a feasible process due to the ineffective hydrolysis and the lengthy times for drying.

3.3 Oven drying of untreated hydrolysed waste to develop a shelf-stable powder

As the drying of hydrolysed abalone shucking product had proved unsuccessful, following discussions with the industry partner it was decided to try to develop an abalone shucking powder with the potential for putting in capsules and selling as a medicinal additive. The following section describes the trials that were undertaken.

3.3.1 Methods and Results

Trial One: Drying whole and diced viscera

Abalone processing waste (viscera) was dried at 60°C for 24 hours. A Contherm Digital Series incubator, located at the Public Health laboratory, was used to dry the waste.

Two separate treatments for the abalone waste were trialled which included no dicing and dicing the viscera into smaller pieces. The abalone waste was placed on the same baking tray, with the two treatments at each end of the tray (Figure 11).

Figure 11: *Trial one: abalone waste prior to drying (without dicing on the left, diced on the right).*

The samples were weighed pre and post-drying to analyse moisture loss, and were semi-frozen at the time of weighing. Samples were observed at 6 (Figure 12) and 24 hours (Figure 13) drying.

Figure 12: Trial one: a*balone viscera after 6 hours drying.*

Figure 13: *Trial one: abalone viscera after 24 hours drying.*

After 24 hours, the dried abalone was scraped of the baking tray with a spatula.

The percentage moisture loss was determined by the weight using the following equation:

$$\text{Moisture Content (\%)} = \frac{\text{Original Sample (g)} - \text{Dry Sample (g)}}{\text{Original Sample (g)}} \times 100$$

There was no significant difference in the moisture loss between whole and diced viscera, calculated at 79% and 78% respectively (see Table 5). However, upon visual and touch differences, it was found that the diced viscera was much dryer than the whole viscera. The un-diced sample had sections of moist gut after 24 hours drying. It is noteworthy that the results were made inaccurate due to some of the dried abalone viscera not being able to be removed from the tray. This was rectified in the next experiment.

Table 5: Results of Drying trial 1.

Abalone Viscera	**Before**	**After**		
Treatment	**Weight (g)**	**Weight (g)**	**Difference (g)**	**% Moisture loss**
No dicing	207.3	44.2	163.1	78.7
Diced	125.5	28.3	97.2	77.5
Combined	**332.8**	**81***	**251.8**	**75.7**

Duplicate samples of the diced and whole abalone viscera were placed into an oven set at 95°C for 24 hours to determine moisture content. The same equation as shown above, using a variation of the AOAC Official Method 925.10 (AOAC International, 2005), was used. The difference in moisture content between the diced and un-diced viscera became apparent after overnight drying. The moisture content was 7% for diced and 16% for whole/uncut viscera.

Trial two: Drying diced viscera for shelf life trial

565g of diced abalone viscera was dried using the methods mentioned in Trial One. Dicing the abalone prior to drying was pursued in this trial due to the faster drying time. Also, baking paper was placed onto the tray to prevent the dried viscera and fluid from sticking to the tray (Figure 13 and 14).

Figure 13: *Trial two: Waste diced while frozen (L) and the same waste after 5 minutes in the oven (R), releasing large amounts of liquid.*

Figure 14: *Trial two: Baking paper was used which made the extraction on the dried waste easier. The viscera could be flaked off the paper, rather than scraping, leaving minimal waste.*

The diced viscera from the second drying trial had a moisture loss of 77.1%, similar to the values from the first trial (Table 6).

Table 6: Results of second drying trial .

Abalone Viscera	**Before**	**After**		
Treatment	**Weight (g)**	**Weight (g)**	**Difference (g)**	**Moisture loss(%)**
Tray 1 (diced)	244.7	59.4	185.3	75.7
Tray 2 (diced)	320.1	69.9	250.2	78.2
Combined	**564.8**	**129.3**	**435.5**	**77.1**

After drying, a small portion of dried product (15g) was placed into a snaplock bag on the 3/2/15. The bag contained a silicon desiccant sachet to absorb moisture (Figure 15).

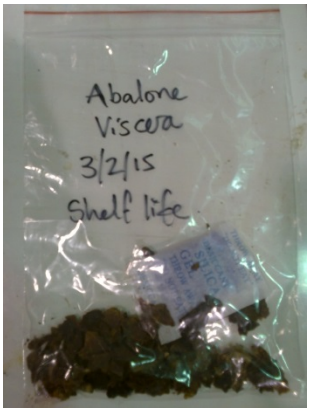

Figure 15: *Trial two: Dried viscera (diced) used for shelf life trial. The snaplock bag contains a sachet of silica to absorb moisture.*

The bag containing the viscera was kept at ambient temperature (22°C) and visually assessed (daily) over a period of 7 days. The product was observed for any growth of bacteria/mould, and sensory

changes including odour were checked daily by the researcher and categorised according to the following scale.

Category 0	Category 1	Category 2	Category 3	Category 4	Category 5
Fresh/neutral odour.	Mild fishy odour, normal for dried seafood	Some fishy odour, but expected for dried viscera	Moderate fishy odour. Starting to make its presence known.	Strong fishy odour. Sour. Bordering on rancidity	Very strong fishy odour. Rancid. Overpowering

The sensory results after the 7 day trial are found in Table 7 below.

Table 7: Results of sensory analyses

Day	Date	Mould/Bacteria Visible?	Odour
0	03/02/15	No	3
1	04/02/15	No	3
2	05/02/15	No	3
3	06/02/15	No	3
4	07/02/15	Not observed (w/end)	-
5	08/02/15	Not observed (w/end)	-
6	09/02/15	No	3
7	10/02/15	No	3

The dried viscera was milled using a Progredi Compact Smoothie Maker (Figure 16).

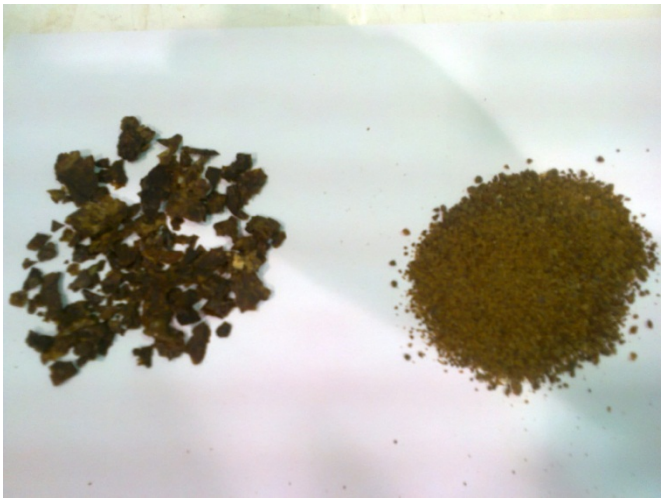

Figure 16: *Dried abalone viscera (left) and ground viscera (right) using the Progredi smoothie maker.*

The dried, milled viscera was sent to Silliker for bacteriological (Total Plate Count, standard being <10 cfu/g and *E.coli*) (Table 8) and heavy metal testing (inorganic arsenic, cadmium, copper, lead, mercury, selenium) (Table 9). Microbiological testing was repeated after two years of ambient storage.

Table 8: Results from TPC and E.coli

Microbiological Test	Results (CFU/g)
1 week of ambient storage	
Standard plate count	700
E. coli	<10
Two years of ambient storage	
Standard plate count	
E. coli	

Table 9: Heavy metal Testing

Contaminant	Food	Max. Level (mg/kg)*	Ab. Viscera (mg/kg)
Arsenic (inorganic)	Molluscs	**2.0**	<0.05
Cadmium (Cd)	Molluscs	**2.0**	2.0
Copper (Cu)	Molluscs	**N/A**	17.6
Lead (Pb)	Molluscs	**2**	0.15
Mercury (Hg)	Molluscs	**Mean level of 0.5**	0.030
Selenium (Se)	Molluscs	**N/A**	2.60

*As stated by the Australia New Zealand Food Standards Code - Standard 1.4.1 - Contaminants and Natural Toxicants. http://www.comlaw.gov.au/Details/F2015C00052

Trial three: Milling the viscera

900 grams of abalone viscera were dried over 2 trays. The resulting product was sent to Silliker for Nutritional Informational Panel testing (see Table 10)

Table 10: Nutrition Information Panel

Average Quantity Per 100g

Analytical Results

Desc. 1: Product: Dried Abalone Viscera

Sample Number: 452838286
Condition Rec'd: NORMAL
Temp Rec'd (°C): 21.0

Condition Comment: 6.2

Analyte	Result	Units	Method Reference	Result Date	Loc.
Ash	10.5	g/100g	FAB 14	25/02/2015	SYD
Carbohydrates	10.9	g/100g	FAB 19	26/02/2015	SYD
Energy	1700	kj/100g	FAB 19	26/02/2015	SYD
Fat	15.5	g/100g	FAB 13.1A	25/02/2015	SYD
Fatty Acid Profile			FAB 32	25/02/2015	SYD
Saturated fat	3.7	g/100g			
Trans fat	0.6	g/100g			
Mono-unsaturated fat	5.0	g/100g			
Poly-unsaturated fat	6.2	g/100g			
Sodium (Na)	2650	mg/100g	FAB 98	25/02/2015	SYD
Moisture	8.1	g/100g	FAB 6.1B	24/02/2015	SYD
Protein	55.1	g/100g	FAB 93	20/02/2015	SYD
Total sugars	<0.5	g/100g	FAB 24	24/02/2015	SYD

The dried viscera was ground using a Grindomix GM200 The dried product was ground for 10 seconds at 10,000 rpm.

The Grindomix GM200 produced a very uniform powder. It was far more powerful and faster than the Prodgredi smoothie maker. The temperature of the milled product did not exceed 30°C after 10 seconds of grinding.

The moisture content was calculated after samples of the diced/dried and diced/dried/milled samples were placed into an oven for 24 hours at 95°C .

The moisture content of the dried vs. milled products is shown in Table 11 below.

Table 11: Moisture content of the Dried v milled product

Moisture Content %	I.D.	Before Weight sample (g)	After Weight sample (g)	Loss (g)	Moisture Content (%)	**Average**
Diced Abalone shuckings	7	10	9.21	0.79	7.9	
	9	10	9.22	0.78	7.8	**7.85**

	I.D.	Before Weight sample (g)	After Weight sample (g)	Loss (g)	Moisture Content (%)	**Average**
Diced Abalone Shuckings (milled)	3	10	9.15	0.85	8.5	
	2	10.02	9.14	0.88	8.8	
	34	10.04	9.2	0.84	8.4	**8.55**

The water activity was measured with an AquaLab Series 3 TE Water Activity meter.

The results from the water activity are shown in Table 12 below

Table 12: Water Activity results

Water Activity	**Date Dried**	**Average A_w**
Dried viscera (diced)	11/02/2015	**0.38**
Dried viscera (diced/milled)	11/02/2015	**0.39**

3.3.3 Discussion

Hydrolysis of the abalone shucking and drying was ineffective. However an optimised drying method to produce a powder has been developed, diced abalone shucking material on baking paper dried for 24 hours at 60˚C. Moisture loss was ~77%, and final moisture content was 7%. The dried diced samples could easily be milled into a powder.

If a commercial dried/powdered abalone product were to eventuate, a pre-dicing or mechanical chopping would hasten the drying process, as will placing onto material such as baking paper to prevent wastage. The Grindomix GM200 was very successful in milling the product into a fine powder. The temperature was taken immediately after milling and did not exceed 30°C from the 10 seconds of grinding.

In regard to the sensory assessment, the abalone shuckings already have a strong odour. It is not completely unpleasant, but possesses a strong seaweed/fishy type smell. The odour was quite strong during the drying process but improved as the product lost moisture. Over the 7 days of storage at ambient temperature (22°C), no microbial growth was observed and the odour remained the same. The product seems to be relatively stable over a short period of time.

The low moisture content (~8%) and low water activity (0.39) should be ideal to stop the growth of mould and bacteria, as it is proven that a moisture content <10% and a water activity value of <0.8 will ensure a long shelf life. The microbiological results after one week were satisfactory, with 700 CFU/g for the total plate count and <10 CFU/g for *E. coli*.

In regard to the heavy metal results, the only parameter of concern was Cadmium. It was found to be at the maximum level allowed by FSANZ, at 2mg/kg. It was requested by the client that Cadmium was to be tested, and the results were at the limit of the FSANZ levels. An enquiry to the Silliker Lab confirmed that the sensitivity of the heavy metal testing is 0.1mg/kg. The cadmium issue needs further investigation if the product is to be commercialised.

Abalone viscera accounts for approximately 33% of the total weight of the animal. Therefore, waste can be seen as an opportunity for value addition. It is well documented that abalone possess beneficial properties, so utilising waste products makes commercial sense. Marine neutraceuticals are a relatively new field that is concerned with extracting health enhancing products from predominantly marine plants and invertebrates.

A study by Zhou, 2012 tested freeze dried viscera from *Haliotus discus hannai Ino.* The nutritional profile contained 53.04% protein, 19.28% sugars and 18.09% polysaccharides, which is not too dissimilar to the nutritional profiles of *Haliotis* viscera found in the table below.

A comparison of results from a previous study of Southseas Abalone shuckings versus CESSH results are found in the table below:

Table 13: Nutrition Information Panel Results

	Southseas Abalone Results	**CESSH Results 02/15**
	Average Quantity Per 100g	Average Quantity Per 100g
ENERGY	1656kJ	1700kj
PROTEIN	52.9g	55.1g
FAT - TOTAL SATURATED	13.1g 4.2g	15.5g 3.7g
CARBOHYDRATE - TOTAL SUGARS	13.9g 7.1g	10.9g <0.5g

SODIUM	4270mg	2650mg
DIETARY FIBRE	4.5g	-
CHOLESTEROL	439.6 mg / 100g	-

The nutritional parameters are very similar; however, the sugars in the initial NIP were 7.1g as compared to <0.5g for the product tested by CESSH. The reason for this may be the lack of purging in the first lot of testing, which may have accounted for the high sugar content. Abalone feed on algae, which is essentially a simple carbohydrate. The batch tested by CESSH may have been purged prior to harvest, resulting in a lower value.

4 Conclusions

The project has resulted in production of a powdered abalone product that could potentially be used as a medicinal additive. However the cadmium levels require further investigation. The results have been provided to the industry partner for cost benefit and other considerations.

References

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