Creating a shelf stable marinated jellyfish product from the underutilised species *Catostylus mosaicus*

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Jacquie Edwards
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AFFS – Food Technology
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CONTENTS

NON TECHNICAL SUMMARY:

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OBJECTIVES:

1. To develop a process resulting in a marinated semi-dried jellyfish product
2. To assess the suitability of packaging type and marinade formulation to achieve product stability of the semi-dried jellyfish
3. To assess the sensory attributes of the product through focus and discussion groups in relation to imported products
4. Undertake pre-marketing test trials of the product through domestic Asian food wholesales and suppliers given the development of a successful product
5. Develop a comprehensive processing manual for the product

OUTCOMES ACHIEVED

The major outcome from this work is the capability of the Australian seafood industry to take advantage of the large and potentially lucrative market of Asian consumers for jellyfish, both export and domestically. Seafood processors now have a documented successful process for producing a high quality ready-to-eat jellyfish product acceptable to Asian palates. This makes harvesting jellyfish from Australian waters worthwhile for the licenced fishers as there will be higher demand for raw product.

The critical factors involved in producing a high quality product have been established and yet the process is adaptable enough to allow for differing specific tastes according to cultural origin.

The results of this project work generated enormous interest from many sectors of the fishing industry. Nationally, there was huge interest from fishers wishing to know how they could get into the fishery and how to handle the harvested catch onboard. Several seafood processors (including those with export registration) were keen to learn of the method of processing and local seafood wholesalers were interested to be included in the chain.

Significantly, there was huge interest indicated from international Asian buyers and several Asian-based seafood companies have approached us for product and/or with collaborative joint-business venture offers.

A survey of jellyfish products in both the domestic and Japanese markets showed that dried whole and low value semi-prepared jellyfish was available, but there was a clearly demonstrated demand for a convenience food product. In Japan, reports indicated that demand for high quality jellyfish has always exceeded supply to date and retail prices range from AUD 8/kg to AUD 85/kg depending on the product form and quality.

The world market demand for dried jellyfish is around 25,000 tonnes per year, with the main producers being China, Indonesia and Malaysia. In recent years, Asian countries have found that their local wild jellyfish stocks have declined and have approached Australia for access to our unutilised resource. The jellyfish species, *Catostylus mosaicus,* is identifed as one of ten species that are traditionally used as a food product and is seemingly abundant in Australian waters. Preliminary feed back from buyers of dried processed jellyfish indicate that Australian product would be comparable to that considered as high quality in their markets.

One of the major impediments to establishing a viable commercial fishery for jellyfish in Australia is the lack of value-adding options for the industry. Seafood processors have high-lighted this issue and emphasized the lack of available knowledge of jellyfish processing techniques.

The focus of this project was to develop a high value ready-to-eat jellyfish product for the Japanese and other Asian markets. To achieve this outcome, all the aspects of producing dried jellyfish were investigated including harvesting, transport, the drying process, stabilisation of the dried-product and storage. Then the product development was considered including factors of: most appropriate rehydration process; cooking and cooling process; desired product texture and appearance; marinade formulation; jellyfish to marinade ratio; consumer preference for product quantity and product packaging.

We therefore measured the physical, microbial and sensory attributes of the product. The product and the package design was assessed by consumers who were familiar with, and commonly ate, jellyfish.

Results showed that the Australian jellyfish species *Catostylus mosaicus* is ideally suited for processing for the Asian market. The finished product appears to be more opaque and yellow-coloured than imported salted products, although this did not affect the acceptability of the jellyfish end-product produced. The appearance of the salted jellyfish was perceived as ‘expensive looking’ by the two Japanese consumers recruited to assist in establishing cooking and preparation parameters. Difficulty was experienced in defining cooking and marinating regimes as little documented information is available. This difficulty was compounded by advice from several consumer sources conflicting with results from sensory trials.

The concept of a ready-to-eat product was well received by consumers. However, the acceptability of marinade flavour was decidedly subjective and it is apparent that vast differences in the flavours of marinades for different Asian regions exist. It was established that it is more important for the marinade to consist of strong salty flavours than for it to exactly mimic commercial products. In producing traditional Asian food products such as attempted in this project, there is particular difficulty overcoming the perception that Western styles of formulation might be inferior to traditional forms.

A base recipe for marinating jellyfish has been established through sensory testing and consultation with Asian consumers. The marinade has been assessed through storage and

has been shown to provide good preservation of the cooked jellyfish strips. This work has demonstrated the importance of maintaining a low storage temperature for the quality and texture of the product.

Project results have highlighted several areas where further investigation is needed including: a rapid, less labour-intensive method for drying jellyfish; a simple and rapid method of removing the outer skin of the jellyfish bell; and, as investigative interviews with Asian jellyfish consumers revealed wide differences in taste preferences according to country of origin, marinades for ready-to-eat products need to be adapted for the specifically targeted market.

Test marketing of the ready-to-eat jellyfish product within local Asian food wholesalers was considered inappropriate at this time. There is not a stock pile of dried product available currently in Australia for further value-adding. Therefore if pre-marketing trials resulted in demand for further product, it would be unable to be supplied, hence creating a negative market perception of Australian product.

Additional to this report, a complete processing manual has been produced for the drying of jellyfish through to production of the ready-to-eat product. The manual incorporates a hazard analysis table for dried jellyfish production as a basis for processors to develop their own food safety plan.

KEYWORDS: jellyfish, dried, processing, sensory evaluation, Asian market

ACKNOWLEDGMENTS

A project of this nature is not able to be undertaken in isolation and necessitates input of various kinds from many diverse people. We were overwhelmed by the willingness of various individuals, companies, other researchers and corporations to provide assistance in our endeavours throughout this project work and gratefully thank all those who contributed.

The project team wish to especially acknowledge the enormous help, advice and encouragement from the following participants:

- Les Spinks (Seafood Exporters P/L) – the project instigator and collaborator
- The Fisheries Research and Development Corporation – for supporting the work financially through funding by a Seafood Services Australia grant
- Leigh Marshall (JISECC P/L) – for packaging expertise and advice
- Grant Vining – for expert Asian marketing information

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We would also like to warmly acknowledge the Asian sensory evaluators – who not only provided sensory asessments but freely gave of their time, knowledge and advice over and above sensory panel requirements.

BACKGROUND

The jellyfish species *Catostylus mosaicus,* present in Australian waters, is identifed as one of ten species that are traditionally used as a food product. The species has been consumed as part of the Northern and South East Asian diet for over 500 hundred years in both fresh and dried form (B. Ding, pers comm, 1998). Jellyfish as part of the Asian diet is valued more for its texture than flavour, the latter attribute considered as being neutral with the ability of taking on chosen flavourings. Additionally, traditional Asian medicine considers jellyfish to be a cooling "yin" food and it is prescribed to aid in curing gout, arthritis and bronchitis; to lower blood pressure and as a skin softening agent. In South Korea, jellyfish is promoted as a weight loss aid and Australian Aboriginals have prescribed dried jellyfish powder as a treatment for burns (Heshih & Rudloe, 1994).

The world market demand for dried jellyfish fluctuates around 25 000 tonnes p.a., with about half this quantity consumed within the Japanese market. The main producers of dried jellyfish product are China, Indonesia and Malaysia, with a combined production per year of 5 000-8 000 tonnes. Of this quantity, only 2 000 tonnes is considered to be high-grade and destined for markets in Japan, Taiwan, Hong Kong, Korea and Singapore. Japan consumes 80% of the highest grade product and to date, demand has always exceeded supply. Retail prices in Japan range from AUD8/kg to AUD85/kg depending on product quality .

In recent years, Asian countries have found that their local wild jellyfish stocks have declined and fishers have looked further afield for potential supplies. Since Australia demonstrates limited use of its jellyfish resource as a commercial fishery, it is not surprising that we have attracted strong interest from Asian companies wishing to gain access to our local stocks of edible species. Prospective seafood industry investors and buyers have shown eagerness to ascertain the quality and accessibilty of *Catostylus mosaicus* from Australian waters, demonstrated by the increasing number of approaches to State Government bodies and commercial organisations. Preliminary feed back from interested buyers of dried processed jellyfish indicated that Australian product would be comparable to that considered as high quality. In keeping with the overall market standing of Australian seafood in the global market, our objective was to develop, design and produce a high-value ready-to-eat convenience product for the top end of the consuming market. This market in Japan demands between 1200 and 1600 tonnes annually.

A review of jellyfish products in the domestic and Japanese markets demonstrated a demand clearly existed for a high-value ready-to-eat product. Lower value semi-prepared jellyfish product was available in the market place, but there was no pre-marinated product found in either Japan nor Australia. In Queensland, a major wholesaler/retailer has seen demand for jellyfish products increase from 500kg p.a. to 6 tonnes p.a. within 3 years.

Previous evaluation of the market potential of jellyfish species from Australia has had favourable results (Wootton *et al*, 1982; Hudson *et al*, 1997). The NSW Fisheries Department has produced a management plan with a small number of fishing permits being issued. The resultant 10 tonne harvest was used for export test marketing into Asia although the results from these trials are unknown (Hudson *et al,* 1997).

The major impediment to establishing the commercial fishery in NSW was attributed to lack of value-adding options available to the fishers (P. Dwyer, pers comm.1997). Seafood processors have high-lighted this issue with comments on the lack of available knowledge of processing techniques (R.& S.Massey; L. Spinks, pers. comm.1998).

Until now, the concept of doing more than merely drying the jellyfish has not been

considered seriously. However, given that imports of marinated seafood products have doubled in the last 4-year period (data obtained from the Qld Government Statisticians Office, 1998), it was considered likely that jellyfish would suit this processing style. Imported jellyfish product currently available is only semi-processed for the consumer and is supplied with sachets of marinade inside the retail pack. Such product still requires up to 2 days preparation and cooking prior to adding the marinade and consumption. The effect on shelf stability of adding marinades directly to the product has not been established. A product of this type allows greater package weight using less jellyfish. It offers the advantage of greater convenience to the consumer and differentiates the product from others on the market.

Jellyfish needs to be cleaned and consumed or processed within hours of being caught as it rapidly degrades by liquefaction. Unlike other traditional seafood products, the use of refrigeration or freezing as a method of preservation is not a practical approach with fresh jellyfish. Therefore jellyfish must be harvested, cleaned and processed within the first 48h of capture.

The processing of jellyfish has been practiced for many years in Asian countries, however processing methods are not widely documented. The process involves a stepwise reduction of moisture with salt and alum compounds. The application of salt and alum reduces water content and limits autolysis and microbial spoilage. The number of salt/alum applications and the processing time determines the quality of the final product. Jellyfish processing methods vary between species and processing companies (Sloan, 1985) but a moisture content of 65–70% of the bell is desirable in the final product.

Jellyfish is traditionally graded according to the size and colour of the bell (body) with the largest bells attracting the highest prices on the Japanese market. Smaller bells are sold whole or shredded in packs, in some cases sachets of marinade mixes are added.

This research addresses the issues of packaging, shelf stability and marinade formulation to ensure products are acceptable both on the domestic and Asian markets. It also provides a means for the continued success of the commercial jellyfish fishery and identifies an avenue for other states to capitalise on their jellyfish resources.

NEED

The *Catostylus mosaicus* resource in Australian waters is presently underutilised. NSW and Victoria are currently developing jellyfish fisheries and the draft NSW management plan allocates annual catches of up to 2,000 tonnes. In 1997, NSW had 75 fishers who were endorsed to catch jellyfish for the season November to March but landings for the first two seasons are recorded at only 2.2 tonnes. The small landing figure reflects the low demand for the raw product due to insufficient processing knowledge and hence, a low return to the fishers.

A strong need exists to stimulate investment and commitment within the jellyfish industry. Developing and establishing the quality and stability of a value-added jellyfish product will ensure domestic producers are able to compete effectively with imported products.

A domestic and export market exists for marinated jellyfish products. Currently, the

Australian market is entirely served by imported products. A common commercially available pack of jellyfish consists of approximately 150g of semi-dried jellyfish plus a small sachet of marinade. From extensive communication with Asian consumers and wholesalers/importers, a need was identified for the jellyfish product to be more convenient and user friendly. Currently the procedure involved in de-salting, re-hydrating and marinating dried jellyfish can take up to two days to provide a ready to eat dish.

Dried jellyfish end-product provides around only a 10% yield from the total wet weight harvested. The simple dried imported jellyfish product is sold cheaply (wholesale price of ~$6/kg) and, with Australian labour and transport costs (production cost ~$5.80/kg, L.Spinks, pers. comm.), production of this product would not be cost effective for fishers nor processors. Hence the need to add value to the dried product. Semi-dried jellyfish packaged with sachet of marinade wholesale for ~$12/kg. By combining jellyfish with a marinade, local processors will be able to be competitive with imported products based on quality and convenience.

We were approached by an established seafood processor and exporter (L.Spinks, 1997) to assist in the technological development of a value-added jellyfish product. The company, Seafood Exporters Pty Ltd, had identified an opportunity to develop a new product and supply the strong demand for jellyfish in Asia. This research project investigated the development and packaging of a pre-marinated ready-to-eat jellyfish product made from Australian jellyfish and processed locally.

OBJECTIVES

The project sought to:

1. To develop a process resulting in a marinated semi-dried jellyfish product.

2. To assess the suitability of packaging type and marinade formulation to achieve product stability of the semi-dried jellyfish.

3. To assess the sensory attributes of the product through focus and discussion groups in relation to imported products.

4. Undertake pre-marketing test trials of the product through domestic Asian food wholesales and suppliers given the development of a successful product.

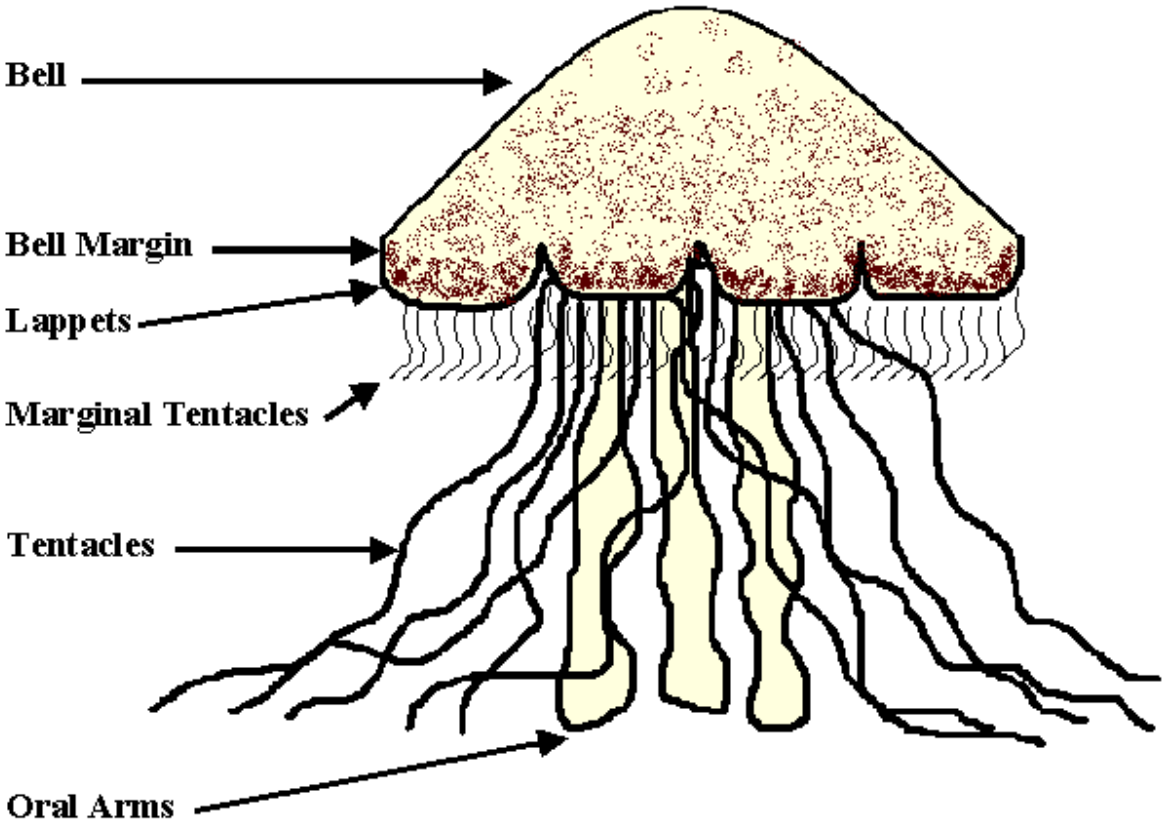
5. Develop a comprehensive processing manual for the product.

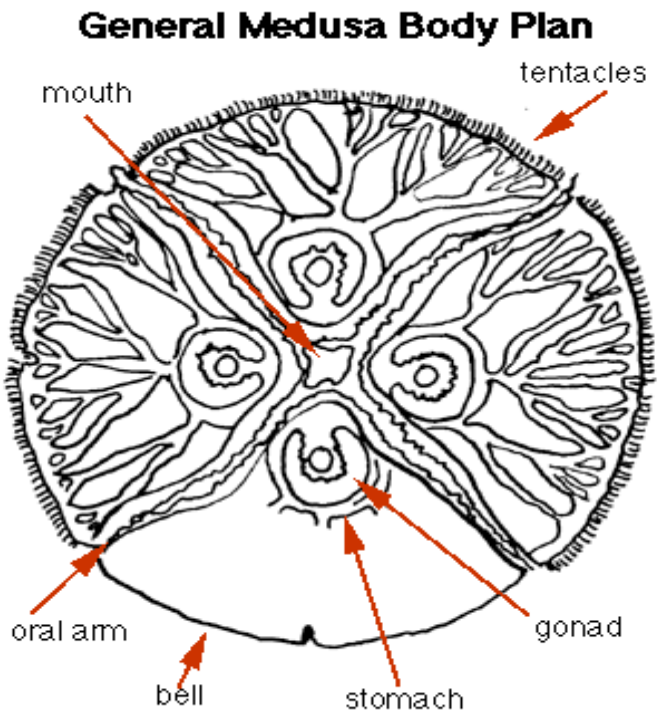
GLOSSARY OF TERMS

Bell / umbrella	The body of the jellyfish. Generally the most valuable part although both the oral arms and bell may be processed. The bell consists of a jelly like substance, mesoglea, which is surrounded by the ectoderm, a thin membrane.
Oral arms / tentacles	Located below the bell and around the mouth, usually four oral arms are present in the Australian species *Catostylus mosaicus*, but some jellyfish species have many more.
Nematocysts / cnidocysts	Cells which are located on the ectoderm and contain irritants that cause itchiness, redness and rash. The cnidocysts are pressure activated and still cause a reaction even when the animal is dead. Treatment is usually recommended as washing with a mild salt or alcohol solution.
Potash Alum / Alum	Potassium Aluminium compounds used in salting jellyfish. They act as a disinfecting agent and precipitate proteins. It is essential for obtaining a good quality salted jellyfish product and preventing putrefaction during processing.
Bleaching powder	Compounds that can be added to the first salting stage to whiten the final product. Usually bicarbonate compounds are used for bleaching jellyfish bells.
Salted jellyfish	Traditionally processed jellyfish where salt and alum are used to remove the moisture from the product over of several days to weeks.
Dried jellyfish	Jellyfish dried through mechanical means such as a drying unit. This method has not been successfully employed to process Australian jellyfish.
Rehydrating	The process of allowing the jellyfish strips to absorb water after cooking. Generally, the suggested rehydration time after cooking is between 3hrs to overnight.
De-salted	Jellyfish which has been washed and allowed to soak (after several water changes) and is now ready to prepare for eating.
Marinated	The final product. Jellyfish is firstly cooked than re-hydrated and has had flavouring ingredients such as rice wine vinegar and soy sauce added.

Further terminology information is presented in Figure 1.

Figure 1: Anatomy of edible jellyfishes
(South Carolina Department of Natural Resources, www.disl.org)





METHODS

Physical attributes

Moisture content

The moisture of dried and re-hydrated jellyfish was determined using AOAS Official Method 952.08 Solids Total in Seafood (modified). A known weight of finely diced jellyfish sample was placed, in a lidded metal canister, into a drying oven at 100ºC. The jellyfish moisture content was calculated as the percentage change in weight over 24hrs. The moisture content of jellyfish bells and tentacles was determined separately.

Salt content

The salt content of salted and de-salted jellyfish was determined according to Volhard titration method (AS-2300.6.5). A sample of jellyfish was dissolved by boiling in silver nitrate and nitric acid solution. Potassium permanganate was added until the solution become colourless and further boiled for 5min. The solution was then titrated with ammonium thiocyanate solution and the salt content calculated as excess of silver nitrate present in solution.

Water activity

The water activity of dried and rehydrated jellyfish was determined using an Aqualab Water Activity Meter in accordance with AS 0304.

Microbial assessment

Sample preparation

Samples were macerated for 60 sec in a Seward BA6021 type stomacher with peptone diluent. Serial dilutions were made as appropriate, depending on number of trial days elapsed.

Microbial enumeration

Approximately 15mL of nutrient agar at 45°C - 50° C was mixed with 1mL aliquot's of sample dilution in Petri dishes and allowed to set. Incubation was at 30°C for 72h to enumerate mesophilic and at 4°C for 14 days to enumerate psychrotrophs. Plates were counted and the number of organisms recorded as colony forming units per gram (cfu/g). Total plate counts were determined according to AS 1766.3.5. Examination of samples for coliforms was performed according to AS 1766.2.3.

Coliform enumeration

Approximately 5mL of Violet Red Bile Agar (VRBA) was poured into petri dishes and allowed to set. An aliquot (1mL) of the diluted sample was mixed with approximately 10mL of VRBA at 45ºC–50ºC in the petri dish and allowed to set. Incubation was at 30°C for 18h to enumerate coliform bacteria. Plates were counted and the number of organisms recorded as colony forming units per gram (cfu/g).

Jellyfish preparation

Salted jellyfish bells were thoroughly washed under running fresh water until all salt was visually removed. The bells were then left to soak for 3hrs. The bells were cut into thin strips approx. 3mm thick. The strips were cooked in fresh water at 80^{o}C for 10mins, cooled in ambient fresh water and left to rehydrate at room temperature for 3hrs, then drained before adding marinade and presenting to consumers.

Marinade development

A short list of appropriate marinades was determined through evaluation of commercially available jellyfish marinades and consultation with Asian Supermarket proprietors in China Town, Brisbane (see also Appendix 3). A series of marinade dressings were formulated and were compared to commercial marinades for flavour and consistency (recipes are given in Appendix4). The effect of the marinade on the jellyfish strips and the marinade shelf-stability were assessed through accelerated storage trials.

Ready-to-eat marinated jellyfish

Jellyfish and marinade were prepared as above. To prepare the final product, marinade was added to the drained jellyfish strips in a proportion of 20% of the product weight.

Consumer acceptability assessments

Consumers were recruited by the Sensory and Consumer Science team at the Centre from the Asian community in Brisbane. Consumers were required to have previously eaten jellyfish, were aged 18 years and over and to be able to read and write basic English. Marinated jellyfish was prepared for each panel as and the samples were covered until presented to the consumers at room temperature.

A preliminary sensory assessment was conducted with 21 consumers of Asian origin. Where three experimental marinated jellyfish products and one commercial product were presented to the Asian panel. Further consumer acceptability testing was then conducted with 68 consumers of Asian origin. A full description of the sensory methods used is available in Appendix 2 .

Consumers were asked to rate the appearance, odour, flavour and texture of the jellyfish samples on degree of liking or just right scales using standard rating test procedures (AS2542.2.3 1988). They were also asked to rate the overall acceptance of the product. Results were analysed using randomised block analysis of variance (ANOVA) with consumers as blocks. Where a significant ($P<0.05$) F-ratio was found, pair-wise comparisons using Fishers least significant difference procedure were completed.

Packaging

A thorough assessment of available packaging types was undertaken (examples are illustrated in Appendix 5). The packaging of imported jellyfish products were listed and, in consultation with a packaging supplier, the cost and benefits of each packaging type was established. Samples of polyester/polyethylene laminate and foil laminate packaging

materials were obtained. Marinated and non-marinated cooked jellyfish strips were placed into the packaging for accelerated storage trials. Further discussions were held with an Asian Marketing Consultant and advice on package design and colour was obtained. Four designs were produced as mock-up retail type bags and supplied to the Asian consumers for their feedback during consumer acceptability testing. Examples are attached in Attachment 1.

Storage Trials

Cooked and rehydrated strips of jellyfish were packaged in 70μm polyethylene polyester laminate (PET) bags with 10% of the total weight as marinade. The PET bags were heat-sealed and the product stored at 4°C, 10°C, 20°C, 30°C and 45°C. Control samples without marinades were also stored at each temperature. The pH, microbial load and physical appearance of all samples were recorded until the stored samples were considered to be unmarketable.

RESULTS AND DISCUSSION

PROCESSING METHOD

The jellyfish used for these trials were captured by dipnet in Northern New South Wales, in water around the mouth of the Clarence River. Jellyfish were stored in seawater until shipment to the processing plant. To process, the bell and tentacles were separated and the jellyfish eviscerated and washed (Plate 1). The cleaned jellyfish bells were mixed with alum and bleach for approximately 3 hours so that all the mucus and dirt from the gut cavity was removed. After 3hrs the jellyfish were washed again and were salted over several days (Plate 1). Finally, the jellyfish were stacked and a weight was placed on the stack to express the remaining moisture from the product. Figure 2 shows the jellyfish salting process employed in a flow chart.

In total, the processing time was at least 15 days (Les Spinks, pers. comm.). Once this process is complete, the jellyfish may be stored for long periods without detrimental effect on the quality and texture (Benjamin Ding, pers. comm.).

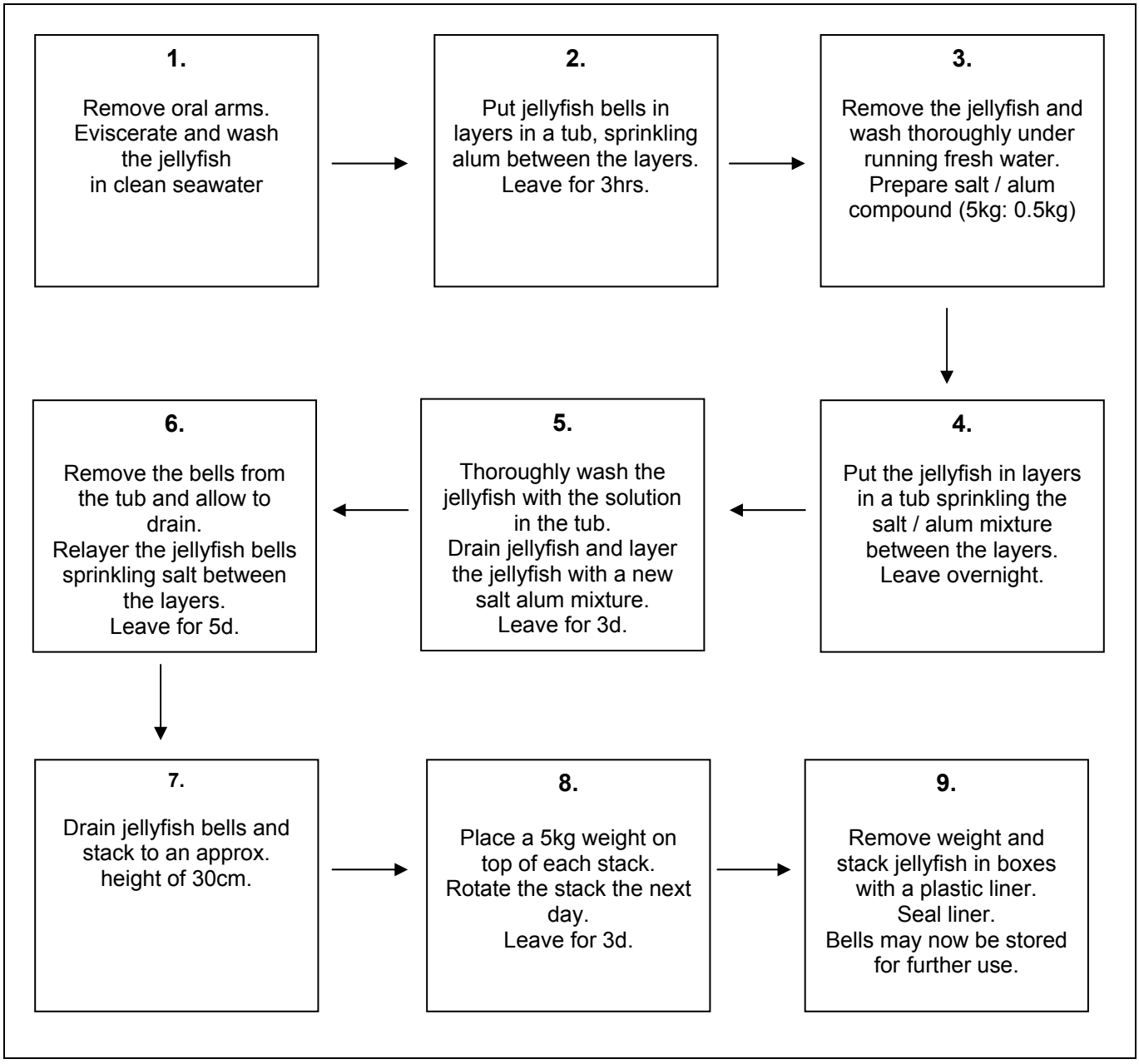
The salt content of the finished salted and dried jellyfish samples was 26%. There was little difference in the moisture content of the bells and tentacles, being 69.91% and 70.29% respectively. The microbial counts on the salted jellyfish were low, being under 200 cfu/g for bells and less than 100 cfu/g for jellyfish tentacles. After de-salting overnight in 10L of ambient water, the jellyfish bell weight increased by 1.5% and the moisture content of the bells was 93.10%. The water activity of the jellyfish increased from 0.758 A_w when salted to 0.980 A_w after de-salting, indicating that in its salted state, jellyfish would be shelf stable. Although similar to moisture content, the A_w value refers to the water which is not bound to food molecules and can support the growth of bacteria, yeasts and moulds. Most bacteria can only grow at fairly high water activity levels (0.80-0.99) but the growth requirements for moulds and yeasts are lower than that for bacteria.

The low water activity and high salt content of the jellyfish is beneficial for the logistics of further processing and developing marinated products. The dried product exhibits stable microbial counts during storage and is able to be stored at ambient temperatures for long periods involving many months.

A full Processing Manual is attached in Appendix 8.

Plate 1. Processing jellyfish.

Figure 2: Flowchart of jellyfish salting and drying process



COOKING PROCESS

The texture of jellyfish is a determinant factor in the market acceptance of new jellyfish products. Currently marketed products require the purchaser (consumer) to perform the cooking and therefore there is very limited information available. It is generally recommended that the strips of jellyfish are placed into boiling water and then transferred to ambient water and allowed to soak. Cooking and soaking recommendations are highly variable involving a variety of temperatures and times.

The jellyfish should be de-salted before cooking in fresh water with several water changes recommended. Kimura-Suda *et al* (1995) found that the process of removing salt during immersion in water was essentially complete after 3hrs at ambient temperatures although recommended de-salting times ranged from "a little time" to overnight. After various trials, the jellyfish samples in this research work were washed under running water and allowed to soak for 3hrs before cooking.

The collagen in jellyfish denatures during cooking between 53°C and 65°C (Kimura *et al*, 1991). The denaturation of collagens determines the texture and yield of cooked products. Table 1 presents the post-cooking yields of jellyfish cooked in water from 50°C to 100°C. With exception of the strips cooked for 15min at 50°C, cooking at 50°C/60°C in comparison to boiling (100°C) did not result in a substantially higher post cooking yields. Additionally greater rehydrated weight gain was not observed. This concurs with the findings of Kimura-Suda *et al* (1995) who found little difference in the rehydrating properties of both heated and non-heated jellyfish strips.

Table 1. Post cooking recovery rates of shredded rehydrated jellyfish.

Cooking temperature (°C)	**COOKING TIME** (MM:SS)	**Initial weight** (g)	**Post cooking weight** (g)	**Rehydrated weight** (g)
100	01:00	85.0	30.80	45.91
50	15:00	112	65.04	77.68
50	30:00	102	33.84	51.40
60	15:00	106	31.0	47.65
60	30:00	104	26.00	44.30

The jellyfish strips cooked at 50°C and 60°C for both 15 and 30mins were chewy and tough and the samples cooked for 30min were substantially darker in colour than boiled samples.

Heating jellyfish above 80°C is believed to cause a network structure of collagens to occur on the surface of the product, which may contribute to the crunchy texture of cooked jellyfish Kimura *et al*, (1991). It is not clear if further heating interferes with the textural properties of the jellyfish. Boiling (100°C) from 8 secs through to 7 mins did not result in greater yield or rehydrated product weight, but the texture of the longer boiled products became excessively chewy and rubbery.

A comparison of jellyfish strips cooked at a range of temperatures indicated that reducing the temperature to 80°C and extending the cooking time to 10mins produced a visually acceptable product. After 30mins of rehydration, the strips appeared plump and a light creamy yellow colour. It was difficult to tell if the strips were overly tough or overcooked due

to the lack of information on cooking. The strips cooked at 80^{o}C for 10mins were the least chewy of all the cooking methods trialed.

Traditionally, the jellyfish strips are rehydrated for several days after cooking although there is evidence to suggest that prolonged soaking interferes with the collagen structure and hence the texture of the final product Kimura *et al* (1991). Softening of products soaked for extended period greater than 24hrs was evident. The jellyfish strips were soaked for 3hrs before sensory appraisal.

These trials indicate that a lower cooking temperature, 70-80^{o}C, reduces the risk of product toughening and will slightly increase yield. These cooking temperatures contradict the recommendations on commercial packets of jellyfish that were sourced through this project. The increases to product weight during re-hydration after cooking is essentially complete after three hours, although a 24h rehydration period will contribute to extra softening of the jellyfish strips.

MARINADE DEVELOPMENT

Jellyfish is served in several ways: eg entrée; side dish with a meal; snack food with drinks and the marinade styles can vary according to serving method. Additionally, marinades can be very different between the Japanese and Chinese cuisine styles. Jellyfish is rarely eaten on its own; instead, it is consumed with other seafood, meats or vegetables.

Commercial marinades sold with jellyfish which were tasted with the Centre's Sensory Unit were generally described as slightly salty, meaty or soy flavour and having a dominant sesame flavour and odour. Two distinctive marinades were identified; a liquid type that was placed in several small sachets inside the jellyfish packaging and a combination of mixed powder with a sachet of either oil or vinegar.

A list of the marinade ingredients present in commercial sachets is available in Appendix 3. The most common base marinade from the commercial products consisted of a mixture of sesame oil or soy sauce with vinegar and sugar. The average ratio of ingredients in the commercial marinades was sesame oil 3.80g, vinegar 3.80g and spice / powder mix 4.50g. The constituents of the spice mix were not provided. A series of marinades based on the soy sauce & sesame oil combination were prepared using the same ratios and compared to the commercial samples for flavour. The flavour could not be matched, as the contents of the powder sachet were not provided. The commercial ingredients purchased for the experimental marinades and the compositons assessed are provided in Appendices 3 & 4.

The Japanese styles of marinades generally contain more vinegar and only a small amount of sesame oil is added. Direct translation of ingredients in jellyfish products available in Japan are listed in Appendix 5. By contrast, the Chinese style places emphasis on the amount of sesame oil and this is usually the dominant flavour of the dish. Seafood of South East Asia (1976) recommends that the dressing for jellyfish should be composed of a 3:2 ratio of sesame oil to soy sauce with a little vinegar and sugar added to taste. Discussions with Asian supermarket proprietors in Brisbane indicated that jellyfish dressing was generally composed of a 3:1 or 3:2 ratio of sesame oil to soy sauce. The experimental marinades that were trialed are presented in Table 2.

Table 2. Proportions of marinade ingredients trialed

Marinade	Ingredient Proportions			
	Soy Sauce	Rice Vinegar	Sesame oil	Sugar
Sesame Oil Base	10ml	7.5ml	30ml	7.5g
Soy Sauce Base	15ml	15ml	1ml	15g
Vinegar Base	N/A	50ml	1ml	30g
Neutral Base	15ml	15ml	15ml	15g

The marinade with 2 parts soy sauce was a very dark colour and had a salty flavour that was more pronounced than the commercial products. This may be because the commercial products included soy flavours instead of the fermented sauce. The soy sauce was reduced to 1 part, which lightened the colour considerably.

Due to separation of the oil and soy components of the marinades during storage an emulsifier was added to the experimental marinade to ensure that it remained evenly mixed and provided a good coating to the jellyfish strips. Keltrol ®, a xanthium gum, was added at 0.35%, which gave the marinade the best consistency. Keltrol ® was chosen as the emulsifier as it can readily be added to the marinade ingredients without excessive mechanical mixing and additionally provides some thickening to the marinade.

The sesame oil base, sesame oil base with added ginger oil and soy sauce base marinades were chosen for the initial sensory panel.

CONSUMER ACCEPTANCE TESTING

The results of the consumer acceptance tetsing of the experimental jellyfish products is fully discussed in the sensory reports attached as Appendices 6 and 7.

Preliminary sensory assessment

Full results are presented in Appendix 6 and summarised as follows. The mean scores given to the 3 marinated jellyfish products by the first sensory panel of 21 consumers were all very low. All three jellyfish samples were scored below 50 for appearance, odour, flavour and texture indicating that the consumers did not like the marinade styles presented. Additionally, the amount of marinade added to the samples was thought to be insufficient by the consumers. Comments received indicated that a stronger flavour is preferred. The texture of the jellyfish was also rated low with the initial crunchiness rated as just slightly/not crunchy enough. Several of the consumers described the texture as being chewy and rubbery. This result was unexpected and it was decided to reformulate the marinades and add a commercial product to the panel before further sensory analysis was undertaken.

Consumer acceptance testing

Three panels were conducted using 68 consumers of Asian origin. The panels consisted of four samples of marinated jellyfish and the consumers were asked a series of demographic questions, which were spread throughout the questionnaire. Full results are presented in Appendix 7 and summarised below.

Demographics

The majority of the consumers were of Japanese origin and 50% had been living in Australia for 5 to 15 years. From comments proffered, the idea of a ready-to-eat jellyfish snack food was considered to be a good idea by many of the panellists. A slight majority (53%) thought that 100g packs were appropriate for this type of product.

Jellyfish was eaten regularly by most of the panellists. Jellyfish was consumed at least once per month by 42% of the consumers and a further 40% ate jellyfish more than once per year but less than once per month. This category was not further broken down so there is no indication of the frequency of consumption by this 40% of the panellists. The dish is most commonly eaten at home (36%) or in a restaurant / bar (42%). For complete demographic results see Appendix 1.

Marinades

Three marinated ready-to-eat jellyfish samples were assessed by the consumers. The commercial sample was purchased from an Asian supermarket in Fortitude Valley, Brisbane. The two experimental marinades tested were soy and vinegar with ginger and a match for the commercial sample. The proportion of sesame oil was lowered to reflect the Japanese style of marinade. The soy and vinegar marinade was adapted from a recipe published by Neil Perry of Sydney's Rockpool restaurant. The ingredients in each marinade mixture are presented in Table 3.

Table 3. Experimental marinades assessed by Asian consumers

Marinade	Ingredients
Soy based	• 120ml Sesame Oil • 90ml Rice Wine Vinegar • 40ml Light Soy Sauce • 30ml White table sugar • 1.25ml Iodised table salt • 22.5ml Ginger powder • 0.625ml Garlic powder • 0.6g Keltrol ® blend all ingredients until oil and vinegar are emulsified.
Commercial Match	• 60ml Sesame Oil • 60ml Chicken stock powder • 30ml Rice Wine Vinegar • 10ml Iodised table salt • 0.5g Keltrol ® blend all ingredients until oil and vinegar are emulsified.

Sensory evaluation

There was no significant difference (P>0.05) between the commercial product and our experimental match in the appearance, texture, flavour or overall acceptability. Both products were scored within the neither like nor dislike (mean score of 50) range. The experimental match sample received a higher (P <0.05) score (mean score of 59) for odour than the commercial product (mean score of 52). Overall the consumers indicated they neither liked nor disliked the commercial product and the experimental match sample.

The soy sauce flavoured sample was scored overall at 30, indicating the consumers disliked the sample. The other ratings for the soy sauce flavoured sample were similarly low, all being within the dislike range.

All three of the samples were significantly different in saltiness. The commercial marinade was rated as being just right (mean score of 51) in the amount of salt while the match was rated as being too salty (mean score of 71). As was the case for saltiness all three samples were different in the amount of marinade. The amount of marinade was not enough for the soy based sample, just right for the commercial sample and slightly too much for the commercial match sample. It is possible that the results for saltiness and amount of marinade are correlated, in that if a consumer thought a marinade was salty, less of that marinade would be required.

Texture was assessed using both like or dislike (overall texture) and just right (initial crunchiness and chewiness) scales. There was no difference in the overall liking of the texture of the commercial and experimental match samples, rated at 56 and 53 respectively. However these low scores indicate that the consumers neither liked nor disliked the texture of the samples. The texture of the soy based samples was not liked by the consumers (mean score of 39). This indicates that the marinade is important to the perception of the sample texture as both the soy and experimental match samples were made from the same salted jellyfish and prepared (de-salted, cooked and rehydrated) in exactly the same manner.

The initial crunchiness and chewiness of the experimental marinated jellyfish samples were just above just right, indicating they were slightly too crunchy and chewy. The commercial sample was rated just below just right. The experimental samples were described as being chewy, rubbery and crunchy as opposed to the commercial sample, which was described as tender and soft.

Market Potential

The consumers did not think the soy-based marinade would be liked in their country of origin. Fifty seven percent thought the product would probably not be liked, 13% thought it definitely would not be liked and a further 22% were undecided. It is apparent from these results that the soy-based marinade is not appropriate. This may be due to the mildness of the marinade flavour.

More consumers thought the experimental match sample would probably be liked than the commercial sample but some of the consumers (10%) thought the commercial sample would definitely be liked. Only 4% thought the experimental match would definitely be liked and none thought the soy-based marinade would definitely be liked.

Forty percent of the consumers said they probably would buy the match for the commercial

marinade as opposed to 29% who would probably buy the commercial sample. However, more consumers said they definitely would buy the commercial sample (15%) than the experimental match sample (4%). Again, a large number of the consumers (78%) said they probably or definitely would not buy the soy-based marinade.

Consumer differences by country of origin

Non-Japanese consumers liked the commercial sample significantly more for appearance, odour, texture, flavour and overall. The Japanese consumers, 54% of all the consumers, scored the commercial sample as being not crunchy, chewy or salty enough and as having not enough marinade. This indicates that Japanese consumers prefer a different style of jellyfish than consumers of other Asian origins. Japanese consumers prefer a crunchier jellyfish product with a stronger marinade flavour.

There was no difference between Japanese and non-Japanese consumers in the ratings given to the experimental match sample. The Japanese consumers rated the initial crunchiness of the soy sauce flavoured sample closer to just right than the rest of the panel.

The descriptions of the jellyfish texture by the panellists indicate there could be problems with the salted jellyfish used to produce the marinated products. In comparison to the commercial products the experimental jellyfish was much firmer both prior to and after cooking and soaking. It was believed that high storage temperatures effected the commercial product, but even taking this into account the texture was considerably softer in the commercial products than the experimental jellyfish.

The consumer assessment of the marinated jellyfish strips is more fully discussed in the attached report in Appendix 7.

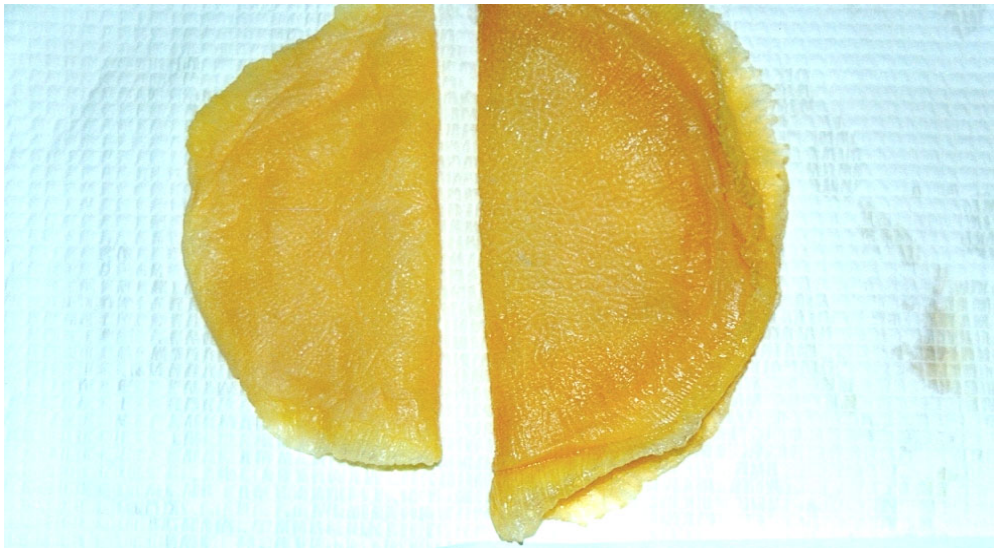
CONSUMER INTERVIEWS

Given the unexpected and negative results of the product assessments from the preliminary assessments, Japanese consumers were consulted to elicit information pertaining to the cooking and preparation of jellyfish products. This was in order to determine if the salting regime or cooking/preparation steps were contributing to the tougher chewy texture of the jellyfish.

The Japanese consumers were asked to prepare the jellyfish in order for the processing steps to be established. Samples of the experimental salted jellyfish bells and a wholesale imported salted jellyfish were given to the consumers to practise with. The consumers were not told which sample was the experimental or the commercial one. There was noticeable difference in the appearance of the samples with the experimental bells being more opaque and yellow (Plate 2).

The consumers brought their prepared (desalted and rehydrated) jellyfish samples to the Centre and interviews were conducted. During the interview period, the consumers kindly prepared the jellyfish end-product as they would serve it at home, to show what steps they had taken to produce the finished dish.

Plate 2. Imported jellyfish bell (left) **and experimental jellyfish bell** (right)



Two consumers kindly offered to attended the Centre for further detailed discussions and another two provided comments on the preparation of marinated jellyfish. The cooking steps as demonstrated by the consumers are presented below.

- de-salt the dried jellyfish bells, changing the soak water frequently for a maximum of 3hrs. Salt can initially be washed off under running fresh water.
- cut jellyfish bells into strips *ca.* 10-15mm thick and place into a heatproof bowl.
- use 1L of fresh water for each 100g of jellyfish strips. Heat the water to 70-80^{o}C
- pour the water over the jellyfish strips.
- immediately pour the water and jellyfish strips into a colander and drain. The jellyfish strips should not be in the hot water for more than a 2-3secs.
- put strips under running fresh water until the cooking process is stopped and the strips are cooled. Allow rehydrating for approx. 3hrs in fresh water. Strips can be stored in fresh water in the refrigerator overnight before use.
- to use, allow jellyfish strips to drain well and then thoroughly squeeze the remaining moisture from the strips.

Once our experimental jellyfish bells were cooked using this method, the texture was more comparable to the commercial samples and was described as more acceptable by the consumers. The experimental jellyfish was still more opaque, yellow coloured than the commercial ones, but we were informed that the thickness of the experimental sample made it look more expensive. The sample was also really crunchy which is an important aspect of acceptability to the Japanese. The commercial product was less liked by the consumers because of its translucency and it did not look like jellyfish (was described as having an appearance similar to arrowroot).
The flavour of the experimental jellyfish was described by one of the Japanese consumers

as being similar to rubber bands; the flavour was described as being rubbery and plastic. It is felt that this may be due to residual alum from the salting process. This indicates that the salting process could be assessed in relation to its effectiveness in producing an acceptable jellyfish product.

The recommended marinade was soy sauce, vinegar, sugar and sesame oil. The flavour of the marinade needs to be very strong, with quite a salty taste. Some of the suggestions were that Japanese products should be used to make the marinade as soy sauce and vinegar from Singapore for example, were very different to common Japanese soy sauce and vinegar. We were informed that our commercial match marinade was a Chinese style and would probably not be used by Japanese consumers, even though Japanese consumers purchased the particular commercial product from which it was copied. The Japanese consumers prefer a more acidic flavour to the Chinese. The consumers noted that the marinade becomes watered down and flavour is reduced. It is common practise to drain jellyfish and re-marinate after a period of storage. It is believed the moisture from the jellyfish dilutes the soy marinade. This can be minimised by thorough draining and squeezing the moisture from the rehydrated strips.

Jellyfish is rarely eaten on its own, even with a marinade added to the basic jellyfish. Chicken, cucumber and other vegetables are added. It is possible that further development work could be undertaken on this theme. Packaged complete meals with jellyfish would present an alternative idea, but further research is needed on shelf life and preservation of such products.

PACKAGING

Bags

Investigation of the materials used to pack Asian foods indicated that the higher quality products were packaged in polyethylene polyester (PET/LDPE) laminates. Generally, these packaging types are full barrier plastics that have a maximum oxygen transfer rate of 53cm/m^2/day and 2g/cm^2/day moisture vapour transfer.

The benefit of a barrier bag is that it ensures that the product retains colour, freshness, aroma and taste. Without the polyester laminate, polyethylene is affected by acids and fats and other compounds in the foods resulting in some of the product ingredients escaping the packaging. This became evident with cheaper jellyfish products, where a patina of salt was visible on the outside of the packaging. The acidity of the jellyfish marinade requires packaging in a laminate bag.

A PET/LDPE bag of 70μm thickness is adequate for packaging the marinated jellyfish product. It is heat sealable and printable. Small entrée sized bags that will hold *ca.* 120g cost cents per unit with minimum run of 10,000 bags.

The foil laminate bag is another packaging option. A low-density polyethylene (LDPE) is laminated to the foil exterior. Low-density polyethylene cannot be used without the foil laminate because it is a poor oxygen / carbon dioxide barrier. The foil layer creates a full barrier package. The option to package using a gold foil is beneficial because of the "premium" appearance of the product. The minimum production run willing to be undertaken by suppliers is considered 20,000 units based on a fixed per unit cost per bag in cents.

Upright, bottom gusseted, DOI packs are currently popular and of particular benefit with this packaging is the resealable ziplock top. These packages are also a polyester polyethylene laminate providing a good barrier to gases and moisture. Small 120g entrée sized DOI packs are priced between 10 -17 cents a unit.

The PET/LDPE bags do not have a barrier to UV light unless they are fully covered with printing. Products, which were stored for 4 days under UV light, exhibited a high-level of drip loss. The texture of the jellyfish was not affected in this time but the appearance was not acceptable. As refrigerated storage is recommended and the packages are likely to be printed on, excessive exposure to UV light is not a major consideration. Packaging using the foil laminate bags would exclude UV light.

Printing

Both the PET/LDPE and foil laminates bags are easily printed. The cost of printing is dependent on the number of colours in each run. Printing costs reduce as the number of bags in each run increases. Generally printing with 1-2 colours will add 10 cents per 1000 bags, 4 colours adds 12 cents per 1000 and 6+ colours adds 13 cents per 1000. It is also possible to print photographs of the product on the bag but this increases the cost substantially.

Colour and design

A common design in retail packages of Asian products is a clear area or window in the package through which the product is visible. Information received from Asian Marketing experts concurred that product visibility was important to its acceptance. Both the PET/LDPE and foil laminate bags can be produced with a clear window although this is easier using the PET/LDPE packages.

Generally, retail packs of Asian foods are brightly coloured and there are a few colours, such as black, which are best avoided. Sombre and dark colours are not recommended for the Asian market.

Of the numerous brands of salted jellyfish which were sourced for this project (Plate 3 and also see Appendix 5), the majority of the packages were based on the colours red, gold and bright blue. Generally the printing on the packages was minimal. All products were visible through the packs. Four mock-up bags using the red, gold and bright blue were made available for assessment by the consumer panel and are included in Attachment 1.

Plate 3. Retail products from Brisbane Asian supermarkets and retail outlets in Japan.

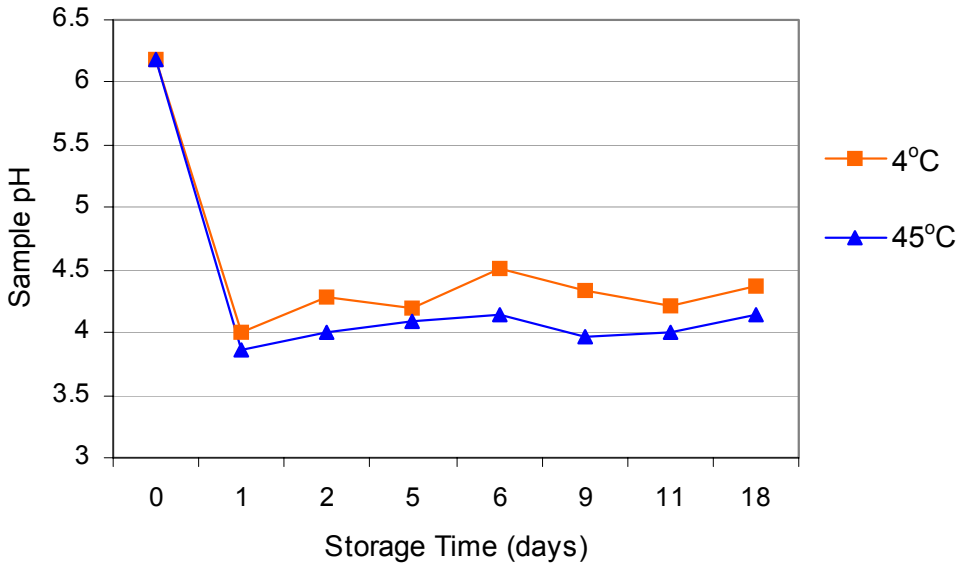
The reaction to the packaging prototypes indicates that there would be some resistance to product in these packages, which were dissimilar to the current jellyfish market. A large proportion of the consumers (40%) picked the transparent with red/gold (sample 791 in Attachment 1) and a further 31% chose the red/gold (sample 054, Attachment 1) packaging samples as their favourite. Overall, none of the samples were liked very much, due to the picture of the jellyfish that was used. The comments from the consumers indicated that a photo of a real jellyfish would not be accepted and looked unappealing. Several of the consumers commented that the package should be clear so that the product can be seen. A more animated picture of a jellyfish would be more popular than the photo that was used on the mock packages and styles should reflect those commonly used in Asian markets.

STORAGE LIFE DETERMINATION

The marinade chosen for the jellyfish strips should provide good preservation through reduced pH and lower water activity. There was a large reduction in the initial microbial load on marinated jellyfish strips after 48hr storage at both 4°C and 45°C. The jellyfish strips stored at 45°C had no detectable microbial load after 48hrs and the number of bacterial colonies present on jellyfish strips stored at 4°C reduced by 84%. The low microbial counts remained stable for the 18 trial days of the assessment. The pH of the samples also remained stable over the storage period. Figure 3 shows the pH of the jellyfish stored at 4°C and 45°C over the 18 trial days.

The combination of the jellyfish and marinade showed a large decrease in pH after 24hr storage for both samples. The pH then remained stable during storage with the pH of the sample stored at 4°C being slightly higher than the 45°C sample.

Figure 3. Jellyfish sample pH over 18-day storage period.



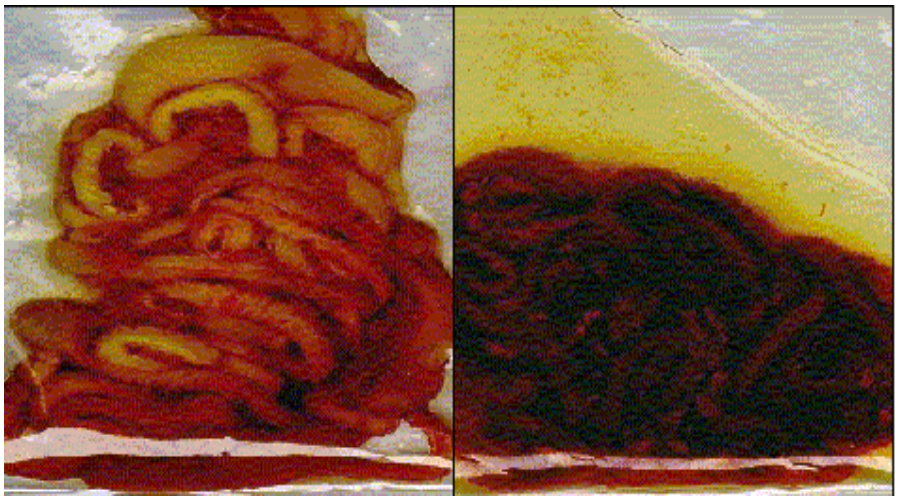
Most spoilage bacteria grow between pH 6 - 8. Increases in the sample pH over storage would be expected with increasing growth of spoilage bacteria. The pH of the samples over the storage period suggests that the marinade would successfully preserve the product. Table 4 shows the results of scientific staff assessments of appearance, texture and odour of the marinated jellyfish over a storage period of 18 days.

Table 4. Assessment of cooked, marinated jellyfish stored at 4°C and 45°C.

Storage Time	Observations	
	Storage temperature 4°C	**Storage temperature 45°C**
2 days	Colour off-white. Slight drip loss visible. Sesame odour.	Product has darkened and is drying around edges of jellyfish. Apparent driploss. Sharp, oldish odour.
6 days	Sweet fresh smell. Colour off-white to light brown. Texture feels firm. Much more drip loss visible.	Old smell apparent, slightly rancid odour. Texture feels mushie / soft. Large volume of drip loss.
9 days	Light brown colour. Texture feels firm. Slight driploss present. Odour fresh and sweet.	Colour very dark brown. Texture very soft. Product starting to smell seafoody.
12 days	Odour is typical of soy and sesame. Texture firm and rubbery.	Jellyfish is very soft. Large amounts of exudate present. Little odour detectable.
18 days	Colour still light brown to off white. Sesame odour. Still slight exudate present.	Dried old appearance. Very soft to mushie. Strong odour of old fish and sesame.

The visual assessment of marinated and un-marinated cooked jellyfish stored at 45°C and 4°C indicates there is a detrimental effect to the appearance and texture of the product when stored at high temperatures. Plate 4 shows the marinated jellyfish strips after 48hrs storage at both 4°C and 45°C. Note at 45° C storage, excessive drip loss and softening are evident.

Plate 4. Marinated jellyfish strips stored at 4°C (left) **and 45°C** (right) **for 48 hours.**



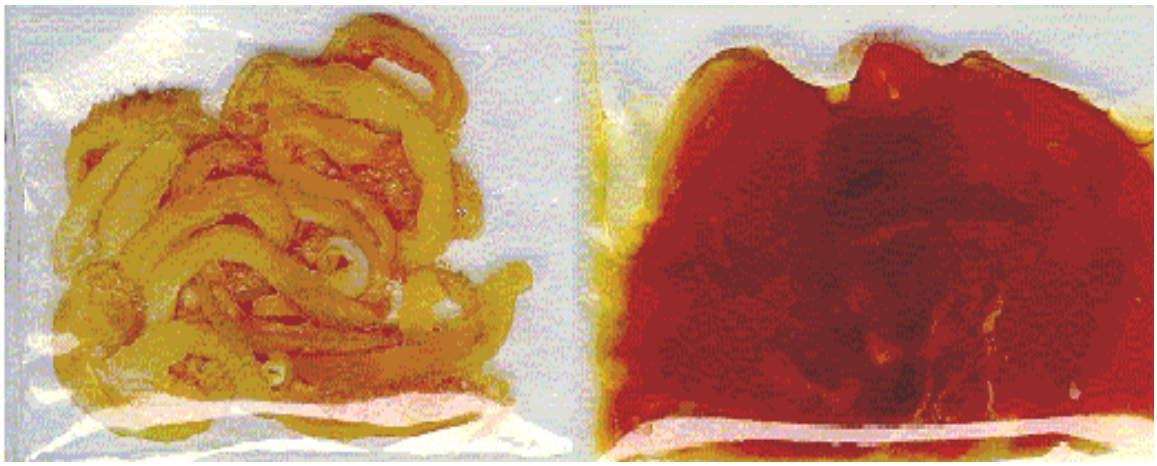
The cooked and marinated jellyfish strips stored at 45°C darkened and the marinade ingredients separated in the packaging after 48hrs. A large volume of moisture was lost from the jellyfish, which detracted from its appearance. The marinated jellyfish samples stored at 45°C were rejected after 2 days storage. The samples stored at 4°C were still acceptable after the 18 days storage period.

An additional problem was encountered in the separation of the marinade ingredients and to overcome this the use of an emulsifier was investigated. Ideally the emulsifier should combine the oil and water phase of the marinade as well as adding some thickening so that the product is evenly coated. The emulsifier added to the marinade was Keltrol ® at a rate of 0.35%.

Two packs of cooked and rehydrated jellyfish without marinade were placed as controls during the running of this trial. These two packs were not opened for analysis but were simply observed for visual and textural changes during the trial. The non-marinated jellyfish samples also become unacceptable after 48hrs of storage at 45°C.

Figure 4 shows that the non-marinated cooked jellyfish samples are a dark brown colour and have a soft mushie appearance when compared to non-marinated jellyfish stored at 4°C for the same period. The amount of moisture in the package from the strips is clearly visible. The un-marinated samples stored at 45°C appeared twice as dark as the ones stored at 4°C and drying could be detected around the outer edges of the samples. The sample was very soft to feel and tended to break up under pressure.

Figure 4. Rehydrated cooked jellyfish strips stored at 4°C (left) **and 45°C** (right) **for 48 hours.**



In order to establish the upper limit for the storage temperature, samples were stored at 10°C, 20°C and 30°C. De-salted, cooked, rehydrated and marinated jellyfish strips were stored. Table 5 presents the assessment of the marinated jellyfish strips during storage. After 24hrs of storage at 30°C there was light drip loss noted from the jellyfish strips. The samples stored at 30°C and 20°C were rejected at 5d and 10d respectively due to discolouration and extensive softening of the jellyfish strips indicating that the product requires chilled storage to maintain high quality during storage.

Table 5. Assessment of cooked, marinated jellyfish stored at 10°C, 20°C, 30°C

Storage Time	Observations		
	10°C	20°C	30°C
5 days	Good colour, shiny texture firm and springy fresh odour	Colour separation in marinade. Slight darkening. Texture not as springy. Seafoody smell.	High level of moisture, discoloured. Soft texture.
10 days	Colour good, Texture firm and plump. Sesame smell.	Colour darkened. Texture soft. Slightly rancid oil smell.	REJECTED
16 days	Colour good, Slight exudate and shrinkage.	REJECTED	REJECTED

The upper limit for storage of marinated jellyfish was determined to be 10°C. Storage trial results indicate that storage at the higher temperature of 10°C could shorten the high quality shelf life of the marinated products, although this is yet to be quantified. As the microbial

counts remained stable over 18d at both 4 and 45°C storage, plate counts were not performed, but the results from the previous trial indicate that microbial growth is sufficiently inhibited by the marinade formulation. These trials indicate that marinated jellyfish strips could likely expect a shelf life of between 30 and 90 days at chilled temperatures.

In all cases, the uncooked, un-marinated samples showed no effect from storage at high temperatures substantiating advice that the dried product could be stored in ambient conditions for long periods.

Storage of both marinated and non-marinated cooked jellyfish at higher temperatures is not appropriate. Previous research (Subasinghe, 1992) has indicated that storage of the rehydrated jellyfish above 20°C rapidly leads to softening and loss of textural properties of the jellyfish. Retail samples which were sourced from Japan all recommended storage below 10°C but it is common to find Chinese imports that recommend storage between 5°C and 35°C. These products were noted to have lost texture during storage and were judged as being not crunchy enough during sensory testing. The results of storage of the experimental jellyfish above 10°C indicate that shelf life would be significantly reduced and quality would be compromised if chilled temperatures were not maintained during storage.

PRODUCT MARKETING

Due to a wish to not compromise the commercial aspect of this project for the research partner, individual approaches have been made. Through promotional articles published in several journals, the availability of novel value-added jellyfish product has been advertised. These articles have resulted in several approaches by exporters.

The research team has promoted the project and product through the following:

- A presentation titled "Jellyfish…from abuse to use" was delivered at the **'99 Innovations for Seafood Conference** 21-23 April 1999. This paper is available in the conference proceedings CD.

- An article titled "Product convenience adds value to jellyfish" was published in the **Asian and Middle East Food Trade** in November 1999.

- Two articles have been publiihsed within **Seafood Australia** and **Professional Fisherman** publications.

- A segment for **"Creek to Coast"** channel 7, was recorded with Sally Jenyns and has been viewed by a nation wide audience in Australia.

PROMOTIONAL ACTIVITIES

1. Jellyfish investment negotiation meeting held with Chinese Food Corporation, Chinese Government and Queensland Government in Tianjin China.
2. Broadcast segment on CCTV – the Chinese satellite television broadcaster, with the Director General for Chinese Trade Development.
3. Presentation of the jellyfish industry and value-added potential at the International 99 innovations in seafood conference Gold Coast.
4. Television promotion of jellyfish industry and value added potential on Channel 7's "Creek to Coast" program.
5. Presentation to Supermarkets into Asia and FRDC on the value added jellyfish product potential in the Asian market.
6. Article published in the Asian & Middle Eastern Food Journal on the value-added jellyfish product developed in Australia
7. Article published in the Professional Fisherman's magazine on the value-adding potential of jellyfish caught in Australian waters.
8. Article published for Seafood Australia on value-added jellyfish and potential industry development.
9. ABC radio interview on the potential of developing the jellyfish industry in Queensland and Australia with respect to value-adding
10. 4BC radio interview on value-adding to an underutilised resource, the common jellyfish.
11. WIN-TV television promotion of jellyfish and value-adding potential in Queensland and Australia.

FURTHER DEVELOPMENT

The project work and results have highlighted several areas where further investigation into alternative production techniques is needed. These include:

The drying process
The traditional methods used for drying jellyfish with salt and alum are labour intensive and hence in Australia, expensive.

- more rapid, less labour intensive methods are needed

Dried jellyfish preparation
Bell preparation requires the removal of the outer skin (ecoderm) to achieve an acceptable end-product. In Asian countries, this is carried out by using simple scrubbing brush, however this step is time consuming and therefore again, expensive with Australian labour costs.

- an alternative method of removing the ecoderm is needed.

The marinade
Investigative interviews with Asian jellyfish consumers revealed large and strong differences in taste preferences according to country of origin.

- ready-to-eat product needs to be targeted very specifically.

Marketing information needs
The project illustrated a strong need for further information to develop a competitive export-based jellyfish industry in Australia. In particular further information on:

- capacity of resource availability and seasonality
- possible markets for processing by-products of jellyfish
- specific product styles to satisfy the diverse market base
- target market segmentation to prioritise market entry
- product packaging preferences

CONCLUSIONS

The Australian jellyfish species *Catostylus mosaicus* is ideally suited for processing for the Asian market as evidenced from feedback received from importers from Asian countries. The finished product appears to be more opaque and yellow coloured than imported salted products, although we have been informed that this does not detract from the acceptability of the jellyfish. The appearance of the salted jellyfish was perceived as expensive looking by Japanese consumers who were recruited to assist in establishing cooking and preparation parameters.

Rubbery flavours were noted in the salted bells however, which does reduce its overall acceptability. It was beyond the scope of this project to assess the salting process, but it is believed the rubbery flavour is a result of residual alum from salting. It is recommended that further assessment of the salting process is undertaken and the salting compound that results in the best quality is established.

The salting process remains inefficient and labour intensive. In order for further benefit to be gained in the cost effectiveness of this product, further investigation of mechanical drying methods should be undertaken.

The concept of a ready-to-eat product was well received by consumers. The acceptability of marinade recipes was decidedly subjective according to country of origin of the consumer, and it is apparent that vast differences in the flavours of acceptable marinades for different Asian regions exist. It was established that it is more important for the marinade to consist of strong salty flavours than for it to exactly mimic commercial products.

Consumers were advised that the jellyfish they would sample was caught and propared in Australian and this may have affected the acceptability results given for the samples. In retrospect, consumers should have tasted the product without prior knowledge of its origins. This is particularly true for traditional Asian foods, where it is perceived that Western styles of reformulation may be inferior to traditionally prepared forms.

A base recipe for marinating jellyfish has been established through sensory testing and consultation with Asian consumers. The marinade has been assessed through storage and has been shown to provide good preservation of the cooked jellyfish strips. This research

has demonstrated the importance of maintaining a low storage temperature for the quality and texture of the product.

This project has provided seafood processors with a documented process for producing a high quality ready-to-eat jellyfish product acceptable to Asian palates. This makes harvesting jellyfish from Australian waters worthwhile for the licenced fishers as there will be higher demand for raw product. However, while the process to produce an acceptable end-product exists, further work needs to be undertaken to intergrate all marketing factors involved in exporting a new product. For this to be achieved, the current project work needs to be extended to establish the most appropriate product for specific markets, positioned at a level that maximises return to the jellyfish industry.

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Personal Communications

Ding, Benjamin 1998-2000 David Glory Group
Dwyer, P. 1997 NSW Fisheries Department
Massey, R.& S. 1998 Berkley, NSW
Seahorse Corporation 1998 Sarawak, Malaysia
(Sdn. Bhd lot 983 Section 66 jalan Tambatan, Pending Industrial Estate, 93450 Kuching Po Box 795, 93716 Kuching,). Jellyfish Processing Step
Spinks, L. 1997-1999 Ballina, NSW

Information sourced from the Internet
Specifically for marinade composition:

http://soar.Berkley.EDU?receipes/meat/seafood/fish/sesame-jellyfish1.rec

http://www.apalachtimes.com/seafood.htm

http://www.alt.net/~lk/Cooking?conversions.html

http://hei01.hei.com/heco/ekitchen/9512jfish.html

APPENDIX 1

Demographic Results from the Asian Consumers

A total of 68 Asian consumers comprising of 35% (24) males and 65% (44) females who had previously eaten jellyfish tested the samples.

Table 1. Distribution of AGE GROUPS for the consumers

Age group	18-30	31-40	41-50	51-60	60+
Number	22	7	21	14	4
Percentage	32%	10%	31%	21%	6%

It can be seen from the table that all age groups up to age 60 were well represented at the consumer evaluations.

Table 2. Distribution of COUNTRY OF ORIGIN of the consumers.

Country	Australia	China	Hong Kong	Indonesia	Japan	Korea
Number	0	3	1	5	37	2
Percentage	0%	4%	2%	7%	54%	3%

Country	Malaysia	Singapore	Taiwan	Thailand	Vietnam	Other
Number	6	1	1	1	9	2
Percentage	9%	2%	2%	2%	13%	3%

All the consumers who attended were of Asian origin, with the majority (54%) of them originating in Japan.

Table 3. Distribution of length of time the consumers have LIVED IN AUSTRALIA

Time in Australia	Less than 1 year	1-3 years	3-5years	5-10 years	10-15 years	15-20 years	More than 20 years
Number	5	1	8	14	20	11	9
Percentage	7%	2%	12%	21%	29%	16%	13%

A large proportion of the consumers have lived in Australia for more than five years. Depending on how much contact they have with their country of origin, this may affect how they thought the products would be liked in their country of origin.

Table 4. Distribution of HOW OFTEN the consumers eat jellyfish.

Frequency of consumption	Once per week	More than once a month	Once per month	More than once a year	Once per year	Every 1-3 years	Less than once every 3 years
Number	1	13	14	27	9	1	3
Percentage	2%	19%	21%	40%	13%	2%	4%

The table above shows that although many of the consumers have lived in Australia for five years or more, they still eat jellyfish fairly regularly, with the majority eating jellyfish at least more than once a year.

Table 5. Distribution of WHEN the consumers eat jellyfish.

When	In home cooking	In a restaurant /bar	On special occasions	As a snack	Other
Number	38	44	15	3	5
Percentage	36%	42%	14%	3%	5%

Jellyfish is most commonly eaten in home cooking or in a restaurant/bar, as shown by the table above. Only 3% indicated that they already ate jellyfish as a snack.

Table 6. Distribution of WHAT TYPE of jellyfish the consumers buy

Type	Instant/ready to use	Dried/salted	Don't buy
Number	42	31	5
Percentage	54%	40%	6%

The majority of the time jellyfish is bought as an instant/ready-to-use product (Table 6), although dried/salted product is also widely purchased. Some of the consumers buy both instant/ready to use and dried/salted product. Sixty five percent of the consumers were able to purchase the type of jellyfish they like in Australia.

Table 7. Distribution of what the consumers EAT JELLYFISH WITH.

Eat jellyfish with	With other ingredients	With a marinade	On its own	Other
Number	42	39	11	13
Percentage	40%	37%	11%	12%

Jellyfish is most commonly eaten with other ingredients and/or a marinade. From the section for 'other' comments made by the consumers, jellyfish is often eaten in combination with vegetables, especially cucumber, and other meats.

Table 8. Distribution of OTHER INGREDIENTS the consumers would like to add to the marinades.

Ingredient	Bonito flakes/ powder	Chilli	Garlic	Ginger	Japanese Mustard	Seaweed flakes/ powder
Number	4	38	29	21	8	12
Percentage	3%	25%	19%	14%	5%	8%

Ingredient	Teriyaki sauce	Wasabi	Yakatori sauce	Your favourite rice seasoning	Other
Number	7	2	3	10	20
Percentage	4%	1%	2%	6%	13%

Chilli, garlic and ginger were the ingredients that the consumers would most like to see

added to the marinades. Vinegar and soy sauce were the most commonly listed 'other' ingredients. The following is a full list of comments received on what consumers eat jellyfish with:

Chicken pieces mixed with sesame oil and sesame seed.

Only jellyfish.

Cucumber, wakame (seaweed) with vinegar sauce.

Mix together with cucumber and vinegar. Mix together with tomato and onion and vinegar.

A Thai dish "Yentafo" which is noodles in clear or rich broth with squid, jellyfish, fish balls and vegetable.

With celery, carrot, cucumber (mixed together).

I ate with combination such as meat, salad etc

With vinegar and cucumber. With chicken pieces and rice paper. Rice, noodle.

With cucumber or with cold noodle.

Cucumber marinated with vinegar.

Rice.

Cucumber and so on.

With rice. eg on sushi.

Chilli, garlic, salt, sesame oil.

With other vegetables (fried).

Rice.

With mayonnaise sauce, soy sauce. Soy sauce, sugar and vinegar. Stir fry with vegetables.

Vinegar (Japanese made from rice).

Normally I eat jellyfish with rice.

Cucumber, Calamari, Garlic.

All vegetable (like cucumber, onion, carrot and lettuce) Mixture with mustard (oriental) sauce.

With cucumber, vinegar and sugar.

Cucumber or sea urchin mixed together.

APPENDIX 2

CONSUMER ACCEPTANCE TESTING METHODOLOGY

Recruitment

Consumers were recruited from the Asian community in Brisbane on the basis that they had previously eaten jellyfish, were aged 18 years and over and could read and write basic English. Some consumers rersponded with comments in their native language which were then translated, hence small nuances of language may have been lost.

Samples

'*Warmup*' Experimental ready-to-eat jellyfish marinated with a diluted version of the match to the commercial marinade.

1. Commercial brand of ready-to-eat jellyfish marinated with its own marinade sachet.
2. Experimental ready-to-eat jellyfish marinated with a match to the commercial marinade.
3. Experimental ready-to-eat jellyfish marinated with a soy based-marinade.

The marinades used for this experiment were formulated from the results of a preliminary session to look at the consumer acceptability of marinated jellyfish. Results from the preliminary session can be found in Appendix 6.

Preparation of samples for consumer acceptance testing

The marinade was added to the ready to eat jellyfish just prior to weighing out the samples. The ratio of marinade to jellyfish was set by the researchers. Samples of 12 ± 1g were weighed into small round opaque plastic dishes 2 hours before the testing commenced. The samples were covered until required to prevent drying out. They were presented to the consumers at room temperature (19-20^{o}C).

Consumer acceptance testing

Each consumer attended one of three sessions held in the Sensory and Consumer Science Unit at the Centre for Food Technology, Hamilton on the 27th and 29th March and 5th April 2000. They each received a small remuneration to cover travelling expenses.

The consumers were briefed on the testing procedure and the use of the computerised data collection system for the sensory test.

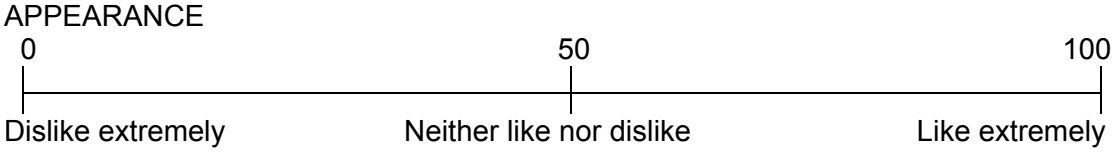
They were told that they would taste four samples of marinated jellyfish, three which were trial products and one of which was an existing commercial product. They were informed that the trial products to be tested were Australian jellyfish which was caught in NSW waters around the Clarence River and the products were intended for export to Asian countries. It was also explained to the consumers that the jellyfish would be very plainly presented as they were to focus on the jellyfish without the addition of other ingredients and garnishing.

They were not informed of the actual flavours of marinade that they would be evaluating.

Samples were presented to the consumers while they were seated in individual booths illuminated with white light (day light equivalent). Each sample, in an opaque plastic dish, was presented on a white tray with a fork and chopsticks and was identified using a three digit blinding code. The samples for assessment were presented in a sequential monadic fashion. Each panellist received the 'warmup' sample first, followed by samples 1 and 2 in a balanced order. Sample 3 was given last to minimise any carry over effects as the soy based marinade also contained ginger. The consumers had breaks of at least 10 minutes between samples. Purified water at room temperature was available to the panellists during the tasting as well as in the breaks between samples. Plain, unsalted rice crackers were also available after each sample to aid palate cleansing.

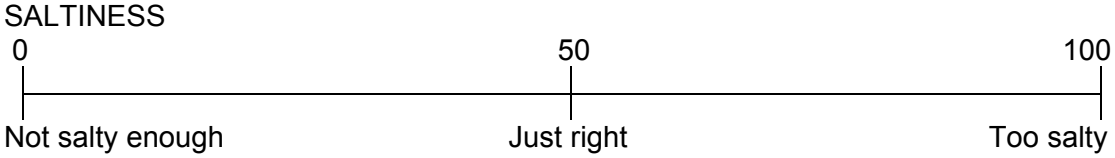
Consumers were asked to rate their degree of liking on linescales for appearance, odour, flavour, texture and overall liking and to select descriptors that they considered applicable to each product. An example of a linescale used to measure attribute liking is below. The values assigned to mid and end points were not presented to the consumers.

Linescale to measure attribute liking.



Some attributes of the product were measured on 'Just right' scales including assessment of assess the desired amount of initial crunchiness, chewiness, saltiness and the amount of marinade. On the 'just right' scales, the midpoint (50) was the 'just right' level for the nominated attribute, with either extremities of the scale being "not enough" and "too much" of the named attribute.

A 'just right' linescale



Panellists were also asked, on a five point category scale, if they would purchase the product, if it would be liked by the people in their country of origin and how it compared to the jellyfish they normally ate. General demographic information was gathered as well as consumption patterns, purchasing habits and ideas on packaging. Data was collected directly into computers presenting a standard rating test (AS 2542.2.3 1988), using an integrated software package, Compusense five version 3.6 (Compusense Inc, Canada). Additional comments were collected on paper.

The consumers were shown examples of 50g, 100g and 150g pack sizes before answering the question relating to pack size and had packaging samples in their booths to answer the question on packaging preference.

APPENDIX 3

Ingredients of commercially available jellyfish products

Name	Weight	Country origin	Style	Ingredient	Address	Other
Tai Chang Natural Food	125g net	China	Instant Gongcai Package Foil laminates	Taigan vegetable, sesame oil, salt, gourmet powder, sodium benzoate	Importers DCB Trading Pty Ltd Alexandria NSW 2015	Expiry 1/4/97 Ph-02-281-2777 Cost-n/a
Instant Natural Jellyfish	150g net $2.40	Gotin Industrial Ltd 94, Tokwawan Rd, Merit Ind. Ctr 5f. b15, Kowloon, Hong Kong. Tel:5267636 Fax;-5267715	Instant natural jellyfish Package Foil laminates	Jellyfish, water, sesame oil, sauce (salt, green onion, sugar, vinegar, pepper, MSG	Trans Asian Food Centre Pty Ltd 298 Oxford St. Leeoerville Western Perth 6007	Expiry/ best by-N/A Store5-35^{0}C
Instant Natural Jellyfish	150g net $2.40	Vietnam French & English writing	Instant natural jellyfish Package Foil laminates	Jellyfish, water sesame, sesame oil, 5 spice powder, salt, MSG	Aussna Trading Pty Ltd 31 Duncan St Fortitude Valley Qld 4006	Expiry/ best by-N/A Store5-35^{0}C 07-32541256
Instant Natural Jellyfish	150g net $1.95	Guandong Province Jiangmen Waihi Food factory	Instant natural jellyfish Package Foil laminates	Jellyfish, salt, potassium sorbate Flavouring & sesame oil	Burlington Centre Supermarket Pty Ltd 102 Bourke Rd Alexandria NSW 2015 Australia	Expiry 9 months from pack on date 08-04-98. Ph-07503783269

Jellyfish	454g	China-Hong Kong first St . ph-540 5811	Polyethylene-NOT INSTANT	18 servings (25g) calories 0 fat 0 cholesterol 0 sodium 2830mg carbohydrates-0 fibre- 0 Protein-1g Vitamins (A)-0, (c)-0,Ca-0,Fe-2%	Burlington Centre Supermarket Pty Ltd 102 Bourke Rd Alexandria NSW 2015 Australia	Best before 30-1-99
Five Star salted whole jellyfish	400g $3.50	Malaysia Trade ocean exporters sdn. Bhd. 700 jalan valdor sungai, vador estate 14200, sungai bakaP, PENANG, MALAYSIA	Polyethylene-NOT INSTANT	JELLYFISH, SALT, MSG, sesame oil, soy sauce & sugar maybe used. Chilli, vinegar, lemon, maybe added	Natasha corporation pty ltd 3/13 –14 hallstrom pl. wetherill park nsw 2164 aust. 02-9756 3169	Expiry, packed on, best by-not available.
Great wall whole jellyfish	375g $2.99	China	Polyethylene-NOT INSTANT	In Chinese?	Yuens market 3852 1283	Expiry, packed on, best by-not available.
Salted jellyfish	375g $4.20	Ket Hoe Sdn Bhd PO Box 608, Penanag Malaysia Ph-610886	Polyethylene-NOT INSTANT	none	Australian distributor Ong trading co Unit13/30 perry st Matraville NSW 2036 02-316 6530	Store in cool place best before 31/12/99

APPENDIX 4

Experimental Marinades for Jellyfish

Ingredients	Japanese	SJ's*	SEA Base modified	Chinese	JE*1	JE*2	JE*3	JE*4	JE*5	JE*6	RN* 1
Vinegar	15ml	7.5ml	7.5ml	50ml	15ml	15ml	5ml	15ml	2.5ml	2.5ml	6ml
Soy lite	15ml	10ml	10ml		15ml	15ml	15ml	5ml	10ml	10ml	24.07ml
Sugar	15g	7.5g	7.5g	30g	15g	15g	7.5g	15g	25gm	2.5g	6g
Sesame oil	1ml	30ml	30ml	1ml	5ml	15ml	5ml	15ml	15ml	15ml	36.1ml
Japanese Mustard Powder	.016g pinch										
Ginger oil natural			0.1ml								
Keltrol (0.35%)	0.161g	0.1925 g	0.1925g	0.252g	0.175g	0.21g	0.34g	0.175g	0.184g	0.21g	0.35g
salt				1g							
water											27.8ml
Comment											
Total	46g	55g	55.1g	81g							

*JE=Jacquie Edwards
*RN=Ross Naidoo
*SJ=Sally Jenyns

APPENDIX 5

Transcripts of interviews and packaging

Japanese Jellyfish Specialist:
Masaya TOYOKAWA [mtoyokaw@nrifs.affrc.go.jp] Thursday, 9 September 1999 12:36
Regarding: Preparation and Cooking of jellyfish:

I think that the length of seconds in the boiled water determine the final texture of the dish. Some trial will be needed to know the best timing. (The case similar to boiling noodle or beans.)

Roll the dried jellyfish like a roll paper and cut into 3-5 mm width pass them through the enough amount of boiled water for a few seconds immediately release in a cooled water wash well by hands while changing the water some times soak in clear water overnight for desalting squeeze (well) water from the material put the material into source B for seasoning we often mix them with sliced cucumber (cut in stick form, adjust the shape and size of jellyfish slice). Source B for dried jellyfish 150 g

Salt	a little
Chemical condiment	a little
Sugar	1 spoon
Sesame oil	1 spoon
Vinegar	1 spoon
Soy source	2 spoon

Masaya Toyokawa
National Research Institute of Fisheries Science, Japan
mtoyokaw@nrifs.affrc.go.jp

Japanese Retail Feedback:
Jellyfish (kurage-"*koo-re-are-ge*)– Japanese Feedback 1/10/98 Mina Fukoshia
Slice thinly
Jellyfish de-salted receive 2-minute cook (check time)

Marinade mix:
Sesame oil
Vinegar
Sugar (white or brown)
Soya sauce

Major Centres in Japan:
1-Yokohama China town
(JR Yokosuka line Tokyo Station 40-50 minutes Motomachi or Yamashita station)

2-Koube China Town

Koubenankin City China town

Distribution:
Major outlets such as Daimaru buy through these large China town areas usually very large restaurants.

Consumption:
Most Japanese consume through Chinese restaurants

Japanese Retail Products & Translation:

Salted jellyfish table of emperor
"The chief of the emperor recommends/tells you that this is an authentic taste."
600yen from the Meidi-Ya-My or **MY** store.

Name: Salted Jellyfish
Contains: Jellyfish Salt & Alum
Bleached (Acid)
Made in: China
Preserve: Keep from direct light avoid high temperature and humidity. Keep in cool dark place. Consume as soon as possible. Warning: If packages damaged do not consumer and contact manufacturing factory or shop.
Explanation: Preserved with salt and popular as an entree with Chinese consumers and is the bell/cap of the jellyfish. "Places salt and alum and then dehydrate followed by adding salt" (Chinese/Japanese translation).
Preparation: (1) Wash jellyfish to remove salt (2) Place in 90 degree Celsius for 3 seconds. (3) Put jellyfish in water for 2hrs to 12hrs when plump ready to use, its very tasty.
Company Name: Marunari "**Trading Company**- in Japanese's "is shoujikabushikigaisha
Address: Kyoutoshi Fushimiku momoyamahashiba nagayoshihigashimachi 65-1
Telephone: (075)621-3939
Useby: 28/3/1999.
Content: 120grams

Jellyfish
Company: Marutomo
Use natural resources without bleach and they really care about the taste.
Manufacture date: - 10/9/1998
Useby date: -8/11/1998
Picture is cooking examples.

They use this material which is very selective without bleach. This colour is a bit strong/darker and you can taste/feel the crunchy texture of jellyfish.
Cook: Vinegared dish for 4 people. Cooking example as in picture.
The material
Sauce for Cooking:
Vinegar one big tablespoon
Soya sauce: Just less than big or table spoon
Sugar one big spoon or tablespoon
Sesame oil: a little bit for smell
Mustard: - (Japanese mustard colour yellow) little bit or to taste.
Materials: Salted jellyfish without bleach is 120grams.
Use a half a cucumber sliced and carrot sliced little pieces (a little bit) seaweed (little bit). Place dried seaweed in water to re-hydrate. Ginger (a little bit)
Preparation: (1) Wash the salted jellyfish in water for 30minutes in order to remove the salt. (2) Remove water and then mix the above materials with jellyfish.
If you like you can add tomatoes sesame seeds etc so you can eat a more tasty dish. "If you have other ideas you can enjoy cooking"
After you, open this package you just close and refrigerate and then please eat as soon as possible.
Name- Salted jellyfish without bleach
Materials name:- Jellyfish
Contains: - 120grams
Use by date: - see front page
Preservation method: - Need refrigeration (1-10 degree Celsius)
Cooking Method: - See above
Manufactured: -Marutomom P
Address: - Ehimeken Iyoshi Komesou1696
Nutrition: - per 100grams energy 32Kcal, Protein 7g, Fat 0.1g, Sugar 0.8g, Sodium 8.1g. They really care about product safety but if you notice a decline in product quality please notify our company.
Consumer consulting centre- 089 983 3888 please telephone here.

APPENDIX 6

Preliminary Sensory Assessment Results

Seven males and fourteen females attended a preliminary session to look at the consumer acceptance of the three marinated jellyfish products. The three products tasted were:

1. Experimental sesame marinated jellyfish
2. Experimental sesame and ginger marinated jellyfish
3. Experimental soy sauce marinated jellyfish

The demographics for this panel are given in Tables 6.1 to 6.10.

Summary of findings

In light of the very poor scores given in this preliminary session, it was recommended that the products be reformulated before being presented for further consumer assessment.

- For appearance, odour, texture, flavour and overall, all three samples scored below 50 indicating that the samples were disliked (Table 6.11).

- The mean scores for initial crunchiness for all samples was just below 50, indicating that the samples were slightly not crunchy enough (Table 6.11).

- For all three samples the mean score for the amount of marinade was below 25 indicating that the consumers thought there was not enough marinade on the samples (Table 6.11).

- The soy sauce marinated jellyfish was described as having a dark colour (Figure 6.1).

- The odour of sesame marinated jellyfish was described as being oily and sesame. The sesame and ginger marinated jellyfish odour was described as ginger and was less frequently described as vinegar compared to the other two samples. The odour of the soy sauce marinated jellyfish was described as being soy (Figure 6.2).

- The sesame and soy sauce marinated samples were described as being rubbery more often than the sesame and ginger marinated sample, which was described as being crunchy more often (Figure 6.3).

- The flavour of sesame marinated jellyfish was mainly described as sesame. The sesame and ginger marinated sample was described as having a ginger and sesame flavour, and the soy sauce marinated jellyfish flavour was described as being soy and sweet (Figure 6.4).

- The vast majority of consumers thought all three samples were poorer in quality than jellyfish previously eaten (Figure 6.5).

- The majority of consumers either probably or definitely would not buy the samples (Figure 6.6).

- The majority of consumers thought the samples would not be liked in their country of origin (Figure 6.7).

- Forty-seven percent of the consumers thought a snack jellyfish product was a good idea or an excellent idea and 24% were not sure (Figure 6.8).
- The majority of the consumers preferred a 50g pack size for a snack jellyfish product (Figure 6.9).
- Blue was the preferred packaging colour by 48% of the consumers (Figure 6.10).

RESULTS

Table 6.1. Distribution of age groups for the consumers**.**

Age group	18-30	31-40	41-50	51-60	60+
Number	4	4	9	3	1
Percentage	19%	19%	43%	14%	5%

Table 6.2. Distribution of country of origin of the consumers.

Country	Australia	China	Hong Kong	Indonesia	Japan	Korea
Number	0	1	2	0	18	0
Percentage	0%	5%	9%	0%	86%	0%

Country	Malaysia	Singapore	Taiwan	Thailand	Vietnam	Other
Number	0	0	0	0	0	0
Percentage	0%	0%	0%	0%	0%	0%

Table 6.3. Distribution of length of time the consumers have lived in Australia.

Time in Australia	Less than 1 year	1-3 years	3-5years	5-10 years	10-15 years	15-20 years	More than 20 years
Number	1	0	7	7	4	2	0
Percentage	5%	0	33%	33%	19%	10%	0

Table 6.4. Distribution of how often the consumers eat jellyfish.

Frequency of consumption	Once per week	More than once a month	Once per month	More than once a year	Once per year	Every 1-3 years	Less than once every 3 years
Number	0	7	3	8	1	1	1
Percentage	0%	33%	14%	38%	5%	5%	5%

Table 6.5. Distribution of when the consumers eat jellyfish.

When	In home cooking	In a restaurant /bar	On special occasions	As a snack	Other
Number	9	21	2	2	0
Percentage	26%	62%	6%	6%	0

Table 6.6. Distribution of what type of jellyfish the consumers buy.

Type	Instant/ready to use	Dried/salted	Don't buy
Number	8	9	8
Percentage	32%	36%	32%

Fifty-two percent of the consumers were able to purchase the type of jellyfish they like in Australia.

Table 6.7. Distribution of what the consumers eat jellyfish with.

	With other ingredients	With a marinade	On its own	Other
Number	17	12	2	2
Percentage	52%	36%	6%	6%

Table 6.8. What the consumers thought of the idea of jellyfish as a ready to eat snack food.

	An excellent idea	A good idea	Not sure	Not a good idea	A terrible idea
Number	3	7	5	5	1
Percentage	14%	33%	24%	24%	5%

Table 6.9. Preference of pack size liked for a ready to eat snack product.

Pack size	50g	100g	150g
Number	11	8	2
Percentage	52%	38%	10%

Table 6.10. Other ingredients the consumers would like to add to the marinades.

Ingredient	Bonito flakes/ powder	Chilli	Garlic	Ginger	Japanese Mustard	Seaweed flakes/ powder
Number	2	13	4	9	6	2
Percentage	4%	25%	8%	17%	11%	4%

Ingredient	Teriyaki sauce	Wasabi	Yakatori sauce	Your favourite rice seasoning	Other
Number	3	2	2	3	6
Percentage	6%	4%	4%	6%	11%

Table 6.11. Mean sensory scores for the three ready to eat marinaded jellyfish products.

	Appearance[1]	Odour[1]	Texture[1]	Initial Crunchiness[2]
Sesame marinade	32 ± 21.9*	39 ± 20.4	39 ± 23.1	47 ± 21.2
Sesame and ginger marinade	32 ± 19.9	45 ± 22.5	35 ± 21.9	46 ± 26.3
Soy sauce marinade	23 ± 20.0	26 ± 20.3	26 ± 19.6	46 ± 21.9

	Flavour[1]	Amount of marinade[2]	Overall[1]
Sesame marinade	29 ± 20.0	20 ± 15.1	25 ± 19
Sesame and ginger marinade	32 ± 21.9	23 ± 19.4	28 ± 21.3
Soy sauce marinade	17 ± 18.4	21 ± 19.8	15 ± 16.9

*Means shown are ± 1 standard deviation.
Line scales & end points: [1] dislike extremely (0), neither like nor dislike (50), like extremely (100)
[2] not enough of attribute(0), 'just right' (50), too much of attribute (100)

Comments made by the consumers:

When do you eat jellyfish? dinner time at home; maybe restaurant

What do you eat jellyfish with? seafood; Japanese rice vinegar with sugar, cucumber

List of other ingredients the consumers would like to see added to the marinades:

lots more vinegar, chicken, dressing
sweet chilli
vinegar
soy sauce, sesame oil, seaweed, (cucumber) thinly sliced, Japanese quiregan?
vinegar, soy sauce
vinegar
mirin,
vinegar

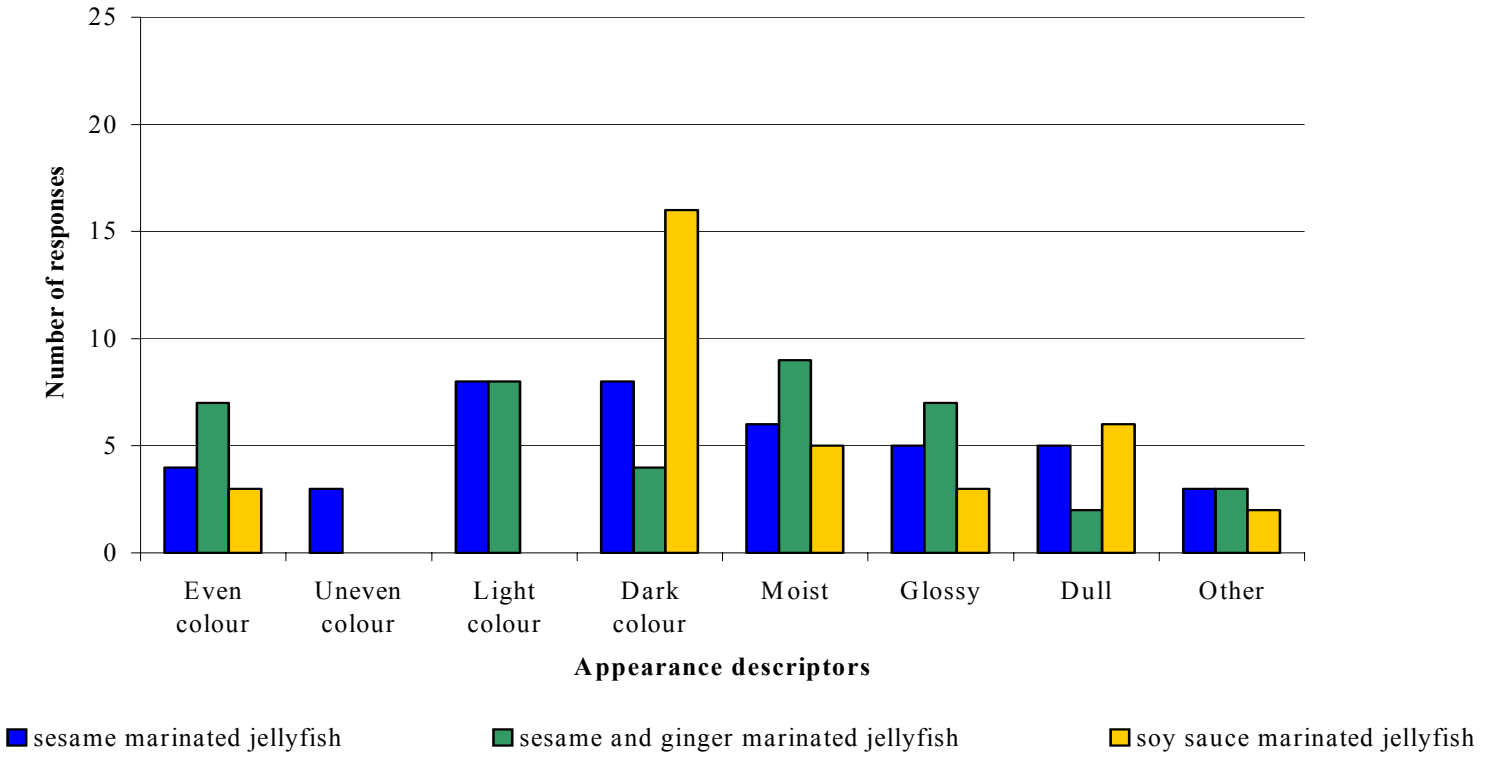


Figure 6.1. Frequency of selection of appearance descriptors for the marinated jellyfish samples.

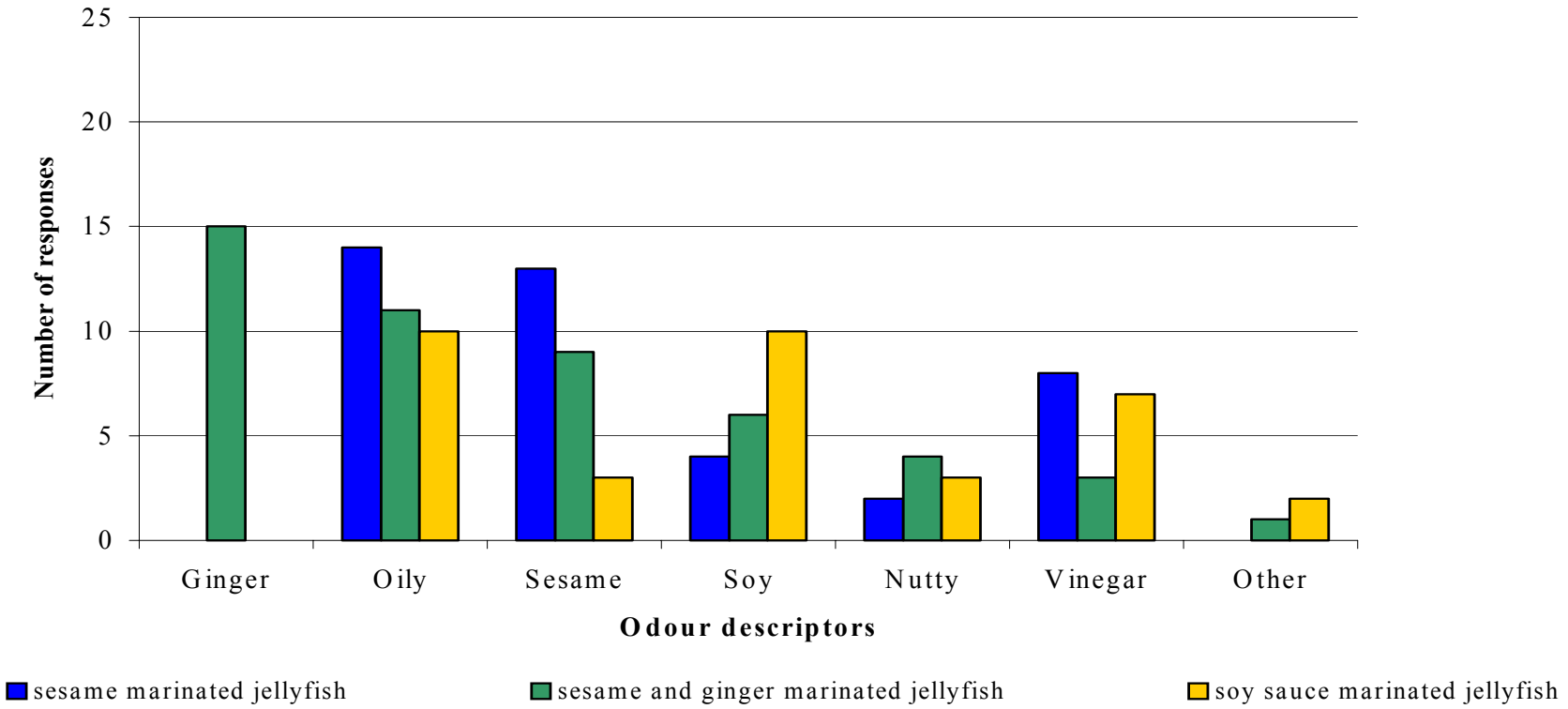


Figure 6.2. Frequency of selection of odour descriptors for the marinated jellyfish samples

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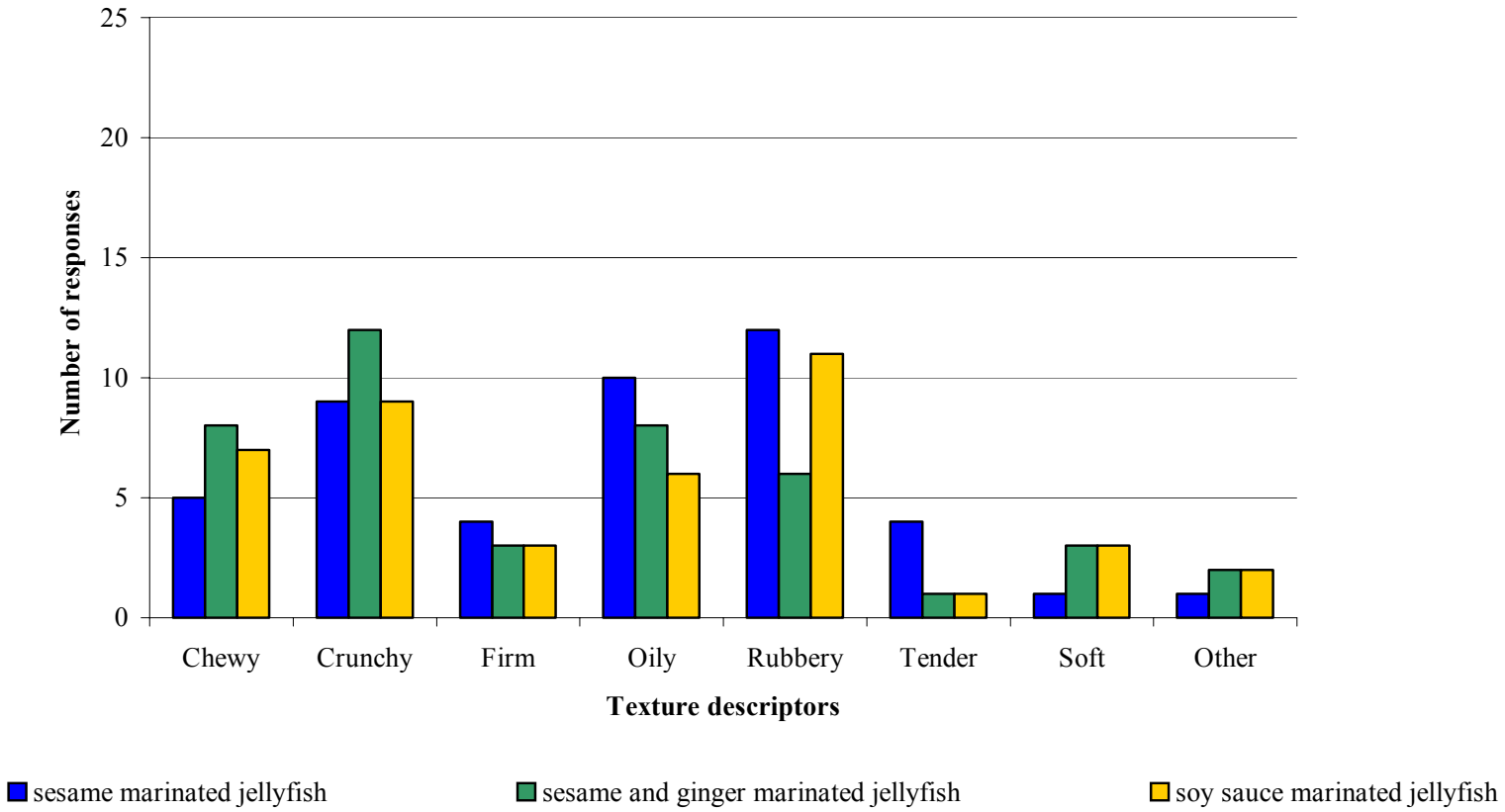


Figure 6.3. Frequency of selection of texture descriptors for the three marinated jellyfish products.

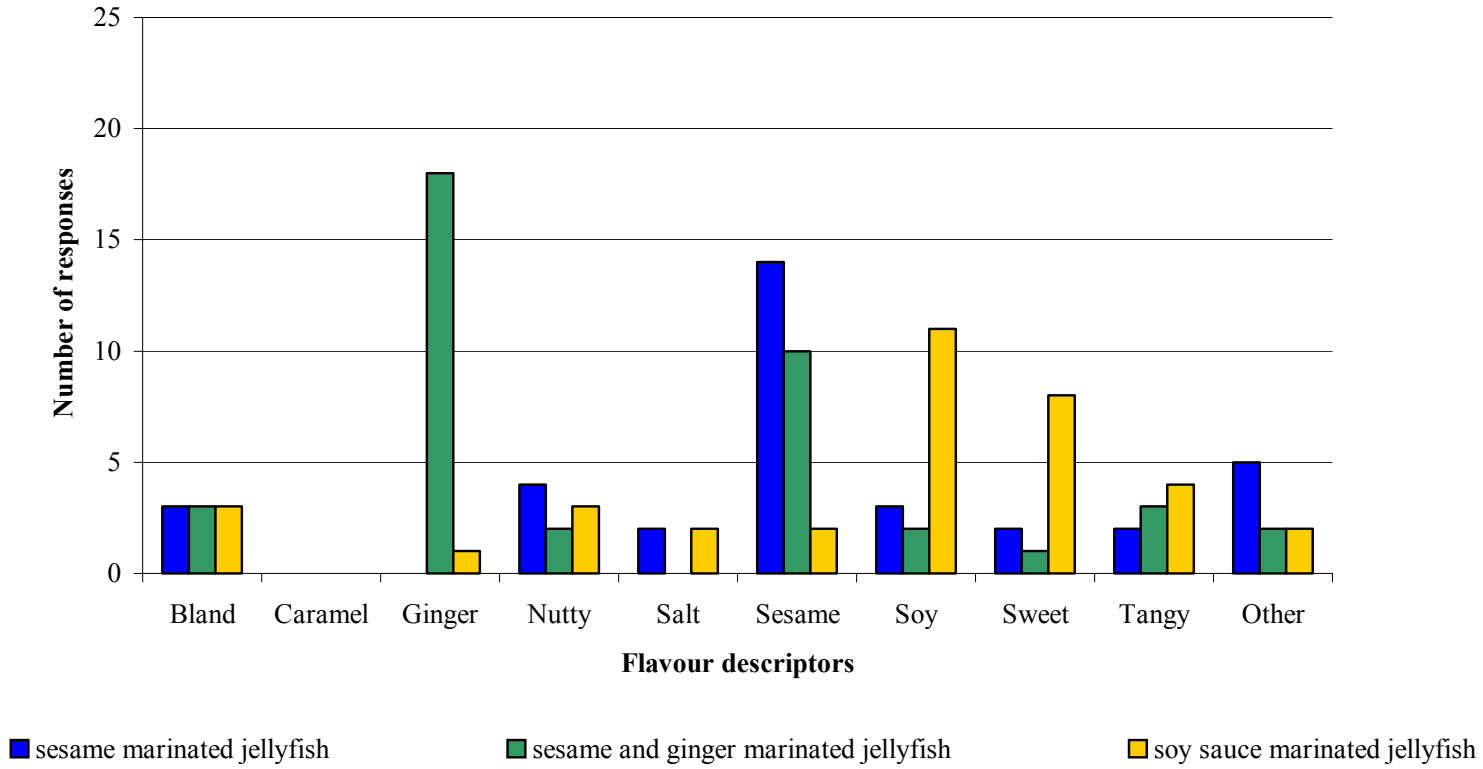


Figure 6.4. Frequency of selection of flavour descriptors for the three marinated jellyfish samples.

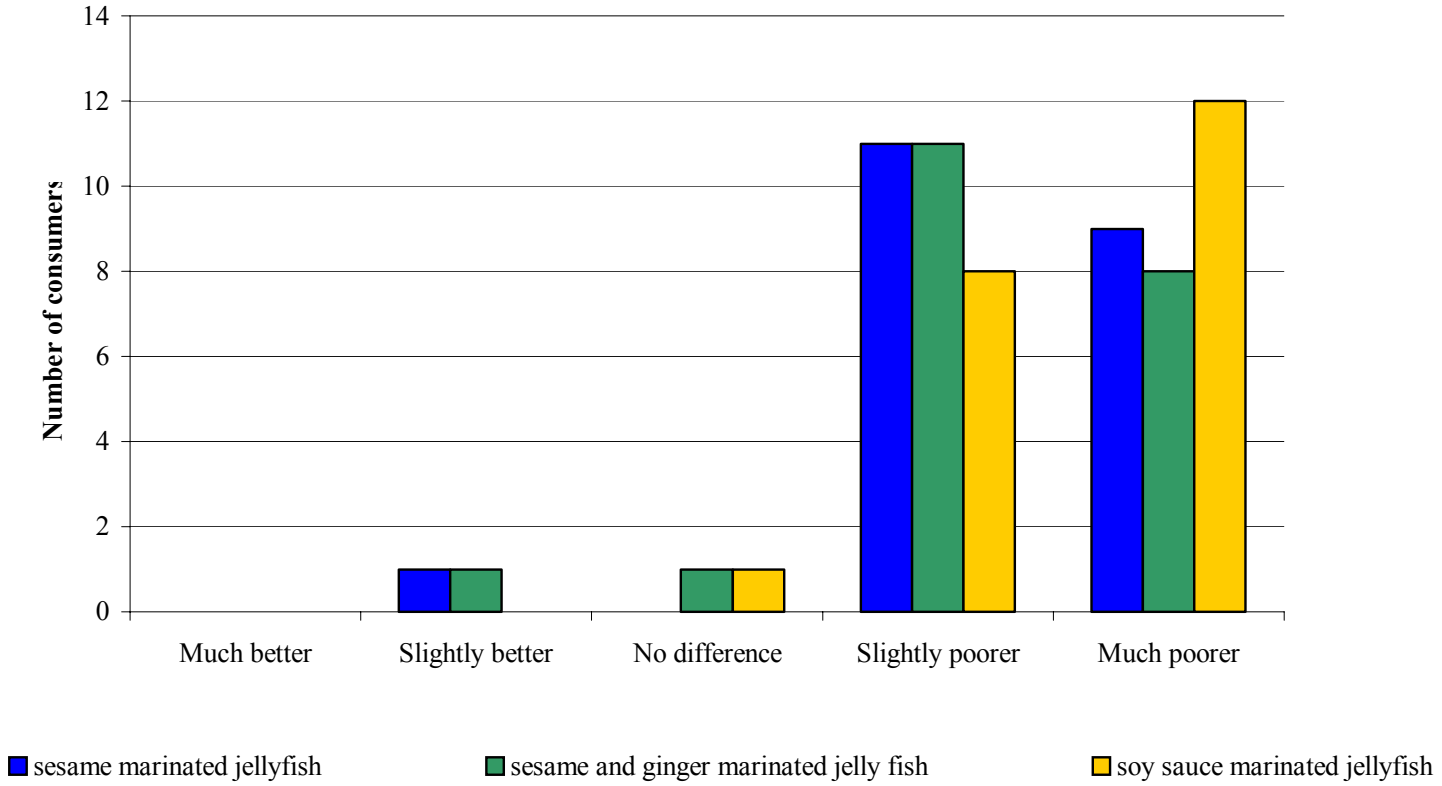


Figure 6.5. Frequency distribution of how the consumers thought the jellyfish compared with jellyfish previously eaten.

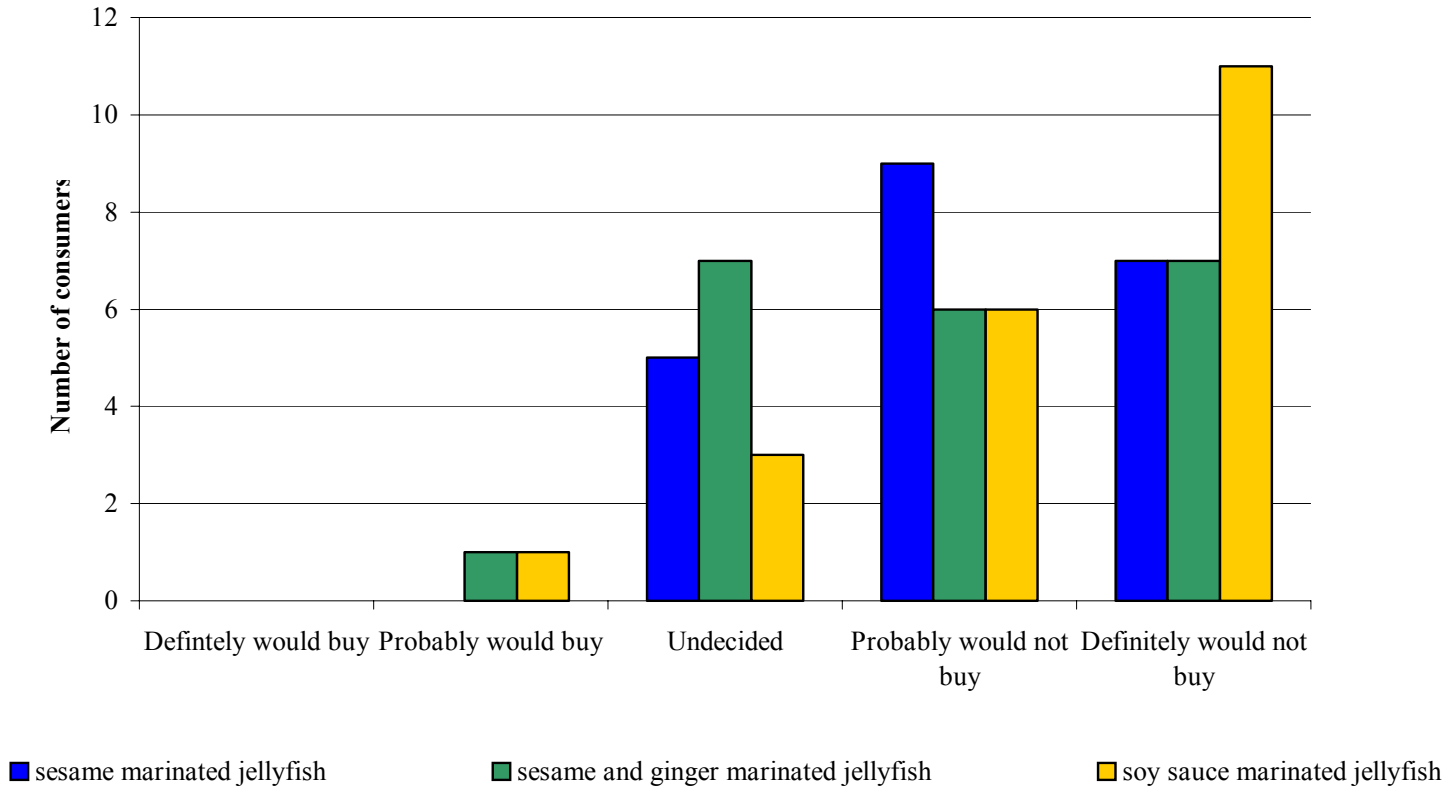


Figure 6.6. Frequency of distribution of consumers likelihood of purchasing the three ready to eat jellyfish products.

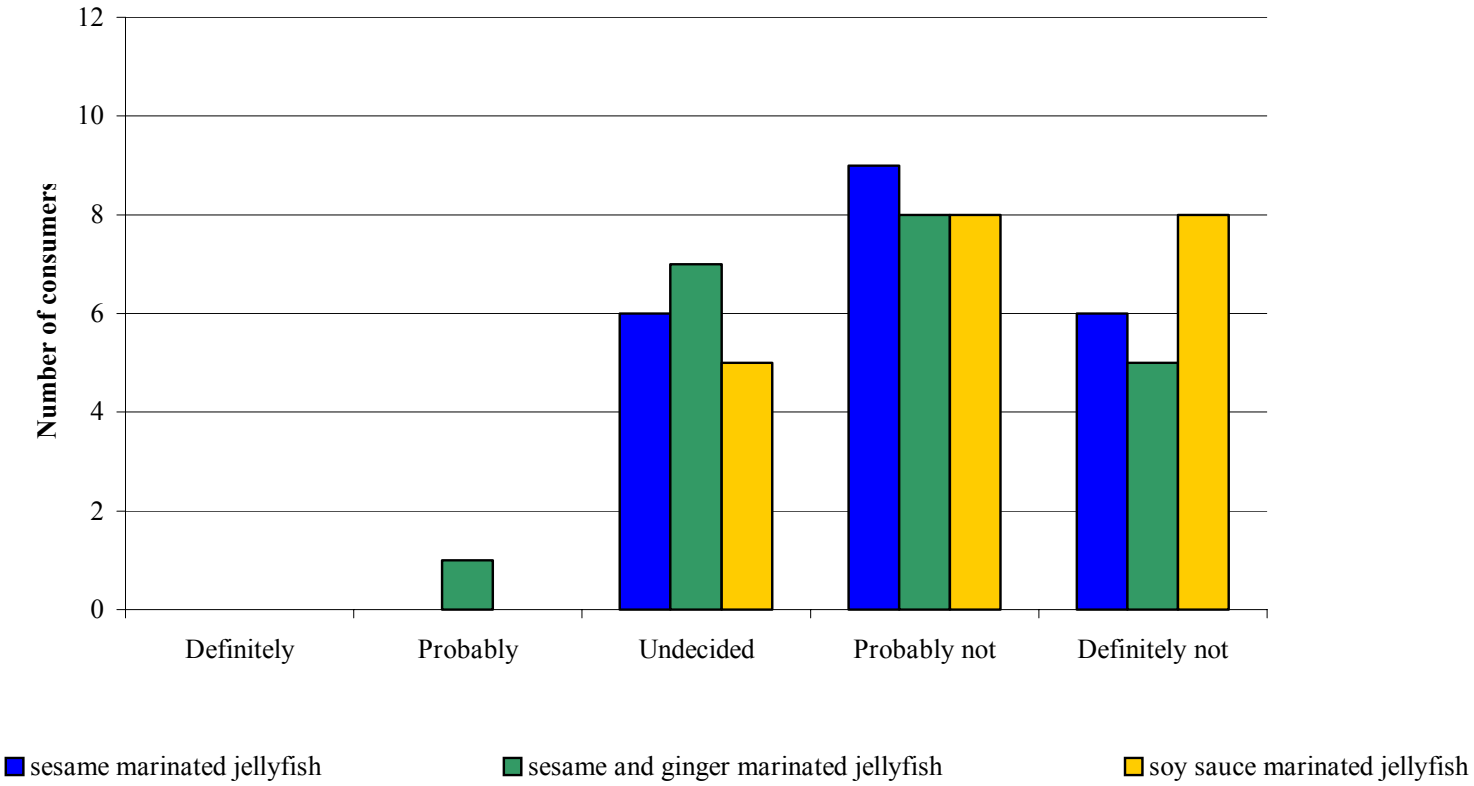


Figure 6.7. Frequency distribution showing whether the consumers thought the products would be liked in their country of origin.

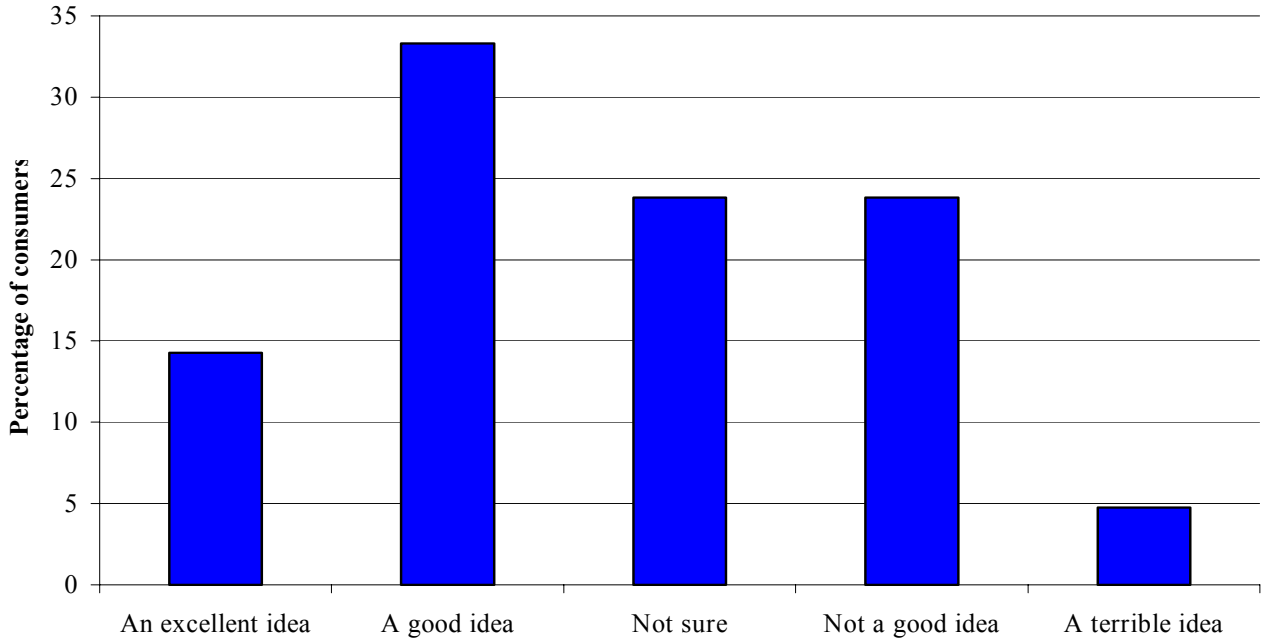


Figure 6.8. Percentage distribution showing what consumers thought of the idea of a ready to eat snack jellyfish product.

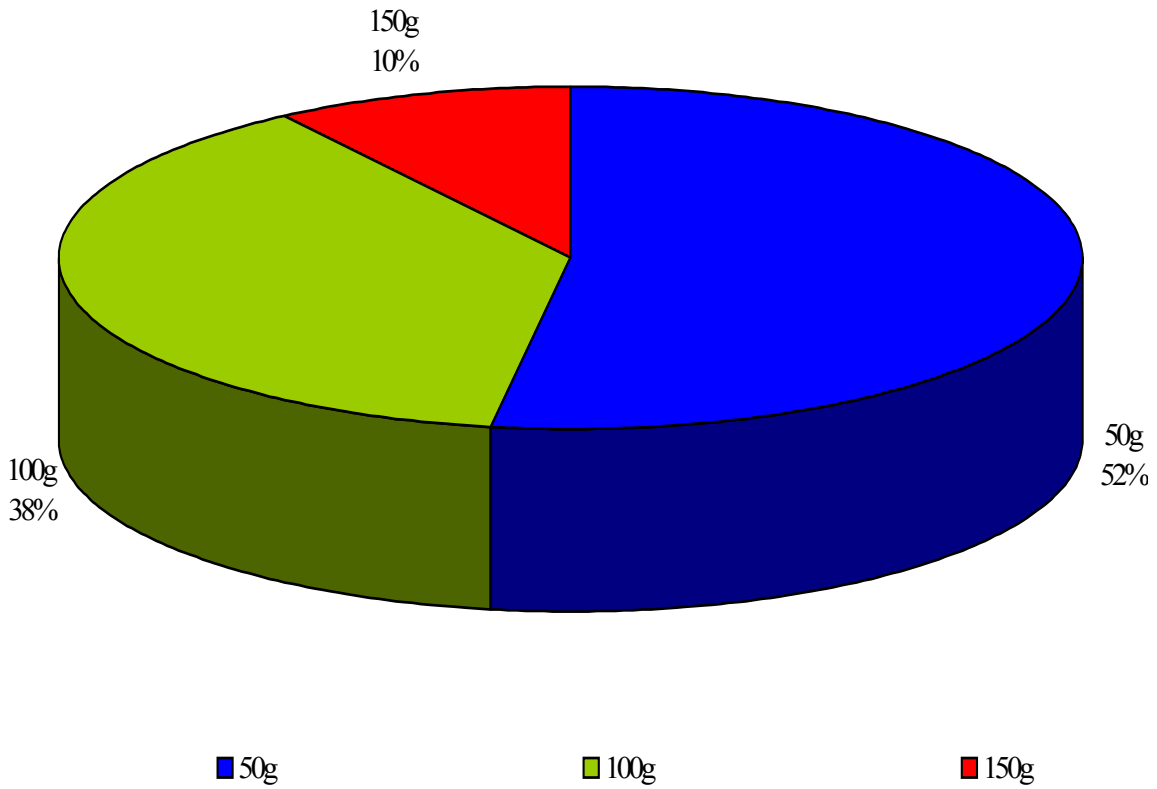


Figure 6.9. Percentage distribution of the consumers choice of pack size they would like for a ready to eat snack jellyfish product.

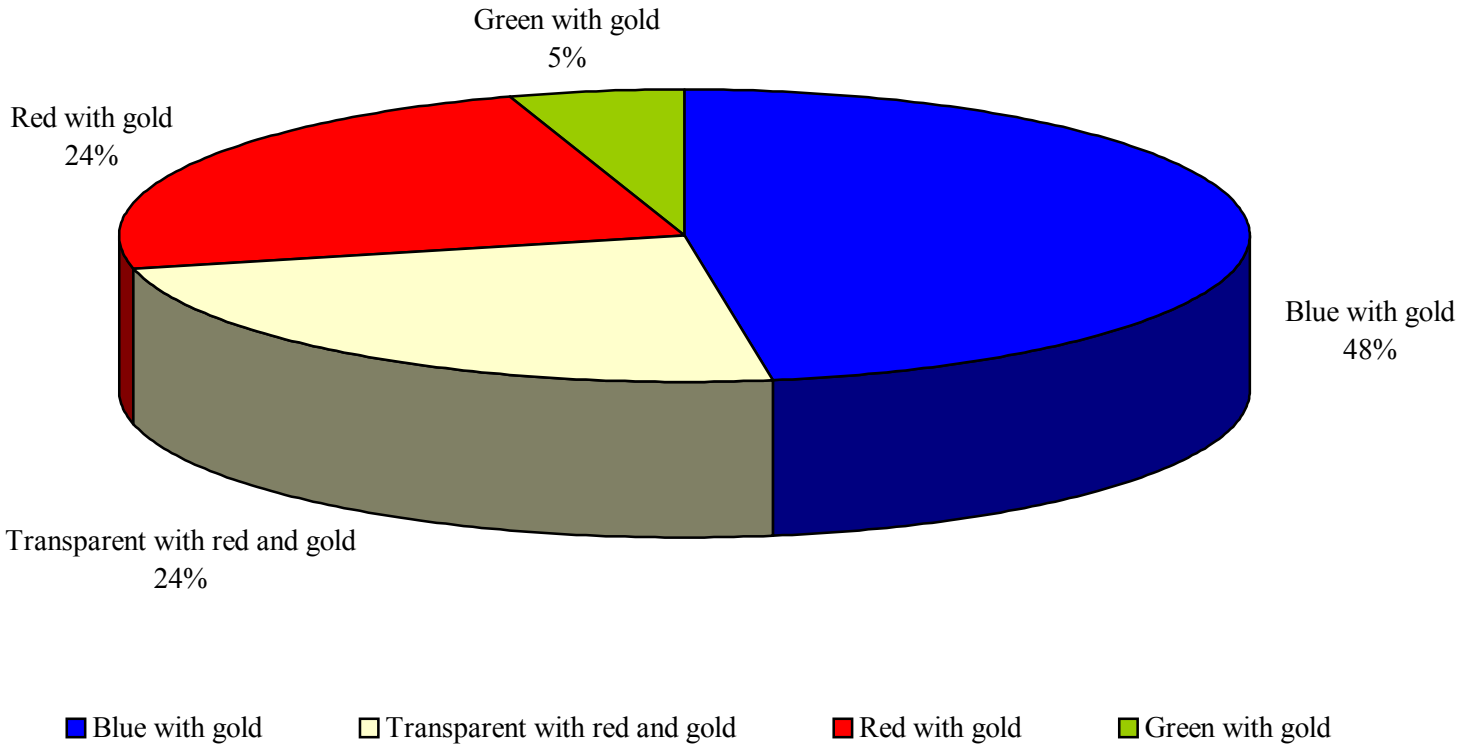


Figure 6.10. Percentage distribution of the consumers liking of packaging samples.

APPENDIX 7

Consumer Acceptance Testing
RESULTS

Prepared by the
Sensory and Consumer Science Unit

Commissioned by:

Sue Poole
Seafood Research Group
Centre For Food Technology

EXECUTIVE SUMMARY

The Sensory and Consumer Science Unit at the Centre for Food Technology was approached by Sue Poole to investigate the consumer acceptability of three marinated ready to eat jellyfish products, including a commercial brand.

Sixty-eight Asian consumers living in Brisbane who had previously eaten jellyfish were recruited, and the testing was completed over three sessions.

Samples were evaluated for acceptability of appearance, odour, flavour, texture and overall liking. Amount of initial crunchiness, chewiness, saltiness and amount of marinade were also assessed on 'just right' scales.

None of the products had high mean sensory scores (all were less than 60) for appearance, odour, flavour, texture and overall liking. The commercial and the match for the commercial marinated jellyfish were more acceptable than the soy based marinated jellyfish, although they were only rated as 'neither like nor dislike'.

The match to the commercial marinated sample was slightly too crunchy, chewy and salty, and had slightly too much marinade, whereas the commercial marinated sample slightly lacked crunchiness and chewiness and was slightly low on the amount of marinade.

The consumers showed a similar propensity to purchase the match for the commercial marinated and the commercial marinated samples with 45% and 44% indicating that they would definitely or probably buy the respective samples. However, the majority of people also thought these products were either slightly or much poorer than jellyfish previously eaten.

The majority of consumers thought that a ready to eat chilled jellyfish product was a good idea and that a 100g pack would be the preferred pack size. Although red was the preferred packaging colour, the comments made regarding the packaging indicate that further work should be carried out in this area.

Fifty-four percent of the consumers who attended were of Japanese origin and so a comparison was made between this group of consumers and the consumers from all 'Other' origins. The mean sensory scores for the soy based and the match for the commercial marinated sample were similar for both the consumers of Japanese and 'Other' origin. However, the commercial marinated sample was liked more by the people of 'Other' origin than the people of Japanese origin.

In summary, none of the samples including the commercial brand were considered acceptable by the consumers, however, those of 'Other than Japanese' origin considered the commercial brand acceptable.

AIMS

- To determine the consumer acceptability of three ready to eat marinated jellyfish products for appearance, odour, texture, flavour and overall liking using Asian consumers living in Brisbane.
- To determine the level of initial crunchiness, chewiness, saltiness and the amount of marinade using 'just right' scales.
- To identify if Asian consumers would be likely to purchase the products.
- To obtain general demographic information on jellyfish purchasing and consumption habits of Asian consumers living in Brisbane.
- To determine if jellyfish as a ready to eat product was a good idea.
- To obtain packaging information for the ready to eat jellyfish product.

METHODOLOGY

Methods used for all the consumeer acceptance testing are attached as Appendix 2 of this document.

RESULTS AND DISCUSSION

A total of 68 Asian consumers comprising of 35% (24) males and 65% (44) females who had previously eaten jellyfish tested the samples. Full demographic information about the tasters is presented in Appendix 1 of this document.

Acceptability Attributes

The results from Table 7.1 show that there was no significant difference in the liking of the appearance of the samples. The mean sensory scores for the commercial and the match for the commercial marinated samples indicated that they were 'neither liked nor disliked', and the soy based marinated sample had a mean score just below 'neither like nor dislike' indicating that it was disliked slightly.

Table 7.1. *Mean sensory scores for the three ready to eat marinated jellyfish products.*

	Appearance[1]	Odour[1]	Texture[1]	Flavour[1]	Overall[1]
Soy based marinade	46 a	46 a	39 a	28a	30 a
Commercial marinade	49 a	52 a	56 b	50 b	52 b
Match for commercial marinade	51 a	59 b	53 b	52 b	51 b
LSD (5%)	6.7	6.1	7.4	6.6	7.3

	Initial Crunchiness[2]	Chewiness[2]	Saltiness[2]	Amount of marinade[2]
Soy based marinade	58 b	59 b	30 a	37 a
Commercial marinade	44 a	43 a	51 b	48b
Match for commercial marinade	60 b	59 b	71c	57 c
LSD (5%)	5.0	4.8	5.4	5.3

Line scales and end points:
[1] dislike extremely (0), neither like nor dislike (50), like extremely (100)
[2] not enough of named attribute (0), 'just right' (50), too much of named attribute (100)

abc within the same column, means followed by different letters indicate significant ($P<0.05$) differences between samples.

The odour of the match for the commercial marinade was liked significantly more ($P<0.05$) than the odour of the other two samples. However, it had a mean score only slightly above 'neither like nor dislike' (a mean score of 59, where a mean score of 50 indicates neither like nor dislike).

The texture of the commercially marinated jellyfish and the jellyfish marinated with the match to the commercial marinade were liked significantly more ($P<0.05$) than the texture of the soy based marinated jellyfish. The preferred texture of the commercially marinated jellyfish and the jellyfish marinated with the match to the commercial marinade had mean scores just above neither like nor dislike, whereas the texture of the soy based marinated sample had a mean score of 39 indicating that it was not liked. This implies the marinade plays an important part in the perception of texture, as both the soy based marinated sample and the match for the commercial marinated sample used the same jellyfish.

Again for flavour, the soy based marinated sample scored significantly less ($P<0.05$) than the other two samples. The soy based marinated sample had a mean score of 28 indicating that it was not well liked. However, the commercial and match for the commercial marinated samples only had mean scores in the region of neither like nor dislike.

'Just right' attributes

For the initial crunchiness and chewiness the commercially marinated jellyfish had a mean score just below 'just right' whereas the other two samples had mean scores slightly above 'just right' indicating that they were slightly too crunchy initially and slightly too chewy.

The samples were all significantly different ($P<0.05$) to each other in terms of saltiness. The soy based marinated sample was not salty enough, the commercial sample 'just right' and the match for the commercial sample was too salty.

As was the case for saltiness, all the samples were significantly different ($P<0.05$) to each other in terms of the amount of marinade. The amount of marinade was not enough for the soy based sample, close to 'just right' for the commercial sample and slightly too much for the match to the commercial sample. It may be possible that saltiness and amount of marinade are correlated, in that if a consumer thought the marinade was too salty and they would want less marinade on the jellyfish, and conversely if they thought it was not salty enough they might prefer more marinade on the sample.

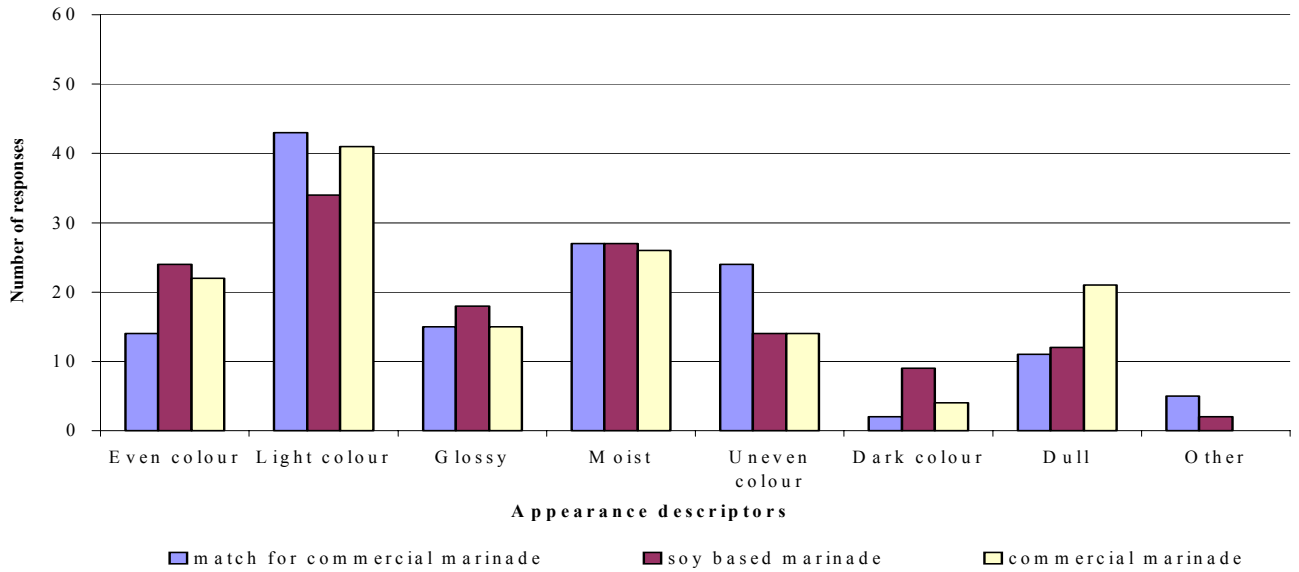
Overall liking

For overall liking, the commercially marinated sample and the match to the commercial marinated sample were liked significantly more than the soy based marinated jellyfish. However, both of these only had mean scores in the region of neither like nor dislike, whereas the soy based sample had a mean score of 30, where 0 was dislike very much and 50 was neither like nor dislike.

Descriptors

Consumers were able to select descriptive words from lists which they thought applied to the appearance, odour, texture and flavour of the three samples. The most frequently chosen descriptors for the appearance of the samples were light colour and moist (Figure 7.1). Uneven colour was selected more frequently for the match to the commercial marinade than for the other two samples and dull was selected more frequently for the commercial marinated product.

Figure 7.1. Frequency of selection of appearance descriptors for the marinated jellyfish samples



The odour of the soy based sample was described mainly as ginger. Oily and sesame were the most frequently used odour descriptors for the match to the commercial marinade, although oily and sesame were also used to describe the other samples but to a lesser extent. Soy, nutty and vinegar were used to describe all three samples (Figure 7.2).

Figure 7.2. Frequency of selection of odour descriptors for the marinated jellyfish samples

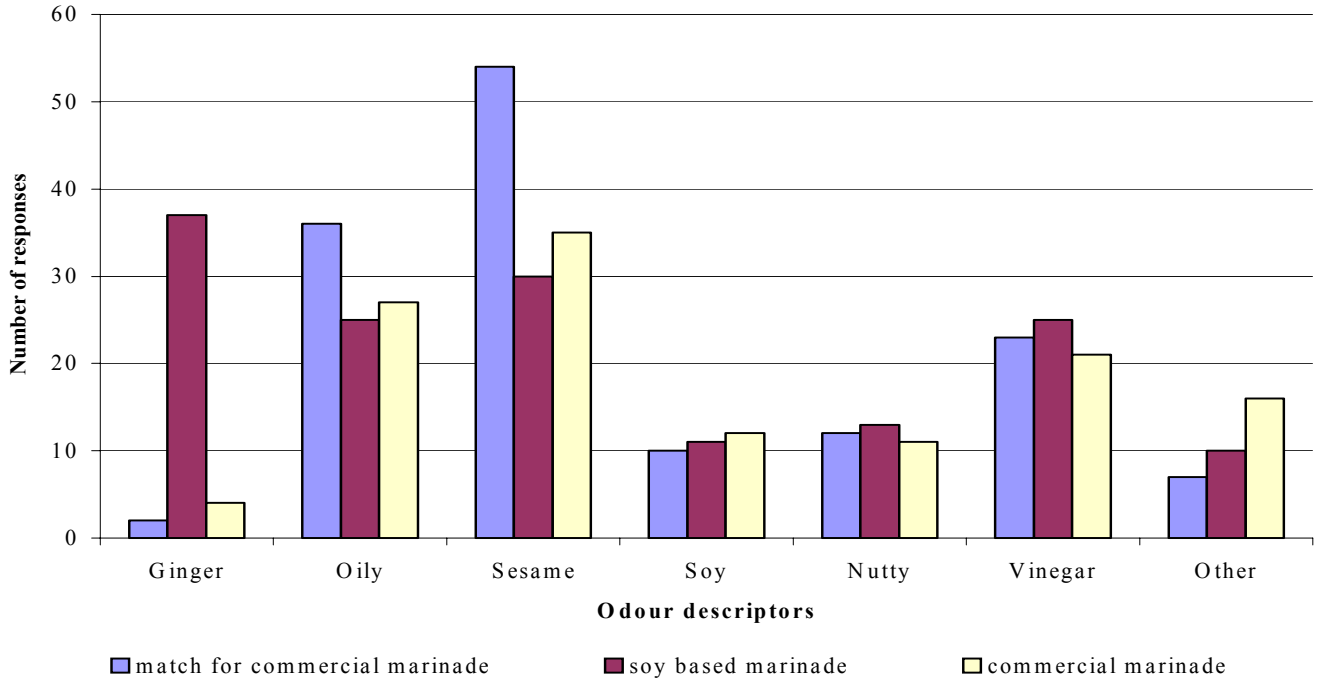
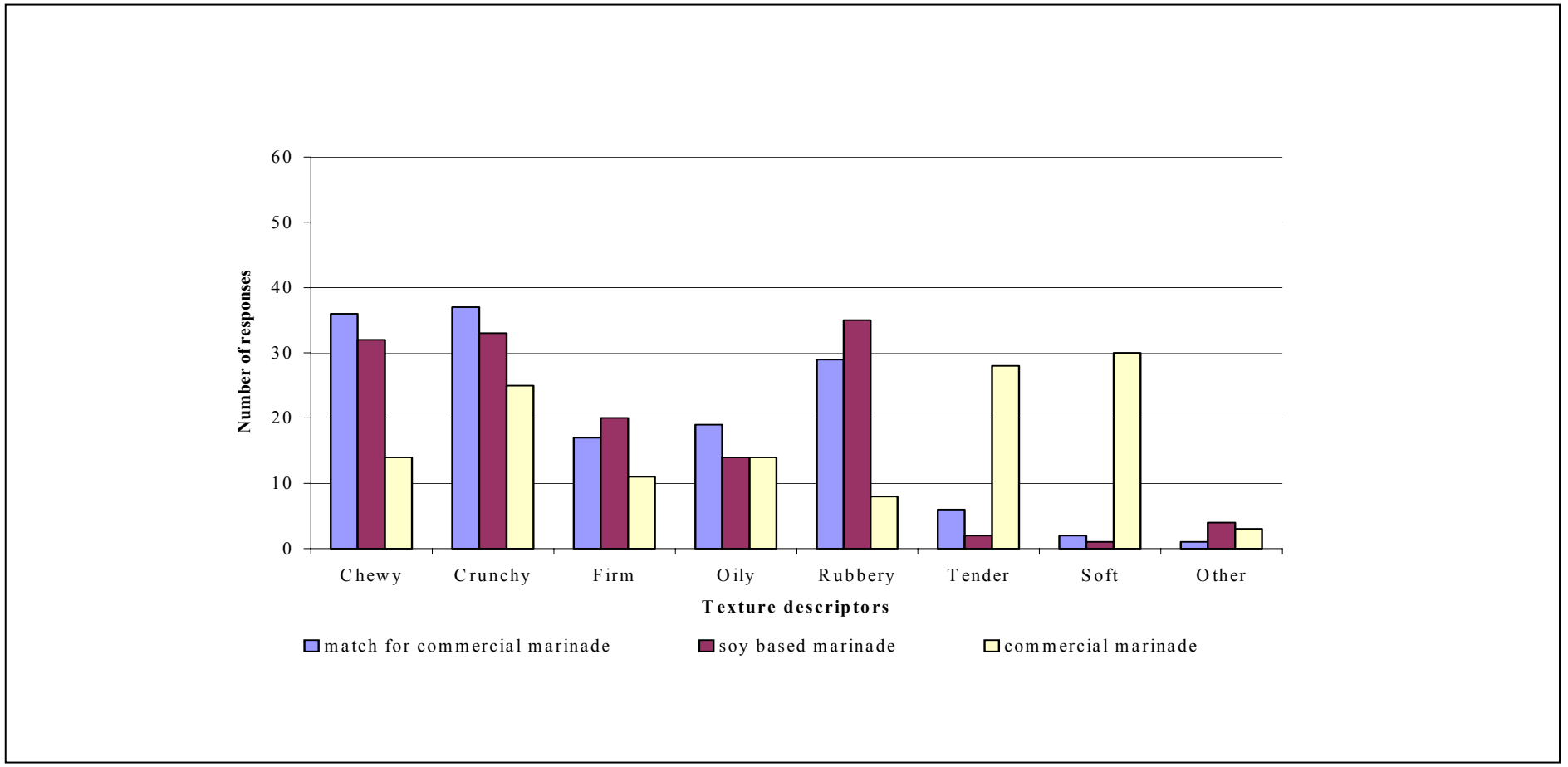


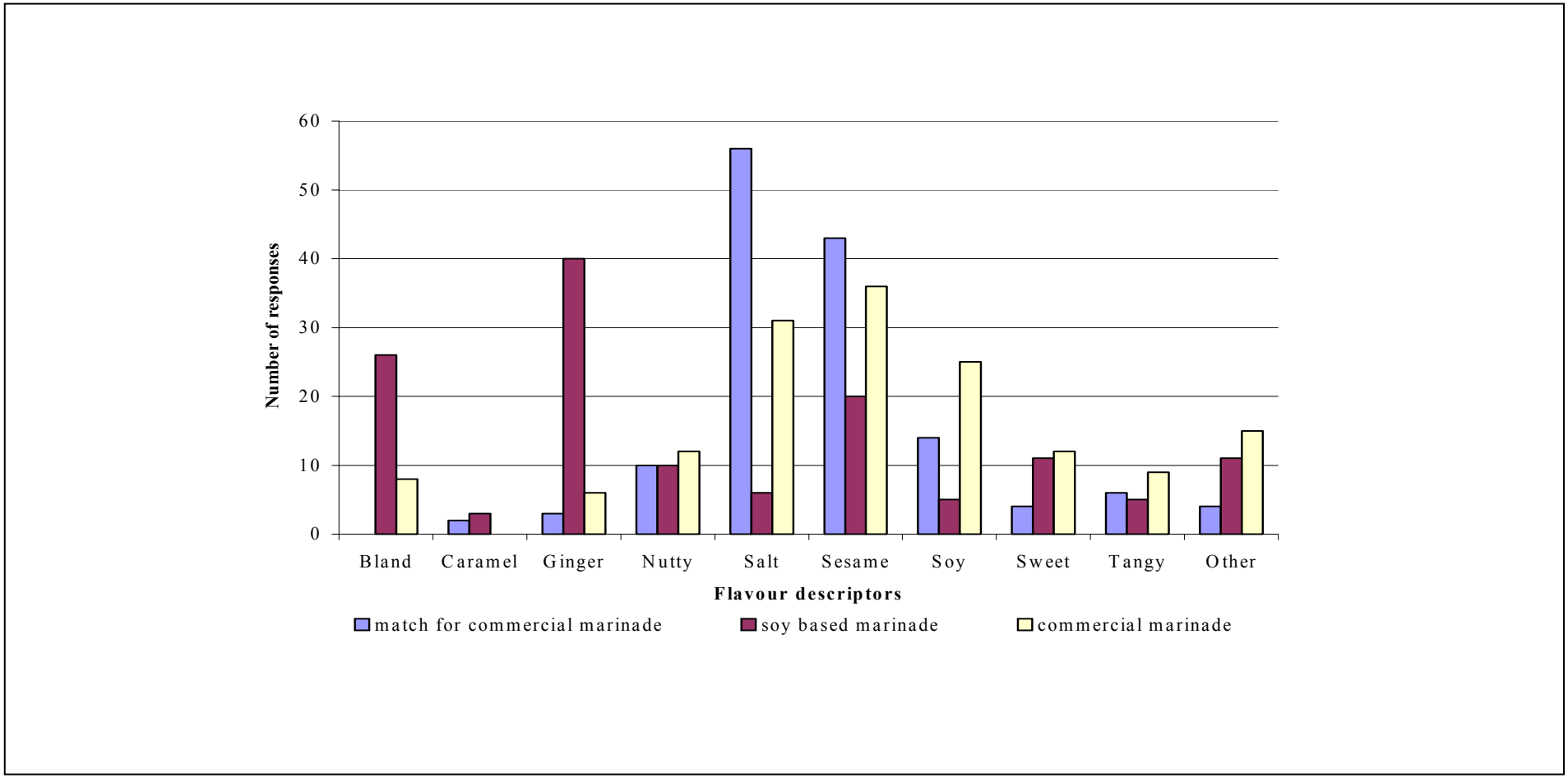
Figure 7.3 shows that chewy, crunchy and rubbery were used more frequently to describe the texture of the match for the commercial and the soy based marinated jellyfish. The commercial sample was described as being tender and soft and not as chewy or rubbery as the other two samples.

Figure 7.3. Frequency of selection of texture descriptors for the three marinated jellyfish samples



The flavour of the match for the commercial marinated sample was described as being salty and sesame (Figure 7.4). This saltiness was also confirmed by the mean sensory linescale scores for saltiness (see Table 7.1). Sesame, soy and salt were the most frequently selected descriptors for the commercial sample and bland and ginger the most frequently selected descriptors for the soy based marinated sample.

Figure 7.4. Frequency of selection of flavour descriptors for the three marinated jellyfish samples



The consumers were asked how they thought each of the marinated jellyfish samples compared to jellyfish they had eaten previously. All three samples were mainly regarded as being either no different, slightly poorer or much poorer than jellyfish previously eaten. However, some consumers indicated the match for the commercial and the commercial samples were slightly better than jellyfish previously eaten (Figure 7.5).

Figure 7.5. Percentage distribution of how the consumers thought the marinated jellyfish compared with jellyfish previously eaten

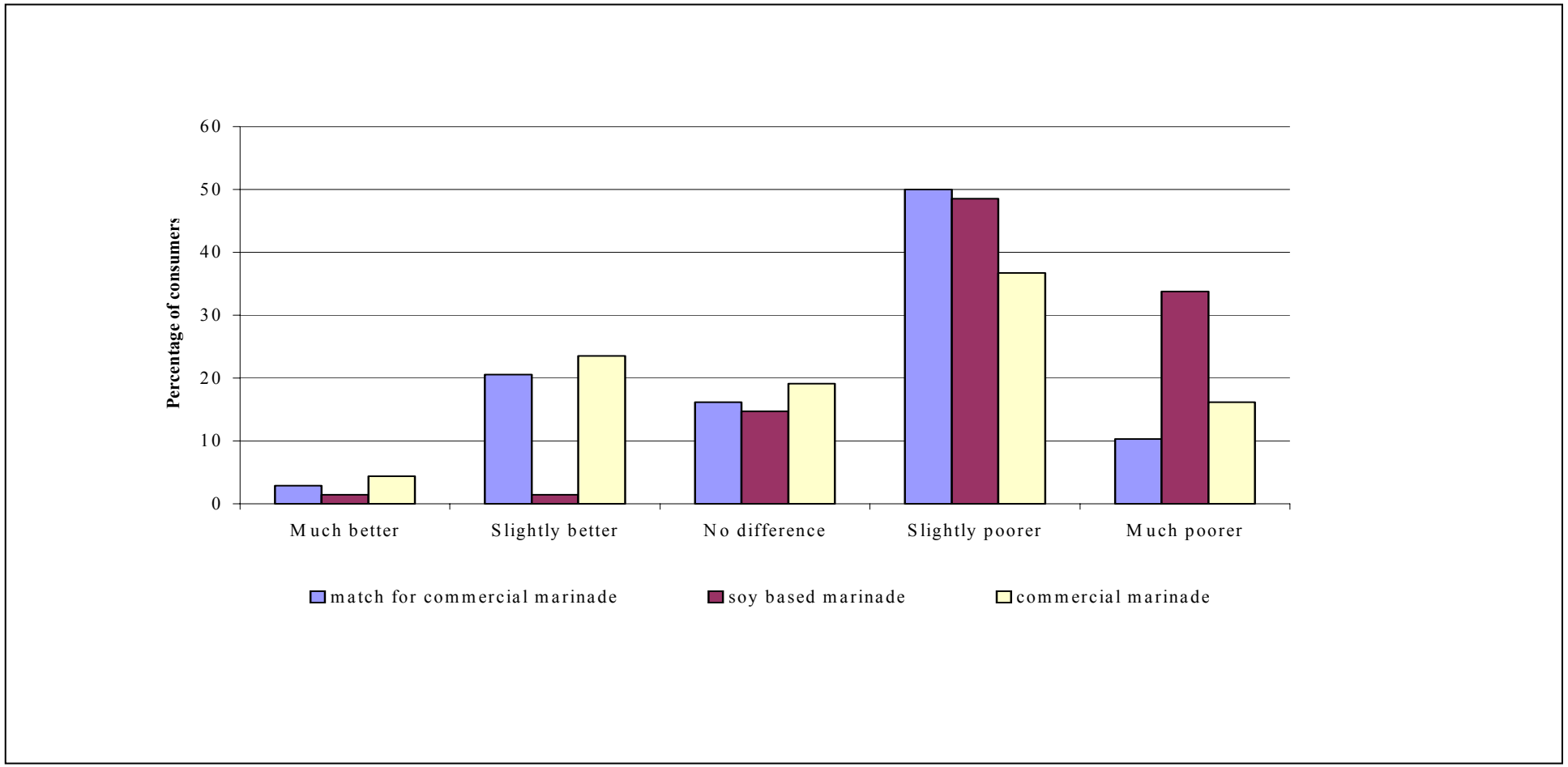
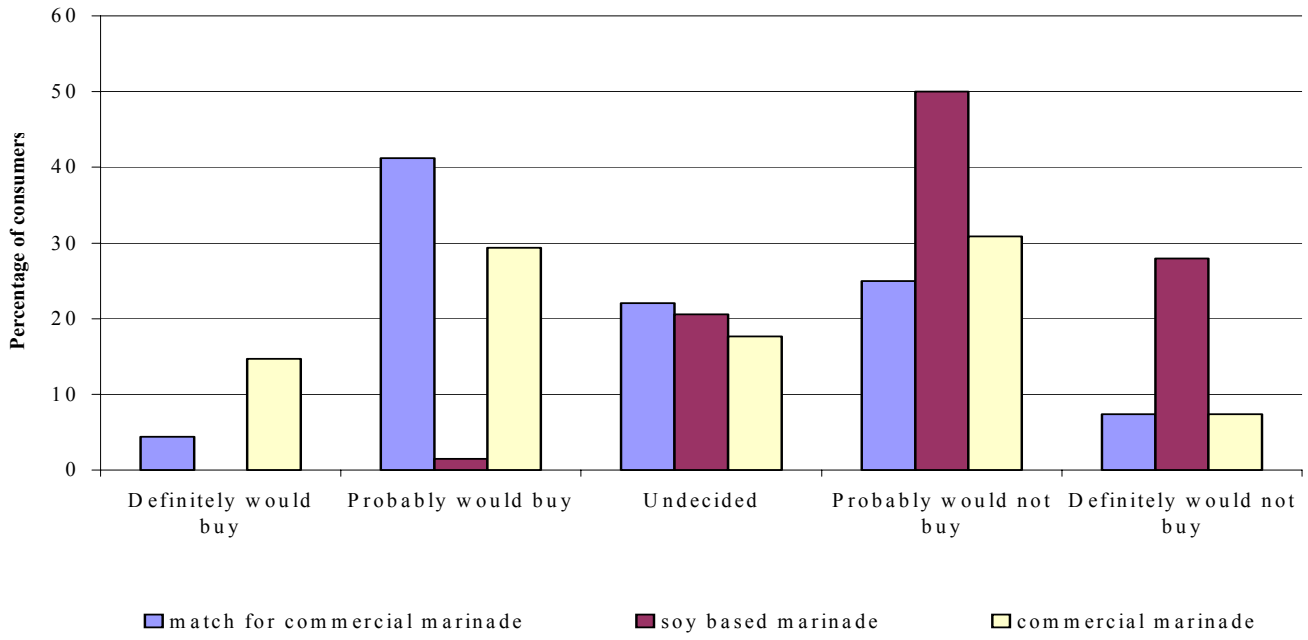


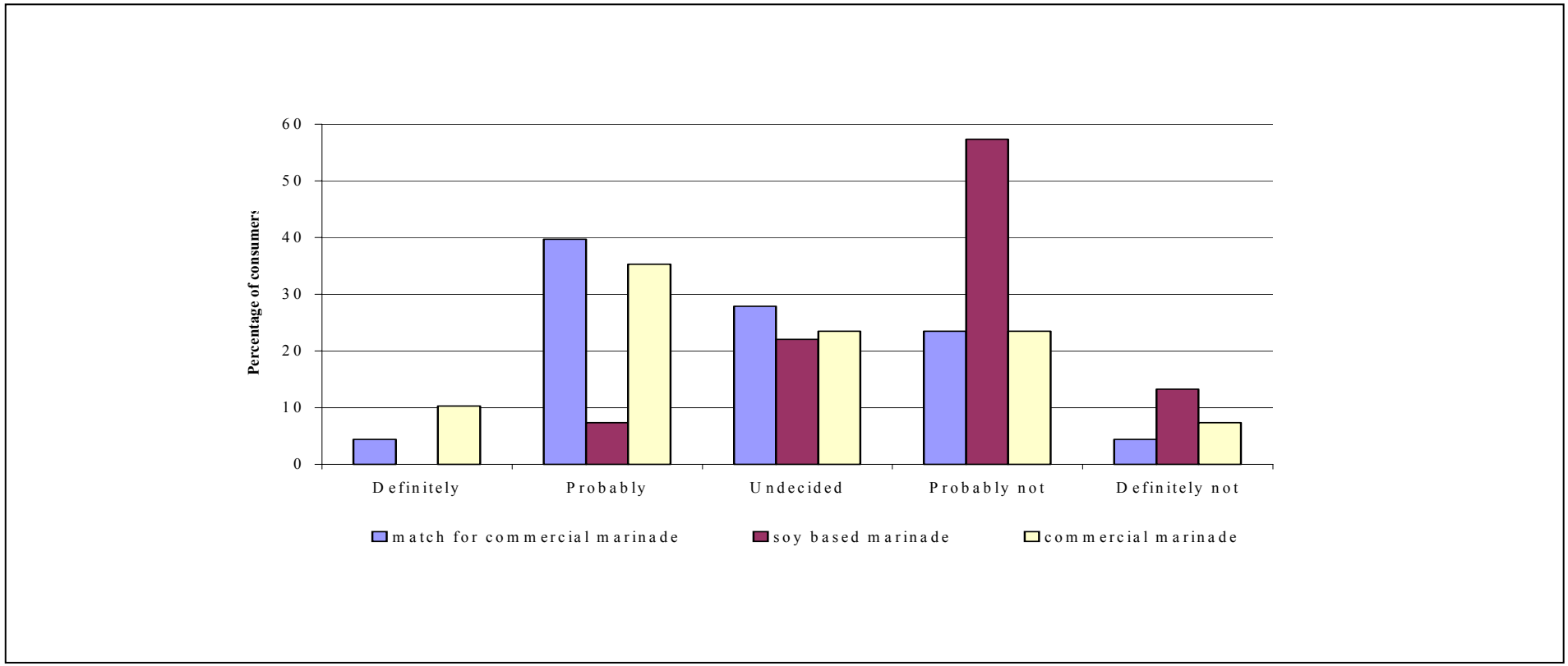
Figure 7.6 shows that over 40% of the consumers indicated they probably would buy the match for the commercial marinated sample. However, large percentages of consumers also indicated that they were undecided or probably would not buy this sample. For the commercial sample, 29% of the consumers indicated they would probably buy this sample, but 18% were undecided and 31% indicated that they probably would not buy the sample. Over 75% of the consumers indicated that they probably or definitely would not buy the soy based marinated sample.

Figure 7.6. Percentage distribution of consumers likelihood of purchasing the three different ready to eat jellyfish samples



When asked if they thought the consumers in their country of origin would like the samples, over 50% of the consumers indicated that the soy based marinated sample would probably not be liked. Over 40% the consumers thought that both the commercial and the match for the commercial marinated samples would probably or definitely be liked in their countries of origin (Figure 7.7).

Figure 7.7. Percentage distribution showing whether the consumers thought the marinated jellyfish would be liked in their country of origin



Over 80% of the consumers thought that a ready to eat chilled jellyfish product was a good or an excellent idea. A 100g pack was the preferred pack size by over 50% of the consumers although 38% indicated that they would like a 150g pack (Figure 7.8). The consumers were shown four examples of packaging and asked to choose which they liked the most. Although red appears to be the preferred colour (Figure 7.9) it should be noted that comments indicated that the actual packaging design was not well favoured by some of the consumers.

Figure 7.8. Percentage distribution of consumers choice of pack size they would like for a ready to eat jellyfish product.

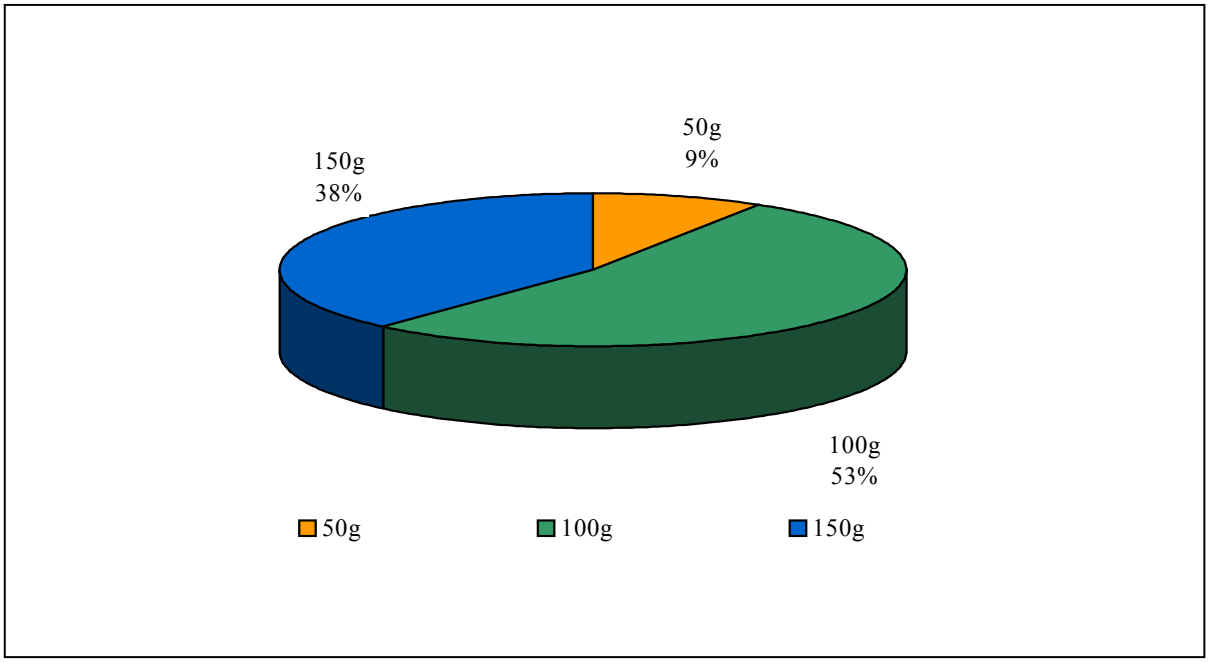
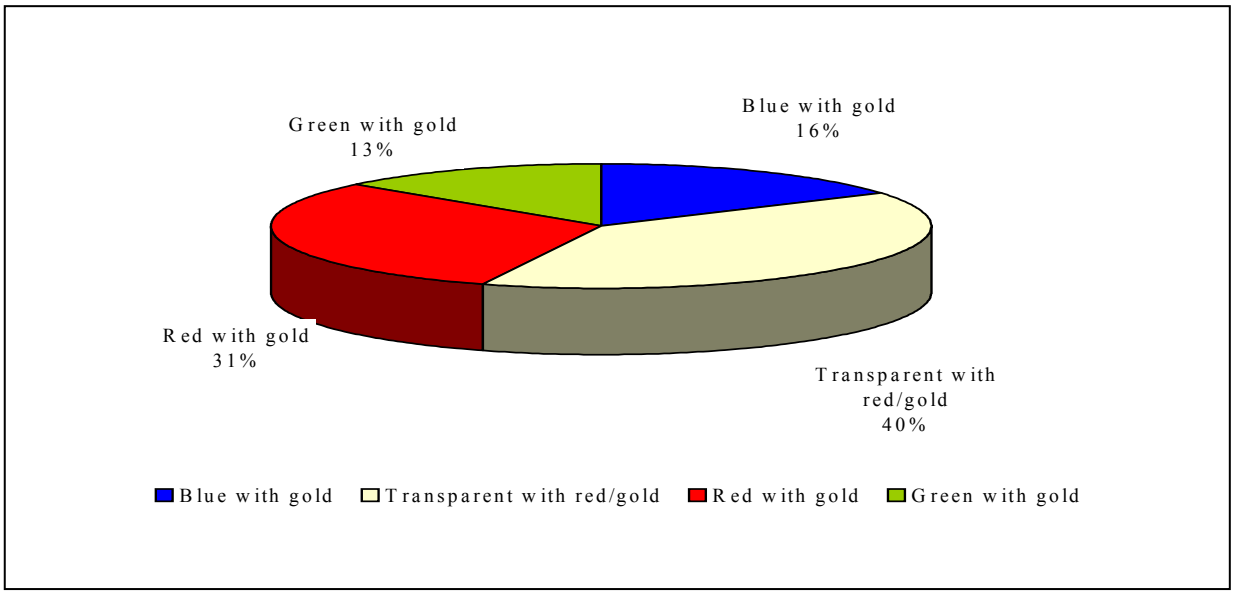


Figure 7.9. Percentage distribution of consumers liking of packaging samples



Consumers of Japanese origin compared with the consumers of all 'Other' origins.

Fifty-four percent of the consumers were of Japanese origin and the results from these consumers were compared against the remaining consumers of all 'Other' origins (46%).

For the soy based marinated sample the only significant difference between the population of consumers of Japanese origin and the consumers of 'Other' origin lies with the initial crunchiness of the sample (Table 7.2). The 'Other' population thought the sample was slightly too crunchy whereas the Japanese population scored the sample close to 'just right' on the scale.

***Table 7.2**. Mean sensory scores of the consumers of Japanese origin compared with the consumers of all 'Other' origins.*

	Country of origin	Appearance[1]	Odour[1]	Texture[1]	Flavour[1]	Overall[1]
Soy based marinade	**Japan**	41 a	46 a	39 a	27 a	29 a
	Other	51 abc	47 a	38 a	31 ab	30 a
Commercial marinade	**Japan**	41 a	46 a	47 ab	39 b	38 a
	Other	60 c	60 b	65 c	65 d	68 c
Match for commercial marinade	**Japan**	48 ab	57 b	54 b	49 c	52 b
	Other	53 bc	60 b	53 b	55 cd	49 b
	LSD (5%)	10.4	4.9	10.4	9.6	9.8

	Country of origin	Initial Crunchiness[2]	Chewiness[2]	Saltiness[2]	Amount of marinade[2]
Soy based marinade	**Japan**	54 b	56 bc	27 a	37 a
	Other	63 d	62 c	33 a	37 a
Commercial marinade	**Japan**	35 a	36 a	46 b	42 a
	Other	55 bc	52 b	59 c	55 b
Match for commercial marinade	**Japan**	57 bcd	57 bc	70 d	56 b
	Other	63 cd	62 c	72 d	59 b
	LSD (5%)	8.1	8.1	8.2	8.1

Line scales and end points:
[1] dislike extremely (0), neither like nor dislike (50), like extremely (100)
[2] not enough of named attribute (0), 'just right' (50), too much of named attribute (100)

abcd Within the same column, means followed by different letters indicate significant ($P<0.05$) differences between samples.

There were no significant differences between the consumers of Japanese origin and the consumers of 'Other' origin for the match for the commercial marinated sample.

The commercial marinated sample was liked significantly more ($P< 0.05$) by the 'Other' population than the Japanese population for appearance, odour, texture, flavour and overall. There were also significant differences ($P<0.05$) for each of the characteristics measured on a 'just right' scale. The Japanese population scored the commercial sample as having not enough initial crunchiness, not chewy enough, slightly not salty enough and as not having enough marinade, whereas the 'Other' population indicated that the commercial sample had slightly too much initial crunchiness, saltiness and the amount of marinade was slightly too much. The 'Other' population scored the chewiness of the commercial sample close to 'just right'.

Figure 7.10a shows that the consumers of 'Other' origin are more likely to probably buy the match for the commercial marinated jellyfish than the consumers of Japanese origin. There is however, little difference between the consumers of Japanese origin and the consumers of 'Other' origin in regards to whether they thought the sample would be liked in their country of origin (Figure 7.11a). Forty-two percent of the 'Other' consumers and 38% of consumers of Japanese origin thought the sample would probably be liked in their country of origin. A large proportion from both groups remained undecided and 27% of the consumers of Japanese origin thought the match for the commercial marinated jellyfish would not be liked in their country of origin.

The majority of consumers from both Japanese and 'Other' origins thought the match for the commercial marinated sample was either slightly or much poorer than jellyfish they had eaten previously (Figure 7.12a).

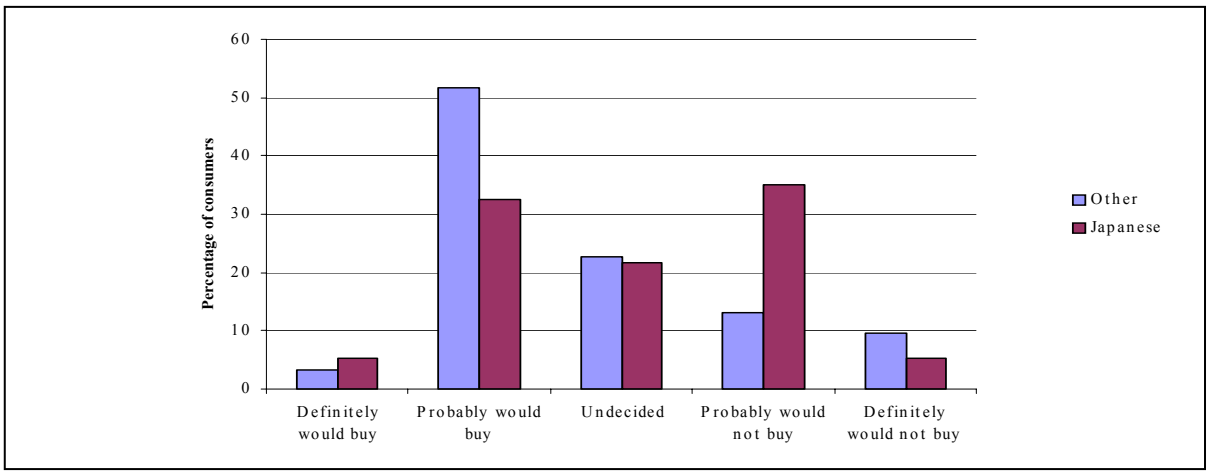
For the soy based marinated jellyfish the majority of both groups of consumers indicated that they probably or definitely would not purchase the sample and indicated that it probably would not be liked in their country of origin. Both groups of consumers also felt that the sample was slightly or much poorer than jellyfish they had previously eaten (Figures 7.10b, 7.11b and 7.12b).

The majority of the 'Other' consumers indicated that they would probably or would definitely buy the commercial sample and thought that it would probably or definitely be liked in their country of origin whereas the majority of Japanese indicated that they probably would not purchase the sample. The Japanese were also either undecided or thought the samples probably would not be liked in their country of origin (Figures 7.10c and 7.11c).

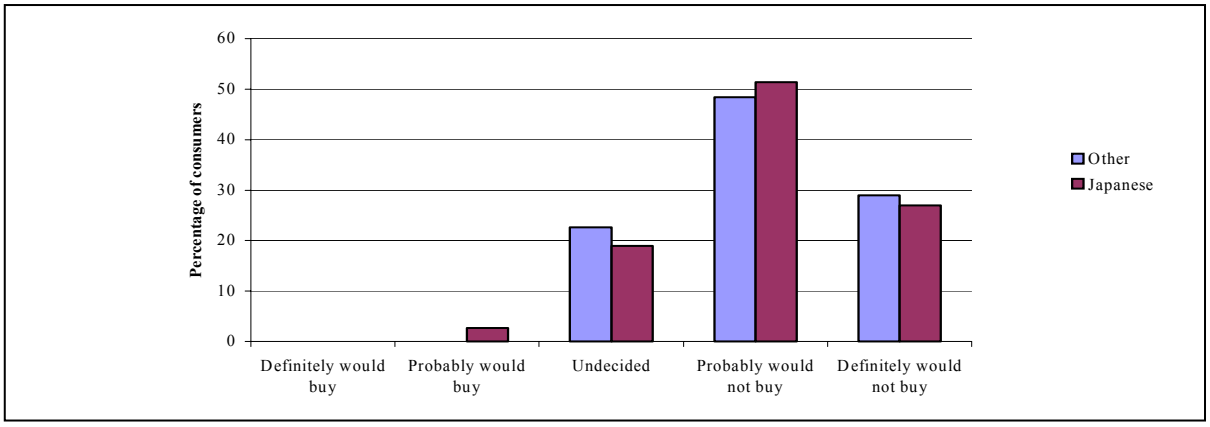
Over 70% of the consumers of 'Other' origin thought the commercial sample was either no different to, or better than the jellyfish previously consumed whereas the majority of Japanese consumers thought the sample was poorer than jellyfish previously eaten (Figure 7.12c).

Figure 7.10. *Comparison of whether the consumers of Japanese origin and 'Other' consumers would be likely to purchase the marinated jellyfish samples*

(a) Match for the commercial marinated jellyfish



(b) Soy based marinated jellyfish



(c) Commercial marinated jellyfish

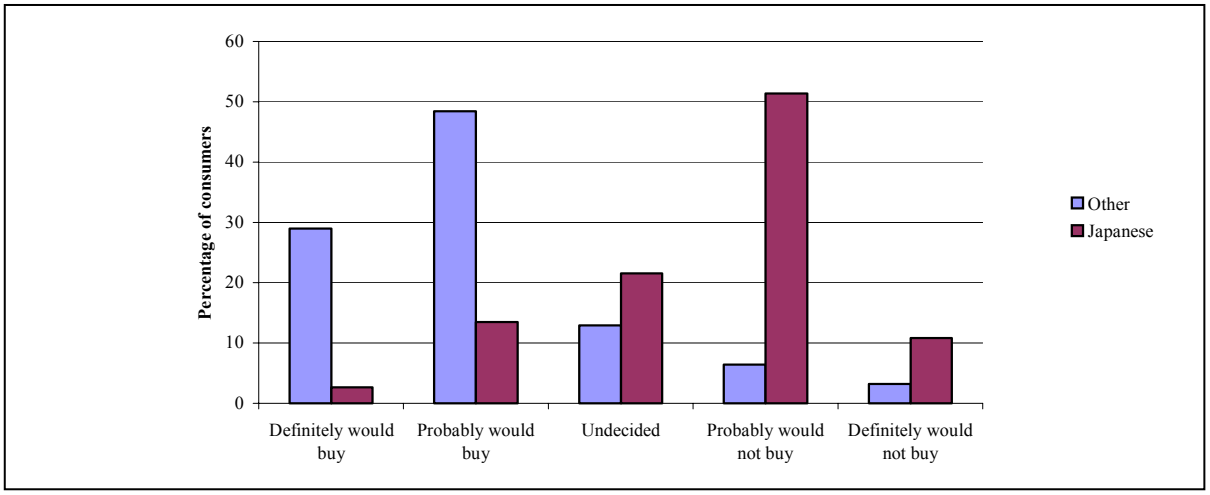
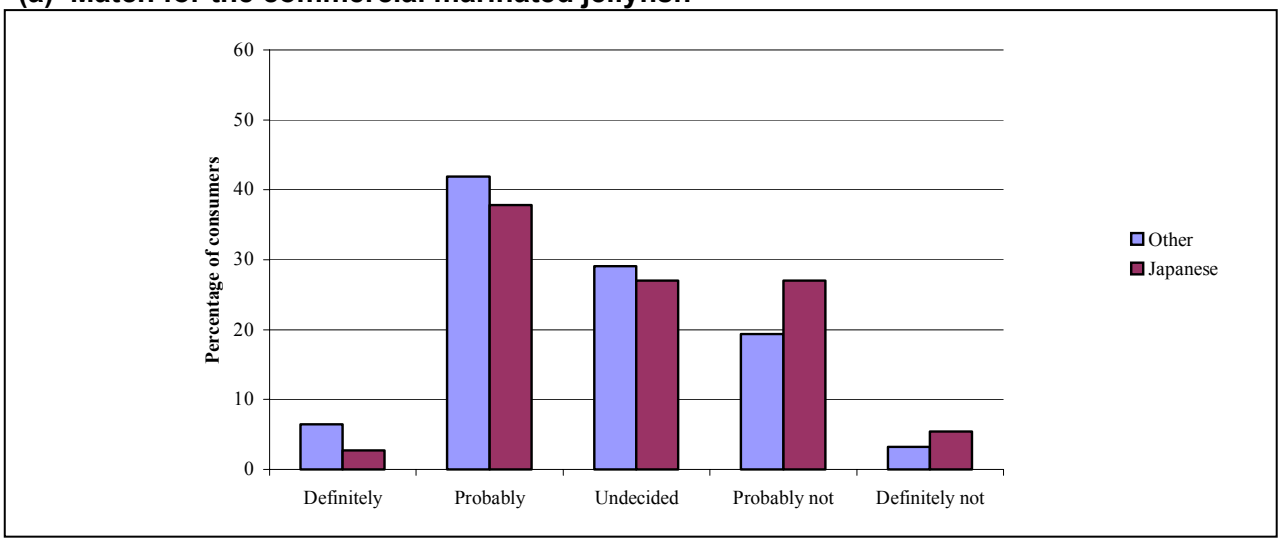
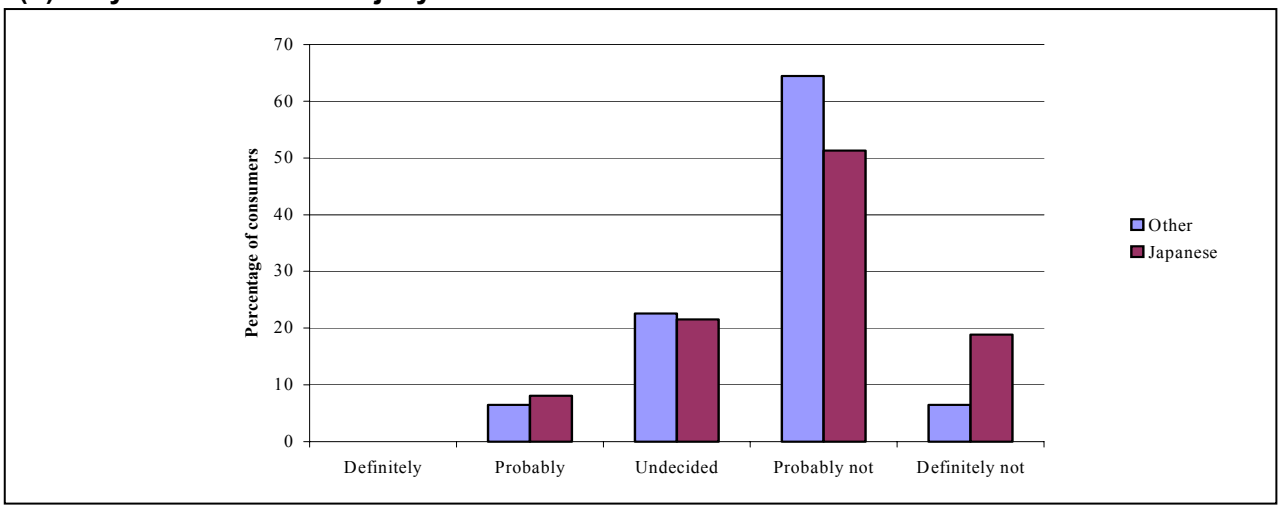


Figure 7.11. Comparison of how the consumers of Japanese origin and the 'Other' consumers thought the marinated jellyfish samples would be liked in their countries of origin

(a) Match for the commercial marinated jellyfish



(b) Soy based marinated jellyfish



(c) Commercial marinated jellyfish

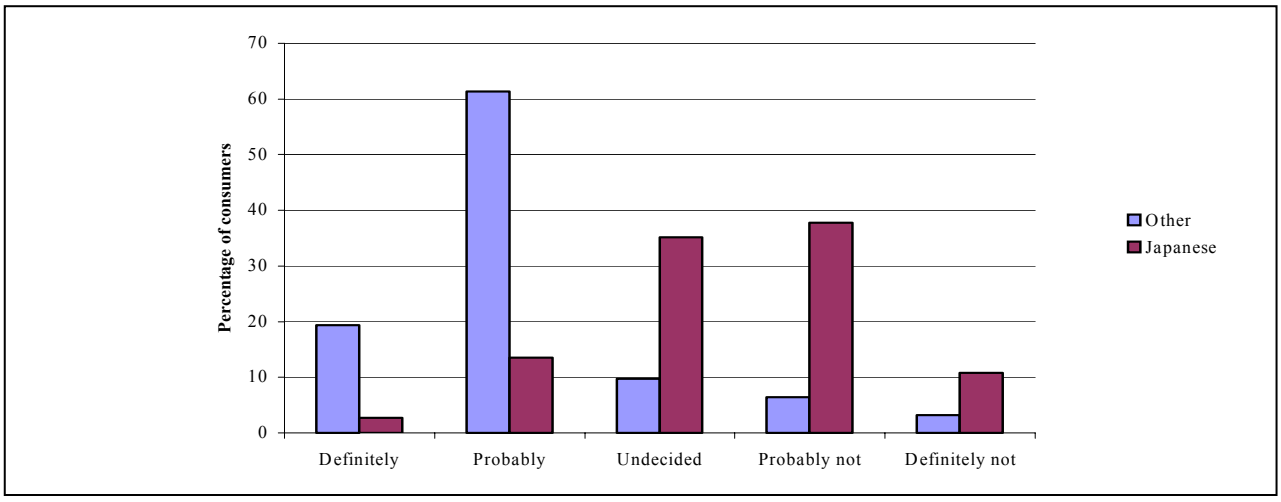
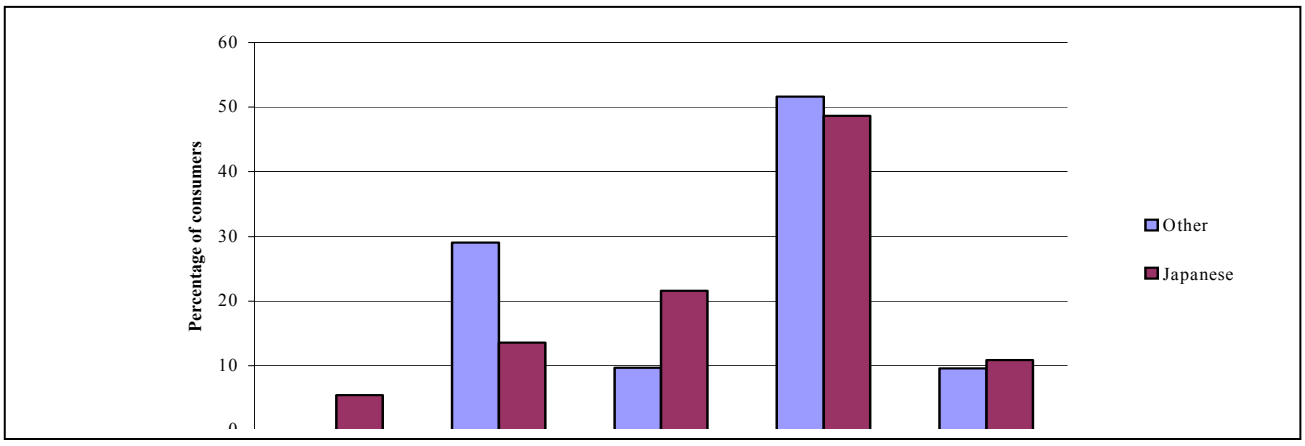
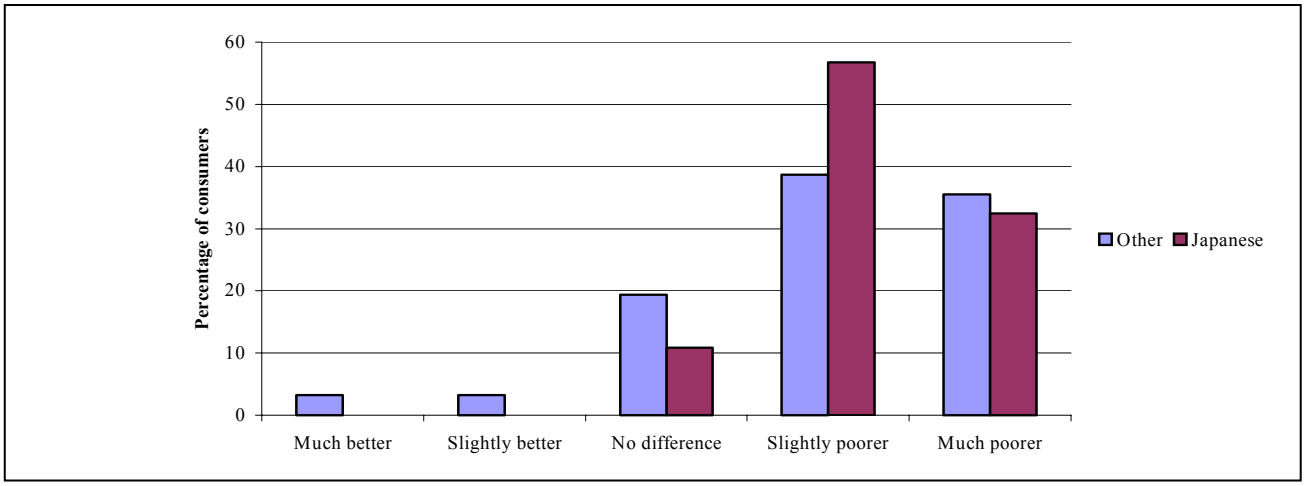


Figure 7.12. *Comparison of how the consumers of Japanese origin and the 'Other' consumers thought the jellyfish samples compared with jellyfish previously eaten*

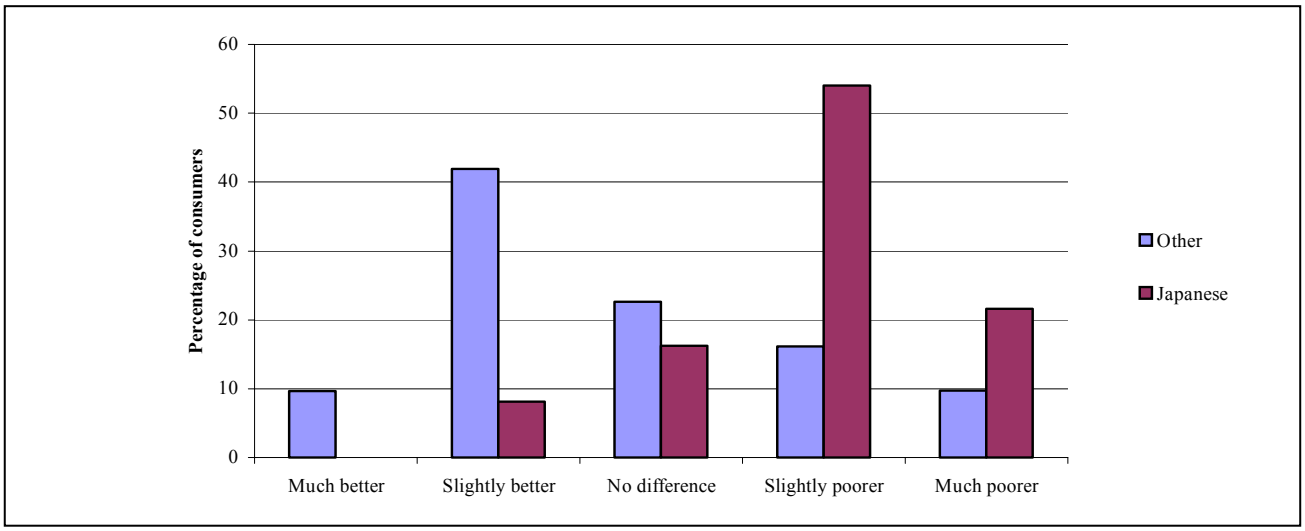
(a) Match for the commercial marinated jellyfish



(b) Match for the soy based marinated jellyfish



(c) Commercial marinated jellyfish



APPENDIX 8

Processing Manual

Processing Manual for producing marinated jellyfish products from *Catostylus mosaicus*

Sue Poole, Jacquie Edwards, Ross Naidoo

2002

AFFS – Food Technology

Queensland Government
Department of Primary Industries

SEAFOOD SERVICES
AUSTRALIA

INTRODUCTION

Jellyfish products are highly prized in many Asian countries. Processing of jellyfish is a traditional practice but is very labour and time intensive. In Australia, with our high labour costs compared to Asian countries, this makes processing traditional dried jellyfish only marginally profitable. Creating a shelf stable, value added product may improve the profitability of the industry but processing must be carried out in a manner which maintains the quality to exacting Asian standards. Product appearance, texture and flavour is vital to consumer acceptance and these factors are highly dependent on the jellyfish processing techniques. Retail prices range from AUD8/kg to AUD85/kg depending on product quality

The Australian jellyfish species, *Catostylus mosaicus,* is identifed as one of ten species that are traditionally used as a food product. The world market demand for dried jellyfish fluctuates around 25 000 tonnes p.a., with the main producers being China, Indonesia and Malaysia. Japan consumes 80% of the highest grade product and to date, demand has always exceeded supply. Although labour intensive to produce if the quality is right the jellyfish products retail for $50-70 AUD per kilo of finished product.

The common blue jellyfish, *Catostylus mosaicus* is widely distributed around the Australian coast. Jellyfish are captured in estuarine and inshore areas, and as such, their capture is controlled by State Government Fisheries Departments. Licensed fisheries exist in Victoria and New South Wales and an experimental fishery has commenced in the Northern Territory. Currently in Queensland, there are applications for developmental fisheries in the Gulf of Capentaria and in Moreton Bay going through the approval process. Interested parties should contact the relevant government body in their state for licensing details.

In recent years, Asian countries have found that their local wild jellyfish stocks have declined and have approached Australia for access to our unutilised resource. Preliminary feed back from interested buyers of dried processed jellyfish indicated that Australian product would be comparable to that considered as high quality. A review of jellyfish products in the domestic and Japanese markets demonstrated a demand clearly existed for a high-value ready-to-eat product. Lower value semi-prepared jellyfish product was available in the market place, but there was no pre-marinated product found in either Japan nor Australia.

One of the major obstacles to establishing a commercial fishery highlighted by seafood processors is the lack of available knowledge of processing techniques and value-adding to the raw product.

Researchers at the Centre for Food Technology (QDPI) investigated the possibility of producing high quality traditional jellyfish products from the common blue jellyfish, *Catostylus moasicus*. The objective was to develop, design and produce a high-value ready-to-eat convenience product for the top end of the consuming market. This market in Japan demands between 1200 and 1600 tonnes annually

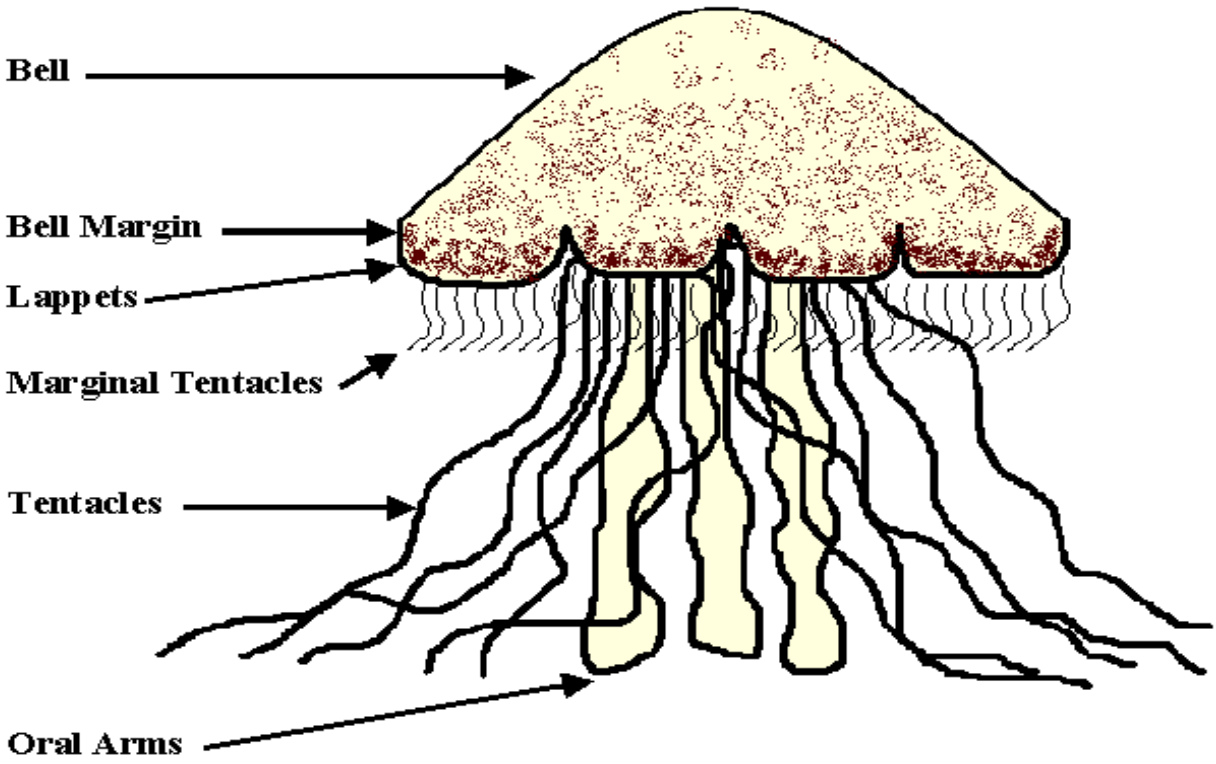
The research was supported with funding from the Fisheries Research and Development Corporation and the results are available in a report from Seafood Services Australia. This processing Manual provides a formalised processing method and information on the critical product specifications on which consumer acceptance of such products is dependent.

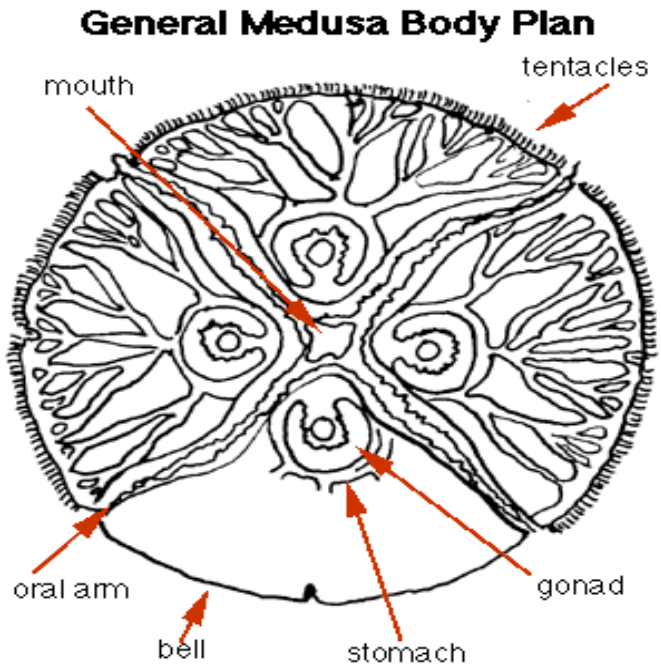
GLOSSARY OF TERMS

Bell / umbrella	The body of the jellyfish. Generally the most valuable part although both the oral arms and bell may be processed. The bell consists of a jelly like substance, mesoglea, which is surrounded by the ectoderm, a thin membrane.
Oral arms / tentacles	Located below the bell and around the mouth, usually four oral arms are present in the Australian species *Catostylus mosaicus*, but some jellyfish species have many more.
Nematocysts / cnidocysts	Cells which are located on the ectoderm and contain irritants that cause itchiness, redness and rash. The cnidocysts are pressure activated and still cause a reaction even when the animal is dead. Treatment is usually recommended as washing with a mild salt or alcohol solution.
Potash Alum / Alum	Potassium Aluminium compounds used in salting jellyfish. They act as a disinfecting agent and precipitate proteins. It is essential for obtaining a good quality salted jellyfish product and preventing putrefaction during processing.
Bleaching powder	Compounds that can be added to the first salting stage to whiten the final product. Usually bicarbonate compounds are used for bleaching jellyfish bells.
Salted jellyfish	Traditionally processed jellyfish where salt and alum are used to remove the moisture from the product over of several days to weeks.
Dried jellyfish	Jellyfish dried through mechanical means such as a drying unit. This method has not been successfully employed to process Australian jellyfish.
Rehydrating	The process of allowing the jellyfish strips to absorb water after cooking. Generally, the suggested rehydration time after cooking is between 3hrs to overnight.
De-salted	Jellyfish which has been washed and allowed to soak (after several water changes) and is now ready to prepare for eating.
Marinated	The final product. Jellyfish is firstly cooked than re-hydrated and has had flavouring ingredients such as rice wine vinegar and soy sauce added.

Further terminology information is presented in Figure 1.

Figure 1: Anatomy of edible jellyfishes
.(South Carolina Department of Natural Resources - www.disl.org)





PROCESSING

The processing establishment will need to have Australian Quarantine and Inspection Service (AQIS) registration as an export processing facility. Importing countries may require processed foods are product certified before allowing entry. AQIS also provides the certificates that satisfy such importing country authorities. Contact your regional AQIS office for information.

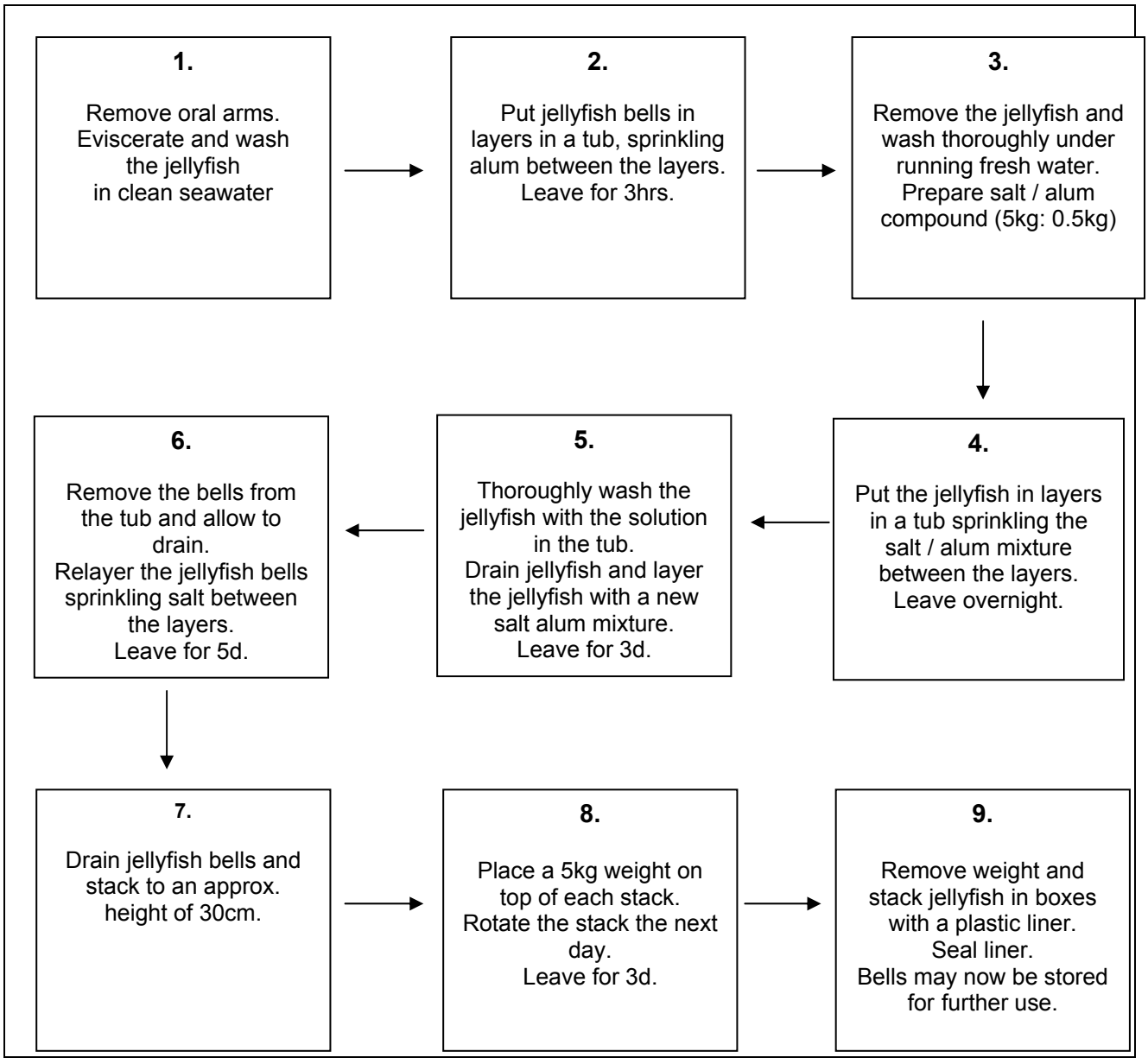
Catching / Harvest

Parties who wish to catch and process jellyfish should contact the relevant government body in their state for licensing details. Harvesting methods for jellyfish may also be controlled under the general regulations of the state's statutory fishing authority management plan. These should be determined and adhered to during fishing operations.

Jellyfish are delicate when live and the capture method should be chosen to minimise the possibility of damage to the animal. Jellyfish are generally captured using dipnets.

Whilst fishing, the captured jellyfish are stored on-board in tubs, either dry or with estaurine or seawater added. Storage tubs should not be overloaded with jellyfish to ensure that the valuable bells are not ripped or squashed by the weight of animals in the tub.

A brief outline of the salting/alum process used to produce dried jellyfish to use as raw material for the value-added product is as follows:
A more detailed procedure is given in Appendix 1 – Salting Regime.



VALUE-ADDING

Raw material procurement

The salted jellyfish should be of good quality before use in processing. The bells should be complete without holes or tears. The colour should range from clear to a tan-yellow shade without any specific discolouration or stains. The surface should have a slightly moist sheen with visible salt to ensure it has been adequately salted.

The moisture content should not exceed 75% and 65-70% is ideal. A minimum salt level of 25% is required. The salted jellyfish must be stored in a cool, dry place at ambient temperature. Refrigerated storage of the salted bells is unnecessary and appears to interfere with the water uptake capacity of the jellyfish.

De-Salting

The salt should be thoroughly removed from the jellyfish bells before cooking and marinating. Under running fresh water, rub the surface salt off and then soak the bells in 4L of fresh water for each 1kg of jellyfish bells. The jellyfish are soaked for 3hrs, changing the water frequently. Once de-salted, drain the bells completely and slice into very thin strips. Slicing is best done by rolling the bells, several can be rolled at once, into a tube and cutting into 1-1.5mm thick slices.

Cooking

The cooking of jellyfish is an extremely quick procedure, similar to a blanch. Overcooking can radically toughen the texture and make the product unacceptable. The cooking temperature is below boiling, at approx 80°C, and 1L of cooking water to each 100g of jellyfish strips is recommended.

Prepare a cooling bath with cold fresh water for after cooking. Do not add ice, as this may cause deterioration in the appearance and texture of the cooked jellyfish.

To cook the jellyfish strips, pour the hot fresh water over the jellyfish then immediately transfer both water and strips to a colander and shake to drain. Place the strips into the cooling bath until cool. Drain thoroughly, then squeeze the strips in the hand to express any remaining moisture. Ensure that the jellyfish strips are not kept in the cooking water for longer than 2-3secs or a rubbery, tough texture will result.

Marinade

The marinade of choice, depending on target market, can be prepared ahead of time and refrigerated until required for use. The jellyfish strips are coated with 200g of marinade for each 1kg of cooked and drained strips. Mix the marinade and strips to evenly distribute the flavour.

Packaging

Sufficient pre-printed packages of an appropriate size should be sourced before processing. Specifications of these will be dependent upon target market.

Labelling

It is recommended that the packages contain the following information either on the primary or secondary label:

- product name
- best before date / use by date
- storage temperature (refrigerated storage only)
- ingredients in order of magnitude
- package weight
- manufacturers details
- serving or preparation instructions
- batch numbers / date of manufacture

Each importing country may have differing requirements and these should be determined before export. Assistance with importing country regulations can be provided from AQIS.

Generally, it may be required that the label indicates the country of origin and the ‘name/address' of the manufacturers. It is also possible that the product ingredients will need to be listed in order of magnitude, including any additives.

Some countries will require certification, which is supplied by AQIS. If the product is to be exported to Japan, separate mandatory standards for quality labelling of processed foods

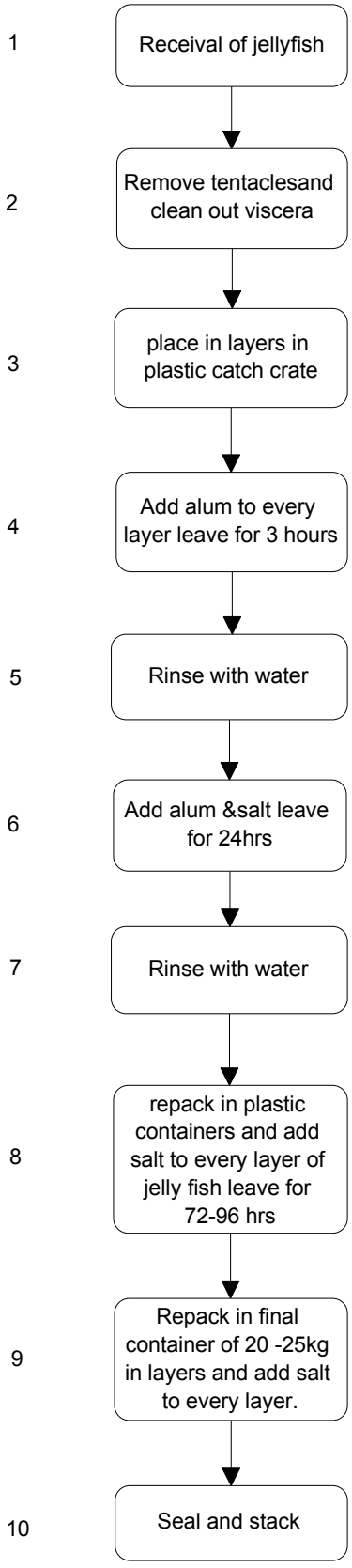
and beverages are administered by Japan's Ministry of Health and Welfare (MHW). Japan's Food Sanitation Law restricts the use of chemicals and food additives, allowing only certain types of additives as well as specifying their maximum tolerable amounts and the foods in which they may be used.

While the Japanese Measurement Law requires that all imported goods and shipping documents display metric weights and measures, there is no law requiring display of the identity of the place of origin.

Storage

After marinating and packaging, the product should be stored below 10°C. It can be held at this temperature for up to 3 months.

FLOWCHART FOR PROCESSING DRIED JELLYFISH



RISK TABLE FOR PROCESSING DRIED JELLYFISH

Critical steps	Potential Hazards	Cause	Sev*	Lik*	Sig*	Reasons for significance	CCP	Control measures
Step 1. Receival of jellyfish	Foreign objects	Accidental / deliberate presence of glass, metal, plastics, bone, stone. Contamination.	L	M	M	May not be detected at a later stage. Potential public health risk.	CCP: Use only approved suppliers	Inspection of raw material to product specifications Only trained receival personnel used for receival inspection. Use only approved suppliers
	Environmental contamination: chemical microbiological	Collection of jellyfish from contaminated waters.	H	L	H	Only catch in clean waters	CCP - Use only approved suppliers	Use only approved suppliers. Raw material quality at receival inspection.
	Pathogen contamination and toxin production: *Vibrio* spp *E.coli* coliforms	Incorrect handling, storage and cleaning Jellyfish filter feeding in contaminated waters. And a lack of temperature control.	H	L	H	Microbial growth may be significant if product is improperly handled. High levels of pathogens may produce toxins which cannot be controlled at a later step. GMP will prevent the likelihood of contamination.	CCP- Product temperature	Only operators trained in: • control of product temperature • hygienic processing techniques.

Sev* – severity if risk occurs
Lik* - liklihood of risk occuring
Sig* - significance if risk occurs

RISK TABLE cont'd

Critical steps	Potential Hazards	Cause	Sev	Lik	Sig	Reasons for significance	CCP	Control measures
Step 2. Remove tentacles and clean out viscera.	Pathogen contamination and growth: *S.aureus* *Vibrio spp* *E.coli* *coliforms* Parasites: spread from process environment to flesh.	Improper handling by supplier and staff. Contaminated from contact with contaminated surfaces.	H	L	H	Microbial growth may be significant if product was improperly handled. High levels of pathogens on product could leave toxins and cannot be controlled at a later step. GMP should prevent the likelihood of contamination.	CCP- Product temperature	Only operators trained in: • control of product temperature • hygienic processing techniques
Step 3. Place in layers in plastic catch crate	Physical, microbial and chemical contamination from the processing environment and unclean catch crates.	Accidental / deliberate presence of glass, plastics, bone, stone or metal. Contamination from: • hands / gloves • aprons • equipment • work benches • dropped product • contaminated water	H M	L L	H M	May not be detected at a later stage. Potential public health risk. GMP should prevent the likelihood of contamination.		Only operators trained in: • control of product temperature • hygienic processing techniques. Maintenance of facilities.
Step 4. Add alum to every layer leave for 3 hours.	Pathogen survival and growth: *S.aureus* *E.coli* *Vibrio* spp Coliforms Halophilic organisms	Salt concentration insufficient to kill pathogenic micro-organisms & product temperature high enough for bacteria to grow and produce toxins. Contamination from low grade salt	H	L	H	If the salt/alum concentration is insufficient microbial growth / pathogen contamination will occur. High levels of pathogens on product could leave toxins and cannot be controlled at a later step.	CCP Salt concentration & quality.	Minimum salt concentration. Salt free of salt-tolerant organisms and other contaminants.

RISK TABLE cont'd

Critical steps	Potential Hazards	Cause	Sev	Lik	Sig	Reasons for significance	CCP	Control measures
Step 4 (cont'd)	Physical and chemical contamination from processing environment	Contaminated salt used. Accidental/deliberate presence of glass, plastics, bone, stone or metal. Contamination from - • hands / gloves • aprons • equipment • work benches • dropped product • contaminated water	H	M	H	No further steps will remove chemical or physical contaminants. May not be detected at a later stage. Potential public health risk. GMP should prevent the likelihood of contamination.		Only operators trained in • control of product temperature • hygienic processing techniques • reporting procedures for any defects or unsound facilities. Maintenance of facilities.
Step 5. Rinse with water	Microbial contamination	Contaminated rinse water	M	L	M	Only potable wash water used.		Use potable water Regular water testing
Step 6. Add alum and salt leave for 24 hours	Pathogen survival and growth: *S.aureus* *E.coli* *Vibrio* spp Coliforms Halophilic organisms	Salt concentration insufficient to kill pathogenic micro-organisms & product temperature high enough for bacteria to grow and produce toxins.	H	L	H	If the salt concentration is insufficient microbial growth / pathogen contamination will occur. High levels of pathogens on product could leave toxins and cannot be controlled at a later step.	CCP: Salt concentration.	Minimum salt concentration.

RISK TABLE cont'd

Critical steps	Potential Hazards	Cause	Sev	Lik	Sig	Reasons for significance	CCP	Control measures
Step 6 (cont'd)	Physical and chemical contamination from processing environment	Contaminated salt used. Accidental/deliberate presence of glass, plastics, bone, stone or metal. Contamination from - • hands / gloves • aprons • equipment • work benches • dropped product • contaminated water	H	M	H	No further steps will remove chemical or physical contaminants. May not be detected at a later stage. Potential public health risk. GMP should prevent the likelihood of contamination.		Only operators trained in: • control of product temperature • hygienic processing techniques • reporting procedures for any defects or unsound facilities. Maintenance of facilities.
Step 7. Rinse with water	Microbial contamination	Contaminated rinse water	M	L	M	Only potable wash water used.		Use potable water Regular water testing
Step 8. Repack in plastic containers and add salt to every layer of jellyfish (72-96 hours).	Pathogen survival and growth: *S.aureus* *E.coli* *Vibrio spp* Coliforms Halophilic organisms	Salt concentration insufficient to kill pathogenic micro-organisms & product temperature high enough for bacteria to grow and produce toxins.	H	L	H	If the salt concentration is insufficient microbial growth / pathogen contamination will occur. High levels of pathogens on product could leave toxins and cannot be controlled at a later step.	CCP Salt concentration.	Minimum salt concentration. Maintenance of facilities

RISK TABLE cont'd

Critical steps	Potential Hazards	Cause	Sev	Lik	Sig	Reasons for significance	CCP	Control measures
Step 8 (cont"d)	Physical and chemical contamination from processing environment	Contaminated salt used. Accidental/deliberate presence of glass, plastics, bone, stone or metal. Contamination from - • hands / gloves • aprons • equipment • work benches • dropped product • contaminated water	H	M	H	No further steps will remove chemical or physical contaminants.		Only operators trained in: • control of product temperature • hygienic processing techniques • reporting procedures for any defects or unsound facilities.
Step 9. Repack in final container of 20-25kg in layers and add salt to every layer.	Pathogen survival and growth: *S.aureus* *E.coli* *Vibrio spp* Coliforms Halophilic organisms	Salt concentration insufficient to kill pathogenic micro-organisms & product temperature high enough for bacteria to grow and produce toxins.	H	L	H	If the salt concentration is insufficient microbial growth / pathogen contamination will occur. High levels of pathogens on product could leave toxins and cannot be controlled at a later step.	CCP Salt concentration.	Minimum salt concentration. Maintenance of facilities

RISK TABLE cont'd

Critical steps	Potential Hazards	Cause	Sev	Lik	Sig	Reasons for significance	CCP	Control measures
Step 9 (cont"d)	Physical and chemical contamination from processing environment	Contaminated salt used. Accidental/deliberate presence of glass, plastics, bone, stone or metal. Contamination from: • hands / gloves • aprons • equipment • work benches • dropped product • contaminated water	H	M	H	No further steps will remove chemical or physical contaminants. May not be detected at a later stage. Potential public health risk. GMP should prevent the likelihood of contamination		Only operators trained in: • control of product temperature • hygienic processing techniques • reporting procedures for any defects or unsound facilities.
Step 10. **Seal & stack**	Pathogen survival and growth: *S.aureus* *E.coli* *Vibrio spp* Coliforms Halophilic organisms	Dried product comes in contact with water and rehydrates .	H	L	H	High levels of pathogens on product could leave toxins and cannot be controlled at a later step.	CCP Product water activity and humidity levels during storage	Keep product in dry storage conditions.

HACCP CHART FOR DRIED JELLYFISH

Critical Step	Potential Hazard	Critical Control Point (factor) CCP	Preventive, Control & Monitoring Measures		
			Monitoring Procedure (Include frequency, person responsible, where recorded)	Target Level and Tolerances	Corrective Action (to be recorded in Production Log)
Step 1 **Receival of jellyfish.**	Pathogen contamination and toxin production: *Vibrio spp* *E.coli* coliforms	Raw material quality at receival inspection.	Receival personnel to be present at all unloads to ensure critical limits are achieved. Supervisor / QA officer to observe unloads at least once per day to ensure unloads being preformed correctly.	Product within specification by an approved supplier. Caught in waters free of contamination. Foreign objects – Nil Temperature	Notify QA officer. Segregate product and document on hold notice.
Steps 1-3	Microbial pathogen growth and toxin production. *S.aureus* *Vibrio spp* *E.coli* coliforms	Product temperature	Supervisor to continuously check to ensure that the product is stored correctly- temperature and maximum time limits are adhered to.	Product to remain at below 4^{o}C.	Supervisor to implement corrective action to eliminate the problem: isolate product, assess product, rework or dump product., retrain staff, increase monitoring levels & record process taken.

HACCP CHART cont'd

Critical Step	Potential Hazard	Critical Control Point (Factor) CCP	Preventive, Control & Monitoring Measures		
			Monitoring Procedure **(Include frequency, person responsible, where recorded)**	**Target Level and Tolerances**	**Corrective Action** **(to be recorded in Production Log)**
Step 4 – 9 Processing (excluding steps 6 & 8)	Pathogen survival and growth of toxins/spores: *S.aureus* *E.coli* *Vibrio* spp Coliforms Halophilic organisms	Salt and alum concentration. Salt quality.	Supervisor / QA officer to observe the salting process at least once per day to ensure the task is being performed correctly. Use of approved suppliers only. Certificate of purity received with every load of salt.	Not less than 8% w/w. Salt to be free of salt-tolerant organisms.	Supervisor to instruct operators in correct methods of operation. Reject salt for use.
	Physical and chemical contamination from salt.	Salt quality	At each step that uses salt, the operator must check each bag to see if it "sparkles".	Visually free from foreign matter- salt must "sparkle" at receival.	Reject salt for use. Supervisor to notify supplier and review approved supplier status.
Step 10. **Seal and stack**	Pathogen survival and growth of toxins/spores: *S.aureus* *E.coli* *Vibrio* spp Coliforms Halophilic organisms	Product water activity and free of salt-tolerant organisms.	Test samples from each batch.	• less than 10 orgs/gm E.coli. • less than 1000 orgs/gm *S.aureas* • less than 10 orgs/gm *V.parahaemolyticus*	Reject batch Re test

APPENDIX 1 – SALTING REGIME

The following description of salting jellyfish is the method adhered to during processing trials undertaken for this project. It is simply the salting method used, and the description is one of many methods, which can be found in published literature. The research did not assess the appropriateness of salting methods and therefore cannot recommend one method over another.

Catching / Harvest

Generally, jellyfish are captured in inshore areas such as estuaries and sheltered bays using a dip-net to scoop them out of the water. Catch rates may be high during the peak season when swarms of jellyfish are not uncommon.

Whilst fishing, the captured jellyfish are stored on-board in tubs. River or seawater may be added to the tubs but is not strictly necessary as the animal will shed mucous and water regardless of the environment to which it is subjected. The animals will generally remain alive for 3 to 5 hours in water and 1 to 2 hours dry. Storage tubs should not be overloaded with jellyfish to ensure that the valuable bells are not ripped or squashed by the weight of animals in the tub.

After capture or during transport to the processing facility, jellyfish should be stored at ambient temperatures. The addition of ice will cause deformations to occur in the bell of the animal, which will not disappear with further processing.

Process Area Preparation

In order to prepare salted jellyfish the following will be required

- Flat bladed knives or mollusc shuckers
- Gloves and protective aprons
- Potable water supply
- Large storage tubs for initial salting
- Food grade salt
- Food grade fine grade alum

Chemical Procurement

Chemicals used for processing jellyfish should be food grade. The most common alum compound used in salting jellyfish is potassium aluminium sulphate $KAl(SO_4)_2$ and is widely known as potash alum. A fine grade of alum should be used to ensure good mixing with the salting compound and even coverage over the jellyfish bells. Any good quality salt may be used.

Care should be taken that the salting compound is made to specifications to ensure that product quality is maintained. Compounds can be made in advance and kept in a moisture proof container until use.

Cleaning / Gutting

The jellyfish are simple to gut and clean. The nematocysts (stinging cells) are located all over the animal but are generally concentrated around the fringes of the bell and oral arms. The toxin produced causes a mild stinging, burning sensation on the skin that later may become a mild itchy rash. *Catostylus mosaicus* does not produce a dangerous toxin but care should still be taken to avoid contact with skin during processing particularly around the eyes.

The jellyfish are laid with the top surface of the bell on the gutting / cleaning table and the oral arms are lifted to expose the connective tissue. Using a blunt rounded blade, the four connection points of the oral arms are cut away as close to the inner surface of the bell as possible. If short cutting motions are made it is possible to remove the gut/ gonad and oral arms in a complete piece.

Using the blade, the area can be gently scraped clean to ensure complete removal of the gut matter as this may lead to staining of the bell surface in the later stages of processing. The cleaned bell is washed under running water rubbing away any dirt, mucous and gonads or gut material remaining. Both surfaces of the bell should be thoroughly washed. The oral arms can also be salted in the same manner as the bells. Firstly the mouth, any remaining gonad and connective tissue from the bell are sliced off the arms. Wash the arms under running water to remove mucous. A dishwashing brush may be useful to gently scrub the surface of the arms before salting.

First Alum / Salting stage

The cleaned jellyfish bells are treated with an alum and salt compound in several steps. The techniques used are varied but generally the processes involve using an initial alumina step to thoroughly clean and disinfect the jellyfish. Prepare a treatment compound by mixing 500g alum with 100g of bleach (usually food grade sodium bicarbonate is used) for each 5Kg of salt.

Sprinkle alum / bleach compound over the base of a large plastic tub, then place jellyfish bells in a layer over the bottom of the tub. Continue alternating a fine sprinkle of alum with layers of jellyfish until all the bells are covered. It is important to only use the correct amount of alum, as too little will result in the jellyfish becoming putrid and liquefying and too much will cause a high residual alum level in the finished product and may result in flavour taints in the finished product.

This mixture is left for 3 hrs to remove mucous and dirt from the product. After 3 hrs remove the bells from the tub and wash thoroughly under running fresh water. Allow the bells to drain for at least 5 mins before further salting.

Second, Third and Final Saltings

A mixture of salt and alum is used to remove moisture from the bells over several days. Using large plastic tubs, sprinkle a layer of the salt/alum compound over the base and then alternate jellyfish and salt/alum until all bells are covered*.*

Dried Jellyfish Storage

After the salting steps, the jellyfish can be stored for later use. The dried bells should be stored in a dry clean cool area. Stored bells can last up to 12months with little loss of quality.

ATTACHMENT 1

Trial packaging

ATTACHMENT 1: Trial packaging

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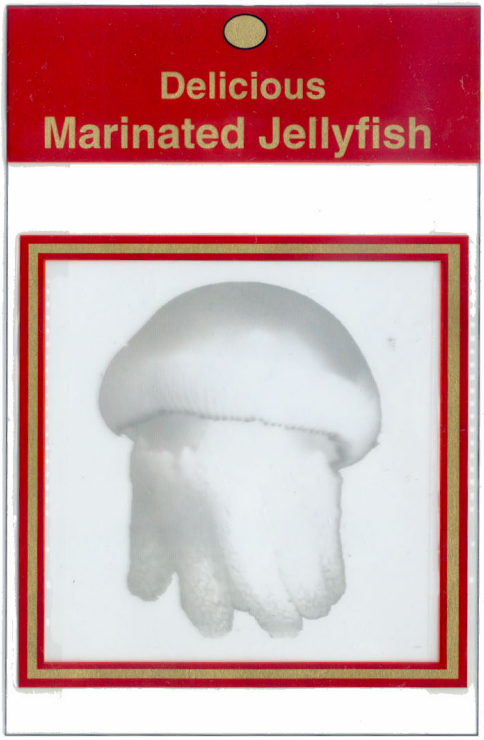

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