SEAFOOD SERVICES AUSTRALIA

Final report

Development of a smoked karasumi and a karasumi sauce

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SEAFOOD SERVICES AUSTRALIA

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97/416 Development of a smoked karasumi and a karasumi in sauce

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NON TECHNICAL SUMMARY

SMOKED KARASUMI

The development of a smoked karasumi was originally proposed to utilise the second grade karasumi which is often darker in colour and unacceptable to the regular Japanese karasumi buyer. The natural variation which occurs in the colour of sun dried karasumi is highlighted in appendix 6. The premium grade karasumi as depicted by example numbers 1, 2 and 3 (appendix 6) are examples of the range of colours of karasumi accepted by the extremely traditional Japanese market.

This project has developed a procedure for the production of a smoked karasumi product utilising the facilities of the industry partner at *Karasumi Australia*. Development trials of a smoked karasumi were conducted using a variety of woods including Hickory, Red Cedar and Tasmanian Oak. These trials were also conducted using a variety of smoking procedures, which utilised both hot and cold smoking techniques and also varied the length of the smoking time from between 1 hour and 2 hours.

The optimum flavour and aroma of the karasumi was achieved using Hickory wood with a cold smoke of 2 hours. These production methods were then replicated 5 times using different batches of karasumi. The shelf life of the smoked karasumi from these replications was tested at 3 monthly intervals for a period of 12 months. The samples were stored at 4^{o}C and 10^{O}C.

Originally this project aimed to develop a market for the lower grade of karasumi by smoking the product to minimise some of the colour and quality imperfections of sun dried mullet roe. This project has found that none of the woods trialed made a dramatic colour change to the karasumi. The only smoking process that slightly darkened the karasumi was the 2 hour hot smoking as shown in appendix 8. Appendix 9 shows the insignificant colour change of the 2 hour cold smoking cycle. Thus, if the karasumi is unacceptably dark as shown by example numbers 5 and 6 in appendix 6 or has some colour blemishes on it prior to smoking then these will still be visible after smoking. The smoking of this dark coloured karasumi does impart a smoky aroma and flavour but is likely to be rejected by the Japanese consumer because of its unacceptable dark colour.

The recommendations of this report are to utilise the mid-range colours of karasumi as shown by samples 3 and 4 in appendix 6. This grade of karasumi is ideal for smoking as it appears only slightly darker than the premium grade sundried karasumi. The concept of a slightly darker smoked karasumi product may appeal to the Japanese consumer.

The results of the consumer acceptance testing of the smoked karasumi using forty-two (42) Japanese consumers indicated excellent export potential for a smoked karasumi product. (see appendix 10) The consumers assessed the karasumi samples for acceptability of appearance, odour, texture, flavour and overall liking as well as the level of saltiness and smokiness. Both the smoked and unsmoked products received high acceptability scores for appearance, odour, texture, flavour and overall liking. However, the smoked karasumi scored consistently higher for all of these attributes. The results indicated that the consumers would be more likely to buy the smoked karasumi over the unsmoked karasumi product.

The shelf life results of the smoked karasumi have shown at 4°C or below the smoked karasumi remains microbiologically sound for up to 12 months when stored in a high barrier vacuum bag. This storage life is equivalent to the unsmoked product and allows for the product to remain at top quality while being exported to Japan. The loss of some of the smoke aroma at the 9 month stage indicates a maximum 9 month shelf life would be ideal for the smoked product.

KARASUMI IN SAUCE

The development of a karasumi in sauce product was originally proposed to utilise the lower grade karasumi processed by *Karasumi Australia* each year. The thinly sliced karasumi bottled in a flavoured oil would hide the imperfections associated with second grade whole karasumi. This project has successfully developed a karasumi in sauce product, however the microbiological risks associated with the production of the sauce limit commercialisation prospects. The recommendation of this report to obtain a safe commercial product would be the sterilisation of the karasumi and oil mix as a whole product in a glass retort system. This would ensure a microbiologically sound product with a suitable shelf life at room temperature.

After numerous formulations investigating both processing conditions and the selection of ingredients the following method has been established. Thinly sliced karasumi (2mm) plus salt, freeze dried basil, and fresh sliced garlic are bottled in small glass jars. Winterised canola oil is then heated to 100°C and filled to the top of the jar. Winterised oil is oil that has been treated to prevent crystallisation or cloudiness occurring at refrigeration temperatures. The jars are then inverted and stored at 4°C. The resultant product has a water activity of <0.78 and a pH of 5.0.

Although the karasumi in sauce product looks aesthetically sound the microbiological results indicate the potential health risk of this product in its current format. The microbiological hurdles created for this product include refrigerated storage (below 4°C), low water activity (<0.78) and pasteurisation of the raw materials by the hot oil at 100°C. These hurdles have been proven to dramatically reduce the microbe count within the product but the relatively high pH (5.0) allows the possible growth of pathogenic anaerobic organisms. Trials of oil blends with lower pH's (<pH 4.0) showed significant impact on the colour of the karasumi due to the bleaching effect of the acidic conditions within the oil. This last hurdle was deemed to have too great an effect on the appearance of the karasumi and was dismissed as a possible processing method. To ensure the microbiological safety of this product full heat processing of the ingredients after filling into the jar are required. A high pressure glass retort required for this

process would require significant capital investment, which is outside the scope of *Karasumi Australia.*

Based on these findings this report does not endorse the karasumi in sauce product due to the associated microbiological risk. Hence, the launch of this product onto the domestic or export market is not possible in its current format.

BACKGROUND

This project follows a similar project investigated by the Centre for Food Technology in 1994 on the development of dried mullet roe (karasumi). Several Australian companies are now using this information in the production of karasumi for the Japanese export and local domestic markets. Due to the strict specifications applied to the karasumi by the Japanese buyers, only 35 to 40% is exported, the remainder is relegated to the less profitable and dwindling domestic market.

Mullet roe is graded into 3 main categories - Premium, First grade and Second grade. It is primarily the first grade roe which is used in the production of karasumi. Premium roe is exported fresh or frozen and second grade (approximately 15%) is sold at a loss or discarded.

Prompted by the need to utilise this second grade roe and the need to better utilise karasumi which is not of exportable quality, *Karasumi Australia* in conjunction with a Japanese seafood importer (*Ishikawa Enterprises*) wishes to develop a range of value added karasumi products. These products will be targeted for the Japanese restaurant and retail trade. After initial market research by *Karasumi Australia* and *Ishikawa Enterprises*, two products have been targeted.

1. A smoked karasumi that will hide discolouration, blemishes and blood filled capillaries in the roe sacs allowing the product to be exportable. No smoked karasumi products have been found in the Japanese market but a positive feedback to its acceptability has been received. A potential market is also believed to exist in other Asian and Middle Eastern countries.

2. A karasumi in sauce, where damaged karasumi can be thinly sliced and used as a major component in an oil based sauce. In Japan, karasumi in sauce is frequently produced by chefs and added to many traditional Japanese dishes, as a dressing or a flavour component in cooked dishes.

NEED

The sea mullet *(Mugil cephalus)* is a major fishery within Queensland and New South Wales. The catches are one of the largest for any commercially caught species in both states with total catches of about 2000 tonnes in QLD and 3500 tonnes in NSW.

Of the available fish, approximately 65% are targeted pre-spawning for roe / melt. The roe is sold as fresh, frozen or dried to produce karasumi. With an increase in the quantity of roe available, up to 3 fold in NSW over the last 15 years, and the down turn in the Asian economy the beach price of roe is said to fall dramatically and could drastically effect the mullet fishing industry as a whole. The development of additional value added products may increase demand supporting the beach price and adding profitability to second grade material.

At present large quantities of mullet roe are receiving only a fraction of their potential value. If new markets could be created for the excess and second grade material (those of poor quality or unwanted size) then the industry as a whole should benefit.

The beach price for roe mullet has dropped from $6 - $7 per Kg in the 1998 season to $3 - $5(Aus) per Kg this season (1999). The price for fresh roe (first grade) has dropped from $42 - $44(Aus) per Kg last season to around $30 per Kg this season with second grade product selling for around $15 per Kg. By value adding, the smoked karasumi is expected to fetch approximately $110-$120(Aus) per Kg and the karasumi in sauce around $70 (Aus) per Kg. (sale price from manufacturer). Even with a loss of about 30% weight during production the expected increase in value is considerable.

BENEFITS

The direct benefits will be most noticeable to the processors who can value add second grade product valued at about $15(Aus) per Kg to an expected on sale of $70(Aus) per Kg, or excess first grade material valued at $30(Aus) per Kg to an expected on sale price of $110(Aus) per Kg.

Fishermen may also become direct beneficiaries with poor quality roe becoming saleable.

Other benefits would be to the export and domestic (retail) sectors having additional products available for sale.

An estimate of 80% to QLD and 20% to NSW was calculated on the basis that a large quantity of the NSW catch is sold to QLD processors which a portion is then on sold or contracted out to specialist manufacturers of karasumi.

PROJECT OBJECTIVES

SMOKED KARASUMI

1. To evaluate packaging and develop a process for smoking karasumi
2. To produce a smoked karasumi product suitable for domestic and export market.
3. To determine the shelf life of the smoked karasumi
4. To launch a smoked product onto the domestic and export market.

KARASUMI IN SAUCE

1. To evaluate packaging and develop a process for manufacturing a karasumi in sauce
2. To produce a karasumi in sauce product
3. To determine the shelf life of the karasumi in sauce product
4. To launch the karasumi in sauce product onto the market

METHODS

SMOKED KARASUMI

Stage 1 Background Information

> Conduct a literature search to obtain the latest information on smoked roe products, the cold smoking process and smoking equipment.

> Source/obtain smoked roe samples from other fish species for assessment and analysis. This will include analysis of the water activity, moisture content, pH, salt and sensory assessment.

> Source various sawdusts and pre-smoking products/ingredients for trials. The purchase of ingredients including karasumi is to be supplied by *Karasumi Australia*

> Compile a list of smoke oven suppliers and equipment. Evaluate machinery for purpose.

> Purchase/lease/commission of smoke oven. This step will be undertaken by *Karasumi Australia*.

Stage 2 Formulation Development

The development of products shall be conducted at *Karasumi Australia's* processing plant utilising their smoke oven.

> Trial various combinations of sawdusts and pre-smoking treatments to produce a range of colour and flavour profiles.

- Assess the colour, aroma, texture and flavour of each of the above products.
- Optimise the colour and flavour profile of the product(s).
- Analyse samples for water activity, moisture content, pH, salt content, and sensory analysis.

Stage 3 Market Research

Properly conducted market research is an invaluable tool for reducing the risk that the product will not satisfy your customer's requirements. Market Research is planned to include a consumer acceptance panel using approximately 50 Japanese nationals to evaluate the products.

This market research was conducted by the Sensory Evaluation group at the Centre for Food Technology in February 2000.

The results of the market research indicated that fine tuning of the product is required. Reformulation work was undertaken as part of this development project.

After completion of the consumer acceptance panels and any possible reformulated product were sent to Japanese buyers and local Japanese restaurants for test marketing and feedback. This step was conducted by *Karasumi Australia*

Stage 4 Packaging

- Evaluation of various barrier films for vacuum sealing.

  NOTE: The design of the inner bag and outer carton commenced at the beginning of development process and will be conducted by *Karasumi Australia*.

Stage 5 Production Trial

- Scale up production to produce samples under a full process environment.
- Assess and analyse production sample against selected product.
- Document the manufacturing procedure.

Stage 6 Shelf Life Evaluation Using Production Trial Samples

Using samples from the production trial at *Karasumi Australia* the shelf life was assessed at the chilled temperature of 4°C and the abuse temperatures of 10°C. Analysis was conducted on a monthly basis for up to 12 months or until product was deemed unfit for purpose.

- Initial analysis included moisture content, pH, water activity, yeast and moulds, standard plate count, coagulase positive staphylococcus, anaerobic bacteria and sensory assessment

- Monthly microbiological analysis of the karasumi included standard plate count, coagulase positive staphylococcus and enterobacteriaceae.

Stage 7 Final Report

Includes all of the technical and relevant marketing information for the development of this product.

KARASUMI IN SAUCE

Stage 1 Background information

- Source samples from Japanese partner of similar products for evaluation and analysis. This will include analysis of water activity, moisture content, pH, salt content, acidity and sensory assessment. Samples to be obtained by *Karasumi Australia.*

- Consult the Australian New Zealand Food Standards Code to determine the legal constraints of the product.

- Evaluate equipment requirements for karasumi in sauce processing.

Stage 2 Formulation Development

The development activities included,

- Trialing various combinations of ingredients to produce the sauce.

- Assessing the colour, aroma, texture and flavour of the initial prototypes. This was done in collaboration with staff from *Karasumi Australia.*

- Analysis of samples for water activity, moisture content, pH and salt content.

- Scale up for pilot production at *Karasumi Australia's* factory.

Stage 3 Packaging

The current packaging, 100ml hexagonal glass jars with screw top lid, (H1036, 100ml 53 mm twist with 5391 lids) are the preferred packaging material for the Japanese market. No other packaging style was evaluated. The design of the packaging was accepted from the beginning of the trial work.

Stage 4 Production Trial

> Scale up production to produce samples under full process environment.
> Assess and analyse production sample against selected product.
> Product from the production trial to be microbiologically analysed.

Stage 5 Shelf Life Evaluation Using Production Trial Samples

> Using samples from the production trial at *Karasumi Australia*, the shelf life shall be assessed at the chilled temperature of 4°C and the abuse temperatures of 10°C. Analysis to be conducted on a monthly basis for up to 12 months or until product is deemed unfit for purpose.

> Initial analysis to include moisture content, pH, water activity, standard plate count, anaerobic bacteria and sensory assessment

> Analysis for pathogens including coagulase positive Staphylococcus to be assessed at the initial stage and at the end of the trial.

Stage 6 Commercial scale up

Commercial scale up of the karasumi in sauce to occur when a satisfactory product has been achieved in the pilot scale stage.

RESULTS AND DISCUSSION

SMOKED KARASUMI

Stage 1: Background Information

Literature Search

The smoking of fishery produce has been around for centuries and was originally used as a preservation mechanism for the extended storage of products without refrigeration. Traditionally this method of preservation served as a means of storage of a fisherman's surplus catch for consumption at a later date or during periods of scarce food supply.

The preservation effect of smoking on fishery produce is said to be due to a combination of the following four factors:

- Surface drying, which provides a physical barrier to the passage of micro-organisms.
- Salting, which reduces Aw and inhibits the growth of many spoilage organisms and pathogens.
- Deposition of phenolic anti-oxidant substances which delays the autoxidation of the highly saturated fish lipids.
- Deposition of antimicrobial substances such as phenols, formaldehyde and nitrites. (Hall, 1997)

Traditionally, fishery products were preserved by heavy salting, thoroughly dried and heavily smoked (sometimes for up to 3 weeks). These days however refrigeration technology has reduced the need for harsh curing and modern smoked fish products are thus salted, dried and smoked more lightly. (Dillon, Patel and Martin, 1994).

Apart from the chemical action of smoking, consumers have acquired a taste for smoked fish products and marketing opportunities have developed for products such as kippers, smoked oysters, smoked salmon and smoked cod. These products enjoy a healthy consumption in many parts of the world because of their unique flavour and colour produced from the smoking process.

Two basic smoking procedures are used today, hot smoking and cold smoking. The difference between the two techniques is the temperature at which the smoking occurs. Cold smoking uses temperatures below 30^{o}C while hot smoking uses a temperature of around 70^{o}C. (Dillon, Patel and Martin, 1994)

The smoke itself is produced through the burning of wood in the form of sawdust or woodchips. The flavours and colours imparted to the fish products are dependent of the types of wood used. Some of the types of wood sources seen as producing acceptable smoke are Beech, Maple, Oak, and Hickory. (Dillon, Patel and Martin, 1994)

Hardwoods are the preferred timbers as they impart milder flavours, while other woods such as hickory are used to impart specific flavours.

Recent advancements in fish smoking has seen the development of the following areas including:

- The use of other ingredients to impart specific flavours such as spices, pepper, lemon peel and juniper berries.
- The treatment of products with liquid smoke.
- The use of pickle injectors for brining the fish prior to smoking.
- Packaging methods such as vacuum and modified atmosphere packaging. (Dillon, Patel and Martin, 1994)

Advancements in smoking technology will continue to change some of the processes used in industry. However, the historical base and the consumer acceptance on which the industry was built will ensure traditional and tested methods of smoking will remain.

Commissioning

The first step in the production of a smoked karasumi product was the commissioning of the smoke oven. The oven was built by contractors at the request and to the specifications of *Karasumi Australia*. A picture of the oven is shown in Appendix 7.

Commissioning of the oven required the establishment of the processing conditions needed for both hot and cold smoking. A one and two hour smoking cycle was set up and the temperature inside the kiln monitored using an Anritsu AM-7001 data collector. The goal of this stage was to monitor the temperature stability of the oven during the burning of the sawdust or woodchips. The following specifications for both hot and cold smoking during the commissioning were established:

Thermostat set temperature

For hot smoking, the thermostat was set on 70^{o}C. Depending on the climate of the surrounds the oven required at least 1 hour to reach this temperature.
For cold smoking, the thermostat was set on 10^{o}C. This low thermostat temperature produced a room temperature of between 25^{o}C and 35^{o}C. The heat for cold smoking comes predominantly from the burning of the woodchips and not from the internal heating elements within the oven. Hence the thermostat which controls the heating element is kept at a very low temperature.

Quantity of wood chip

The fire box, which holds the woodchips, was filled with 200g of woodchips that produced enough smoke for approximately 1 hour.

Chimney Damper

For both the hot and cold smoking the damper in the kiln's chimney was kept fully open.

Internal Oven fans

The smoke oven has two mechanical fans on the back wall of the oven which circulate the heat and smoke throughout the oven. Both these fans were switched on during the smoking process.

Stage 2: Formulation Development

This step involved investigating three main parameters:

1. The variety of smoking woods available.
2. The length of the smoking cycle.
3. The water activity of the karasumi prior to smoking.

The following wood chips were sourced for smoking trials, Hickory, Red Cedar, and Tasmanian Oak. Other timbers such as Cyprus, hoop pine and hardwood were also sourced, however these were not recommended for use by Dillon, Patel and Martin (1994) and so were not trialed. The three woods selected were used to smoke a small sample (6 pieces) of karasumi to determine the colour, aroma, and flavour characteristics of the different woods and their suitability for further production trials.
All three woods were trialed using a 1hour cold smoking cycle. The results are shown below:

Table 1: Comparison of wood samples

Wood	Colour	Flavour and Aroma
Hickory	Minimal colour change to karasumi.	Strong, well rounded smoke flavour and aroma.
Red Cedar	Minimal colour change to karasum*i*	Mild smoke aroma, stronger smoke flavour
Tasmanian Oak	Minimal colour change to karasumi	Mild smoke aroma, stronger smoke flavour.

The Hickory wood chips were selected from this trial based on the strong smoke aroma imparted to the karasumi. This strong initial aroma is important as the first impression given to the consumer when the pack is opened. The Hickory wood smoke also produced a milder smoke taste than the other two woods trialed. The flavour was sweeter and less harsh and was selected also on this basis.

The second step in establishing the processing parameters was the trialing of different smoking times and temperatures using the Hickory wood chips as selected from the first set of trials.

Table 2: Comparison of smoking times & temperatures

Smoking parameters	Product characteristics
1Hour, Cold smoke	Strong smoke aroma, medium smoke flavour. Colour unchanged.
2Hour, Cold smoke	No noticeable difference in smoke flavour and aroma from 1hr cold smoke. Colour unchanged.
1Hour, Hot smoke	Mild smoke aroma, stronger smoke flavour. Karasumi firmer than cold smoked sample. Some darkening of karasumi.
2Hour, Hot smoke	No noticeable difference in smoke flavour and aroma from 1hr hot smoked sample. Karasumi had a firm, dry outer surface with some darkening of the karasumi.

The development of these four processing methods all produced an acceptable smoke karasumi product. The next step was the shelf life determination of these 4 processes to establish the best method both microbiologically and by sensory analysis.

The water activity of the karasumi coupled with the high salt content and the refrigerated storage give this product in the unsmoked version a shelf life of over 12 months. The average chemical analysis of unsmoked karasumi is:

Water Activity = 0.84 - 0.86
Salt = 3.5% - 4.5%
Moisture = 25% - 27%

These specifications are reached after 4 days sun drying (depending on the weather). To allow for the drying effect of the smoking process the karasumi selected for smoking is sun dried for a period of only 2 or 3 days. At this stage the karasumi has a water activity of between 0.90 and 0.88. The karasumi is then smoked and dried to a final water activity the same as the unsmoked product.

Stage 3: Marketing

The market acceptability of the smoked karasumi product developed was determined using consumer acceptance testing conducted at the Centre for Food Technology's Sensory and Consumer Science Unit. A panel of forty-two (42) Japanese people who consume karasumi were recruited to assess the karasumi for acceptability of appearance, odour, texture, flavour and overall liking. The consumer research was conducted over two days in February 2000. The executive summary from the consumer testing is attached to this final report. (see appendix 10)

Stage 4: Packaging

The current packaging of unsmoked karasumi uses a pouch made of high barrier material from Cryovac –Sealed Air. The specifications for this pouch are shown below:

Product Description:	RA 454 – PVDC coated nylon plain pouch
Material:	176251
Size:	110 x 230mm
Oxygen Permeability:	5cc per sqm per 24hrs @ 23°C and 70%RH
Moisture Vapour Transmission rate:	10g per sqm in 24hrs @ 23°C and 70%RH
Gauge:	67 microns

The high barrier to oxygen prevents the ingress of oxygen into the pack and thus slows the onset of oxidation of the lipids and the spoilage by micro-organisms. This material is of very high quality and any other materials would provide only similar or more likely lower barrier properties. It was thus decided to continue to use the barrier film from Cryovac (Sealed Air) already in use for the karasumi for the smoked karasumi product.

Stage 5 and 6: Production Trials and Shelf Life determination

From the initial work done to establish the parameters for the smoking of karasumi the following production trials were conducted.

1. Hickory wood 1 hour Cold smoke
2. Hickory wood 2 hour Cold smoke
3. Hickory wood 1 Hour Hot smoke
4. Hickory wood 2 Hour Hot smoke

The 4 trials were each conducted under set conditions 5 different times. (5 replicates). Each of the replicates consisted of a different batch of mullet roe or karasumi. The results of the microbiological and chemical analysis of these trials are shown in appendix 3.

The process for all replicates is listed below;

1. Approximately 24-30 pieces of karasumi were placed on the middle wire rack of the smoke oven.
2. 200g of hickory wood chips were weighed into the fire box.
3. The thermostat set temperature was programmed in.
4. The ovens fire box heating element was turned to full.
5. The two fans in the oven were turned on.
6. The chimney damper was fully open.
7. After 1hour the karasumi was removed if a 1 hour smoking cycle was required, or another 200g of wood chips are added to the fire box if a 2 hour smoking cycle is required.
8. The pieces of karasumi are then transferred to a 0°C chiller for a period of 30min.
9. The karasumi is then vacuum packed and returned to the chiller for storage.

To determine the shelf life of the smoked karasumi, the samples produced from the 5 replications were stored at 4°C and 10°C. These samples were then tested at 3 monthly intervals to determine their microbiological acceptability. The results of the shelf life trials are shown in appendix 9.

It is clear from these results that the shelf life of smoked karasumi when stored in a high barrier vacuum bag at 4°c has a microbiological shelf life of at least 9 months. Growth of anaerobic and coagulase positive staphylococcus organisms was minimal throughout the storage life of the smoked karasumi.

The sensory aspects of the smoked karasumi were also tested every month during the storage life trial. The results are shown below:

Table 3: Sensory Evaluation of Smoked Karasumi

Treatment	3 Months	6 Months	9 Months
1hr Hot Smoke, 2°c	Good aroma, mild smoke aroma - 5	Fishy aroma, very mild smoke aroma - 5	Stale fishy aroma, minimal smoke aroma - 3
1hr Hot Smoke, 10°c	As above - 5	As above - 5	As above - 3
2hr Hot Smoke, 2°c	Aroma good, moderate smoke aroma - 7	Fishy aroma, moderate smoke aroma - 7	Fishy aroma, mild smoke aroma - 5
2hr Hot Smoke, 10°c	As above - 7	As above - 7	As above - 5
1hr Cold Smoke, 2°c	Aroma good, mild smoke aroma - 6	Very mild smoke aroma - 6	Stale aroma, minimal smoke aroma - 4
1hr Cold Smoke, 10°c	As above - 6	As above - 6	As above - 4
2hr Cold Smoke, 2°c	Fresh seafood aroma, moderate smoke aroma - 8	Fresh seafood aroma, moderate smoke aroma - 8	Aroma quite fresh, mild smoke aroma - 7
2hr Cold Smoke, 10°c	As above - 8	As above - 8	As above - 7

The smoked karasumi samples were assessed for aroma and smoke aroma strength and rated out of ten. (1-5 unacceptable, 6-10 acceptable)

The 2 hour smoking process (hot and cold) was found to produce acceptable smoke aroma up to the 9 month period. The 1 hour smoking process (hot and cold) produced only mild smoke aroma initially. This aroma only diminished further over time until it was virtually undetectable and therefore unacceptable. The 2 hour cold smoked process was selected based on the fresher overall aroma of the karasumi compared to the hot smoke samples. An achievable shelf life of the 2 hour cold smoked karasumi is 9 months.

Commercial scale up

The development of a cold smoked karasumi product using hickory has resulted in the launch of the product by Karasumi Australia into the domestic duty free market. A photo of the retail product is shown below. Commercial quantities of the smoked karasumi are currently being manufactured using the method developed in this work. Further dissemination of the positive findings of the consumer research on the smoked karasumi to Japanese buyers, will provide the impetus for this product to expand further into export markets.

Finished product
Smoked Karasumi

KARASUMI IN SAUCE

Stages 1 & 2: Background Information and Formulation Development

Sliced karasumi in oil is currently made in restaurants by chefs but is not available through retail outlets. This is a new to the market product and consequently information on karasumi sauces/ pastes including processes, ingredients, recipes and expected shelf life is unavailable. However, the industry partner, Mrs Ishikawa, was able to describe the type of product she wanted made, although samples from Japan were not available. The original concept was described as a sliced karasumi product on olive oil, flavoured with salt, basil and garlic.

Preliminary storage trials of some initial product formulations proved the fact fresh basil would be unsuitable because of discolouration during storage (enzyme action causes fresh basil to brown over time). Consequently other sources of basil were located and used in subsequent formulations.

A meeting at the Centre for Food Technology was held on the 19th March 1999 and the following two prototypes were presented to Mrs Ishikawa and Mr Jim Flourentzou:

1. Sliced karasumi with sliced fresh garlic
2. Sliced karasumi with crushed garlic

Both samples were prepared using commercially available olive oil with dried basil and added salt.

The garlic was liked in both the sliced and the crushed forms. However, the appearance of the sliced garlic appealed more to Mrs Ishikawa. It was requested that only fresh garlic be used, and at a lower level than the prototype presented ie reduce it from 3 g per jar to 1 g per jar as the flavour will develop over time.

Initial trial samples of the karasumi in sauce were stored at room temperature (20°C). Over time (4 months) the samples became unattractive due to the darkening of the oil and the discolouration of the pieces of karasumi. At a later meeting with Mrs Ishikawa it was discovered the product would be likely stored at refrigeration temperatures (4°C) at retail level. All further storage trials from this point were conducted at 4°C.

The discolouration of the basil appeared to be the biggest hurdle for the acceptable appearance of the karasumi in sauce. A freeze dried basil and a dried basil were sourced from two suppliers and formulations of both were made up and stored at 4°C. The results of the trial after 1 month are shown below:

Table 4 : Trial of two different types of Basil

Type of Basil	Supplier	Appearance after 1 month @ 4°C
Freeze Dried	Cooke Aromatics	Basil has retained a superb colour, almost fluorescent green.
Dried	Wiberg	Basil has changed to a black colour resembling pieces of black pepper. Unacceptable.

NB: Trial samples both made with canola oil, fresh garlic and salt.

The freeze dried basil from Cooke Aromatics was selected for all further trials based on the results of this trial.

The microbiological stability of the karasumi in sauce required the use of many hurdles to prevent the growth of pathogenic micro-organisms, principally S.aureus during 6 months of storage. One of these was pH or the acidity of the sauce which required the reduction in the pH to around 4.0. A reduction in the pH would provide another hurdle to prevent the growth of pathogenic micro-organisms. A trial was set up to determine the effect of the acidified oil on the sliced karasumi.

Table 5: pH of three different oil mixtures

Trial	Oil Component	pH of the oil*
A	Standard canola oil (non acidified)	4.4
B	Standard canola oil acidified with acetic acid	3.0
C	Commercial Italian salad dressing	1.7

* pH of the oil prior to addition to the karasumi.

Sample jars of the karasumi in sauce were produced with the three different oil components listed above. After an equilibration time of 72hours the following chemical tests were conducted.

Table 6: Chemical results of the three sauces after 72hrs

Trial	pH*	Aw	Salt (%)
A	4.6	0.78	2.7
B	4.4	0.77	3.2
C	3.8	0.88	6.3

- Equilibrated pH conducted on a combined oil and karasumi sample.

After 2 weeks storage of the samples at 4°C, both trial B and trial C showed significant discolouration of the sliced karasumi in the oil. The bright orange colour of the karasumi had been bleached to produce a product that was almost milky white in colour. The low pH of the two oils used in trial B and C (pH 3.0 and pH 1.7) appears to have had an instant bleaching effect on the karasumi when first added. The importance of the colour of the karasumi to the Japanese consumer has meant the acidification of the oil was cannot be used as a processing option. All future trials used standard canola oil (non-acidified) as the preferred medium.

Stage 3: Marketing

The market acceptability of the karasumi in sauce is dependent on the ability of the product to meet the requirements of the industry partner. A refrigerated sliced karasumi in oil with a shelf life of 6 months was determined as the minimum criteria for the product at the outset of the project. As a potential export product a relatively long shelf life is required to allow for the shipping and distribution of the product to Japanese markets. This report shows that the shelf life of 6 months is unattainable due to the microbiological risks associated with the production of the product. These findings therefore prevent the launch or marketing of the karasumi in sauce product in its current format.

Stage 4: Packaging

The karasumi in sauce was presented in 100g hexagonal glass jars and this packaging style was immediately approved by Mrs Ishikawa for the product as being suitable for her market in Tokyo. All further shelf life studies were conducted in these jars.

Stage 5: Production trial

To test the concept of the karasumi in sauce product using the formulation development work already conducted a small production trial was undertaken. The formulation used in the production trial is shown below:

Table 7: Karasumi in Sauce final formulation

Ingredients	Grams per Jar
Sliced Karasumi	20
Freeze Dried Basil	0.5
Sliced fresh Garlic	1.0
Salt	1.5
Canola Oil	55

The production method used for the trial to establish the shelf life of the karasumi in sauce is outlined below.

1. Ensure all surfaces are sterile and area is clean, and food handlers gloves are worn during slicing and weighing out of individual ingredients.
2. Weigh basil and salt into bottles.
3. Using sanitised utensils and clean surface (and gloves), peel garlic and slice thinly.
4. Using separate sterile utensils and surface (and gloves), slice karasumi thinly across the width of the roe.
5. Weigh garlic and karasumi into bottles.
6. Push ingredients down past the neck of the bottles.
7. Heat canola oil to 100ºC. .
8. Pour hot oil into the bottles. Scale at 55g, or to the bottom rim of the neck of the bottle.
9. Immediately as oil has been poured into the bottle, lid and invert.
10. Shaking contents of bottle may be required while inverted.
11. Store refrigerated.

Stage 6: Shelf Life Trials

To determine the shelf life of the karasumi in sauce, sample jars of the product from the production trial were stored at 4°C. After initial microbiological testing the samples were retested at 2 weeks, 1 month, 2 months and 3 months.

Table 8: Microbiological results of shelf life trial 1.

Storage Temp.	Micro. Test	Initial (time 0)	2 weeks	1 month	2 months	3 months
4°C	Standard Plate Count	>1 000 000	<100	<100	400 000	<100
4°C	Anaerobic count	>1 000 000	600	<100	>25 000	<100

To confirm the microbiological safety of the karasumi in sauce a replicate shelf life trial was conducted. Exactly the same process was used to produce the samples as in trial 1. The samples were stored at both 4°c and 10°c.

Table 9 : Microbiological results of shelf life trial 2.

Storage Temp.	Micro. Test	Initial (time 0)	72 hrs	2 weeks	1 month
4°C	Standard Plate Count per gram	84 000	2200	34 000	15000
4°C	Anaerobic count per gram	45 000	1000	500	200
10°C	Standard Plate Count Per gram	NA	250 000	73 000	250 000
10°C	Anaerobic count per gram	NA	22 000	5500	>25 000

The microbiological results from the two shelf life trials conducted on the karasumi in sauce indicate a wide variability in the level of microbiological presence. The inconsistency in the anaerobic and standard plate counts indicate different levels of growth in each of the jars sampled. The relatively high numbers of organisms (250 000 per gram) in some samples shows the potential for growth of micro-organisms in this product and the risks associated with its production. Without the ability to hot fill the complete mix with an acidified pH the microbiological stability of this product is compromised.

FURTHER DEVELOPMENT

SMOKED KARASUMI

1. Further development should include wider dissemination of the results of the consumer acceptance testing of the smoked karasumi. The results of this research show strong evidence of the potential success of this product to export customers. The results of the research conducted on the smoked karasumi indicate a strong liking for the smoked karasumi product, even above the current non smoked product. This evidence may increase the already steady growth of the product in the domestic duty free market by expanding sales in export markets, particularly Japan

KARASUMI IN SAUCE

2. The inability to provide a microbiologically sound production method for the karasumi in sauce in the time frame of this project, means further development is required to bring this product to commercialisation. Investigation into significant capital investment processing methods such as hot filling or canning may produce an acceptable product. These method would however come at a cost above the scope of *Karasumi Australia*. Several processing alternatives have been investigated in this project, and the successful launch of a karasumi in sauce product may require significant changes to the original product and packaging concept.

CONCLUSION

SMOKED KARASUMI

This research has successfully met the project objectives by developing a process for the production and packaging of a smoked karasumi product suitable for both the domestic and export market. After significant production trials the method developed consisted of a two hour cold smoking process using hickory wood. This process imparted a delicate smoke flavour with a strong aroma to the karasumi. The shelf life of the smoked karasumi in a vacuum pack under refrigerated storage has been proven to be at least 9 months. After this time the smoke aroma of the karasumi has greatly diminished.

Successful sensory testing of the smoked karasumi using Japanese consumers has shown the overall liking of the product above the non-smoked karasumi. All attributes including aroma, flavour, appearance, texture and overall acceptability scored higher than its non-smoked counterpart. Based on these results no further changes to the product and process are required.

This research has shown that the smoking process does not successfully disguise the darkest colour ranges or most heavily marked karasumi even after a 2 hour smoking cycle. The dark colour of karasumi grades 5 and 6 (appendix 6) cannot be sufficiently altered by a smoking process to make the appearance of this type of roe acceptable to the customer. The process of wood smoking in a smoke oven has limited scope in the value adding to roe of the grades 5 and 6. Wood smoking of the karasumi does however impart an excellent smoke flavour and aroma to roe of the higher grade (grades 1, 2 and 3 in appendix 6). These grades of roe are best suited for producing premium quality smoked karasumi for the export market.

Although this project did not develop a smoked product utilising roe from grades 5 and 6, a smoked karasumi product was launched onto the market. Based on the consumer acceptance findings, this product can be utilised as a line extension to non-smoked karasumi and has growth potential as such.

KARASUMI IN SAUCE

The original concept brief of a karasumi in sauce product as outlined by Ishikawa Enterprises appeared at the outset to be quite simple. The product was to be a thinly sliced karasumi in oil with garlic, salt and basil with a minimum 6 month shelf life at refrigeration temperatures. Development work involved sourcing an appropriate dried basil that would maintain its colour during storage. The selection of a suitable basil and further recipe development produced an attractive product with excellent taste, which was approved by Ishikawa Enterprises.

Process development was conducted simultaneously with the recipe development, at all times keeping in mind the microbiological safety of the product. Several microbiological hurdles were trialed including hot oil at 100°c, acidification of the oil, low water activity, and refrigerated storage of the finished product.

After an acceptable process was developed a series of 2 shelf life trials were conducted to test the microbiological safety of the process. Results of these trials showed the inability of the process to adequately ensure the microbiological safety of the product. The growth of both aerobic and anaerobic organisms in numbers above 250 000/g proves the ineffectiveness of the process to prevent the growth of micro-organisms in the first 2 months of storage.

This project has developed a karasumi in sauce product utilising broken roe that has an excellent appearance and taste. The inability to develop a microbiologically sound processing method for this product has however prevented its commercialisation as an export product. The further development of a karasumi in sauce may require a complete change in the original brief to allow different manufacturing processes to be investigated.

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Hall, G.M.(ed), "Preservation of fish by curing" 1997, in *Fish Processing Technology*, Blackie Academic & Professional, London.

APPENDIX 1: PROJECT STAFF

The principal investigator of this project would like to thank the following people for their invaluable assistance on this project:

Jim Flourentzou	Managing Director *Karasumi Australia*
Jim Demetriou	Production Manager *Karasumi Australia*
Chris Gore	Assistant Senior Laboratory Technician Centre for Food Technology
Laureen Bond	Food Technologist Centre for Food Technology
Janette McDonald	Team Leader Product and Process Development Centre for Food Technology

APPENDIX 2: INGREDIENT SUPPLIERS

Suppliers of 10Kg bags of Hickory Wood Chips

Smo-King Ovens
4/26 James St
Lidcombe, NSW, 2141
Ph: 02 9649 7322
Fax: 02 9649 6187

Suppliers of glass jars for karasumi in sauce

Cospak (Qld) Pty Ltd
917 Beaudesert Road
Coopers Plains Qld 4108
Ph 07 3274 3833
Fax 07 3274 3112

Suppliers of Freeze Dried Basil for karasumi in sauce

Cooke Aromatics Pty Ltd
67 Thorn Street
Pennant Hills NSW 2120
Ph 02 9980 8066
Fax 02 9980 8371

APPENDIX 3: TABLES OF RESULTS

SMOKING TRIALS
REPLICATIONS 1 - 5 (Initial Results - Time 0)

Each trial consisted of samples of karasumi subjected to Hickory Cold Smoke for 1 & 2 hours respectively (A & B) and samples of karasumi subjected to Hickory Hot Smoke for 1 & 2 hours (C & D) respectively
The control sample is unsmoked.

Initial results
Trial K5 1

Test \ Replicate	K5A1	K5B1	K5C1	K5D1	K5 1 Control
Standard Plate Count Per gram	<100	<100	80 000	<100	A 800 B 3500
Yeasts & Moulds Per gram	<100	<100	<100	<100	A <100 B <100
Peroxide Value Meq peroxide/ kg oil	Nil	Nil	Nil	Nil	Nil Nil
Moisture % per 100g	28.9	26.5	27.1	23.1	26.2
Water Activity	0.90	0.89	0.89	0.82	0.86
Salt % per 100g	2.7	2.7	2.8	4.1	3.5

Initial results
Trial K5 2

Test \ Replicate	K5A2	K5B2	K5C2	K5D2	K5 2 Control
Standard Plate Count Per gram	300	1500	14 000	<100	A 1100 B <100
Yeasts & Moulds Per gram	<100	<100	<100	<100	A <100 B <100
Peroxide Value Meq peroxide/kg oil	4.4	2.9	Nil	4.6	A Nil B 18.1
Moisture % per 100g	29.9	29.8	29.1	28.8	A 27.8 B 30.1
Water Activity	0.90	0.90	0.90	0.89	A 0.87 B 0.91
Salt % per 100g	3.3	3.1	3.0	3.1	A 3.9 B 2.8

Trial K5 3
Initial results

Test \ Replicate	K5A3	K5B3	K5C3	K5D3	K5 3 Control
Standard Plate Count Per gram	800	200	100	600	A 3200 B 6300
Yeasts & Moulds Per gram	<100	<100	<100	<100	A <100 B <100
Peroxide Value Meq peroxide/kg oil	Nil	7.6	Nil	6.0	A Nil B Nil
Moisture % per 100g	28.1	31.3	27.7	28.6	A 29.2 B 30.0
Water Activity	0.90	0.90	0.90	0.88	A 0.90 B 0.90
Salt % per 100g	2.8	3.4	3.4	3.2	A 3.2 B 3.1

Trial K5 4
Initial results

Test \ Replicate	K5A4	K5B4	K5C4	K5D4	K5 4 Control
Standard Plate Count	<100	4000	<100	1800	A 30 000 B 100
Yeasts & Moulds	<100	<100	<100	<100	A <100 B <100
Peroxide Value	Nil	Nil	10.0	Nil	A 3.0 B 3.4
Moisture	29.4	29.2	27.8	27.0	A 32.1 B 30.9
Water Activity	0.90	0.90	0.88	0.88	A 0.92 B 0.90
Salt %	3.1	3.3%	3.3%	3.3%	A 3.2% B 2.7%

Trial K5 5
Initial results

Test \ Replicate	K5A5	K5B5	K5C5	K5D5	K5 5 Control
Standard Plate Count Per gram	200	3400	2200	<100	A 1000 B 180 000
Yeasts & Moulds Per gram	<100	<100	<100	<100	A <100 B <100
Peroxide Value (meq peroxide/kg oil	Nil	Nil	4.1	Nil	A 7.2 B Nil
Moisture % per 100g	30.7	29.7	30.7	27.0	A 29.4 B 29.6
Water Activity	0.92	0.91	0.92	0.89	A 0.91 B 0.91
Salt % per 100g	2.5	2.5	2.8	2.9	A 2.5 B 2.9

APPENDIX 4: TABLE OF CHEMICAL RESULTS

SMOKING TRIAL

Initial results - July 1999
Peroxide Value (meq peroxide /kg oil)

Trial / Sample	K5 1	K5 2	K5 3	K5 4	K5 5
Unsmoked A	Nil	Nil	Nil	3.0	7.2
B		18.1	Nil	3.4	Nil
Cold Smoke 1 hr	Nil	4.4	Nil	Nil	Nil
Cold Smoke 2 hrs	Nil	2.9	7.6	Nil	Nil
Hot Smoke 1 hr	Nil	Nil	Nil	10.0	4.1
Hot Smoke 2 hrs	Nil	4.6	6.0	Nil	Nil

3 Months Storage – October 1999
Peroxide Value – (meq peroxide/kg oil)

Trial / Sample	K5 1	K5 2	K5 3	K5 4	K5 5
Cold Smoke 1 hr 2°C (A)	2.5	2.3	1.6	Nil	2.9
Cold Smoke 1 hr 10°C (A)	Nil	2.5	Nil	Nil	Nil
Cold Smoke 2 hrs 2°C (B)	3.5	6.2	6.4	7.1	Nil
Cold Smoke 2 hrs 10°C(B)	2.3	2.3	Nil	Nil	Nil
Hot Smoke 1 hr 2°C (C)	8.8	6.9	3.3	Nil	Nil
Hot Smoke 1 hr 10°C (C)	Nil	3.1	Nil	3.7	Nil
Hot Smoke 2 hrs 2°C (D)	0.8	3.5	1.3	4.4	Nil
Hot Smoke 2hrs 10°C(D)	2.1	Nil	Nil	3.6	Nil

6 Months Storage- January 2000
Peroxide Value – (meq peroxide/kg oil)

Trial / Sample	K5 1	K5 2	K5 3	K5 4	K5 5
Cold Smoke 1 hr 2°C (A)	9.7	2.8	2.2	4.9	Nil
Cold Smoke 1 hr 10°C (A)	7.0	1.8	Nil	2.3	Nil
Cold Smoke 2 hrs 2°C (B)	11.3	4.0	5.6	7.7	4.0
Cold Smoke 2 hrs 10°C(B)	4.1	1.1	5.1	3.3	Nil
Hot Smoke 1 hr 2°C (C)	9.9	2.3	5.1	4.6	Nil
Hot Smoke 1 hr 10°C (C)	2.0	3.8	3.6	Nil	Nil
Hot Smoke 2 hrs 2°C (D)	6.3	3.1	Nil	5.6	Nil
Hot Smoke 2hrs 10°C(D)	3.3	2.8	Nil	2.4	Nil

9Months Storage – April 2000
Peroxide Value – (meq peroxide/kg oil)

Trial / Sample	K5 1	K5 2	K5 3	K5 4	K5 5
Cold Smoke 1 hr 2°C (A)	2.9	Nil	4.1	8.1	2.1
Cold Smoke 1 hr 10°C (A)	1.9	Nil	2.4	2.2	Nil
Cold Smoke 2 hrs 2°C (B)	2.7	Nil	8.4	1.5	Nil
Cold Smoke 2 hrs 10°C(B)	Nil	Nil	1.9	4.6	Nil
Hot Smoke 1 hr 2°C (C)	5.6	Nil	4.2	1.4	4.6
Hot Smoke 1 hr 10°C (C)	0.8	Nil	Nil	2.9	Nil
Hot Smoke 2 hrs 2°C (D)	Nil	2.2	6.0	3.8	Nil
Hot Smoke 2hrs 10°C(D)	Nil	Nil	Nil	1.8	Nil

12 Months Storage – June 2000
Peroxide Value – (meq peroxide/kg oil)

Trial / Sample	K5 1	K5 2	K5 3	K5 4	K5 5
Cold Smoke 1 hr 2°C (A)	3.9	2.1	15.2	10.0	2.3
Cold Smoke 1 hr 10°C (A)	Nil	1.8	3.3	Nil	2.3
Cold Smoke 2 hrs 2°C (B)	2.0	2.9	4.9	2.6	Nil
Cold Smoke 2 hrs 10°C(B)	Nil	3.5	5.1	3.4	3.0
Hot Smoke 1 hr 2°C (C)	2.0	Nil	5.0	Nil	Nil
Hot Smoke 1 hr 10°C (C)	3.9	2.8	2.4	Nil	2.0
Hot Smoke 2 hrs 2°C (D)	4.9	1.3	3.3	6.0	Nil
Hot Smoke 2hrs 10°C(D)	2.1	1.4	Nil	Nil	1.5

APPENDIX 5: TABLE OF MICROBIOLOGICAL RESULTS

SMOKING TRIAL

Initial Results

Organisms per gram

Trial / Sample	K5 1	K5 2	K5 3	K5 4	K5 5
Unsmoked A	800	1 100	3 200	30 000	1 000
B	3 500	<100	6 300	100	180 000
Cold Smoke 1 hr	<100	300	800	<100	200
Cold Smoke 2 hrs	<100	1 500	200	4000	3 400
Hot Smoke 1 hr	80 000	14 000	100	<100	2 200
Hot Smoke 2 hrs	<100	<100	600	1 800	<100

3 months storage – October 1999

Organisms per gram

Trial / Sample	K5 1	K5 2	K5 3	K5 4	K5 5
Cold Smoke 1 hr 2°C (A)	SPC 99000 Staph 400 Entero <10	SPC <100 Staph <100 Entero <10	SPC 23000 Staph <100 Entero <10	SPC 400 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10
Cold Smoke 1 hr 10°C (A)	SPC 110000 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC 200 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10
Cold Smoke 2 hrs 2°C (B)	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC 200 Staph <100 Entero <10	SPC 1200 Staph <100 Entero <10
Cold Smoke 2 hrs 10°C(B)	SPC 240000 Staph <100 Entero <10	SPC <100 Staph 200 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10
Hot Smoke 1 hr 2°C (C)	SPC 16000 Staph 200 Entero <10	SPC <100 Staph <100 Entero <10	SPC 400 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10
Hot Smoke 1 hr 10°C (C)	SPC 150000 Staph 200 Entero <10	SPC <100 Staph <100 Entero <10	SPC 16000 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC 100 Staph <100 Entero <10
Hot Smoke 2 hrs 2°C (D)	SPC 100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC 200 Staph <100 Entero <10	SPC 300 Staph <100 Entero <10	SPC 100 Staph <100 Entero <10
Hot Smoke 2hrs 10°C(D)	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10

6 months storage – January 2000

Organisms per gram

Trial / Sample	K5 1	K5 2	K5 3	K5 4	K5 5
Cold Smoke 1 hr 2°C (A)	SPC 3800 Staph <100 Entero <10	SPC 600 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC 600 Staph <100 Entero <10
Cold Smoke 1 hr 10°C (A)	SPC 600 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10
Cold Smoke 2 hrs 2°C (B)	SPC 400 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC 200 Staph <100 Entero <10
Cold Smoke 2 hrs 10°C(B)	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10
Hot Smoke 1 hr 2°C (C)	SPC 32000 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC 100 Staph <100 Entero <10
Hot Smoke 1 hr 10°C (C)	SPC 14000 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC 30000 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10
Hot Smoke 2 hrs 2°C (D)	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10
Hot Smoke 2hrs 10°C(D)	SPC 100 Staph <100 Entero <10	SPC 5200 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10	SPC <100 Staph <100 Entero <10

9 months storage – April 2000

Organisms per gram

Trial / Sample	K5 1	K5 2	K5 3	K5 4	K5 5
Cold Smoke 1 hr 2°C (A)	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC 1600 Staph <100 Entero NT
Cold Smoke 1 hr 10°C (A)	SPC 3800 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Cold Smoke 2 hrs 2°C (B)	SPC 100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Cold Smoke 2 hrs 10°C(B)	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Hot Smoke 1 hr 2°C (C)	SPC 1000 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Hot Smoke 1 hr 10°C (C)	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC 19000 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Hot Smoke 2 hrs 2°C (D)	SPC <100 Staph <100 Entero NT	SPC 100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Hot Smoke 2hrs 10°C(D)	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT

12 Months Storage _ June 2000
Organisms per gram

Trial / Sample	K5 1	K5 2	K5 3	K5 4	K5 5
Cold Smoke 1 hr 2°C (A)	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC 1600 Staph <100 Entero NT
Cold Smoke 1 hr 10°C (A)	SPC 3800 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Cold Smoke 2 hrs 2°C (B)	SPC 100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Cold Smoke 2 hrs 10°C(B)	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Hot Smoke 1 hr 2°C (C)	SPC 1000 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Hot Smoke 1 hr 10°C (C)	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC 19000 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Hot Smoke 2 hrs 2°C (D)	SPC <100 Staph <100 Entero NT	SPC 100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT
Hot Smoke 2hrs 10°C(D)	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT	SPC <100 Staph <100 Entero NT

APPENDIX 6: COLOUR VARIATION OF KARASUMI

SUN DRIED KARASUMI – COLOUR VARIATION

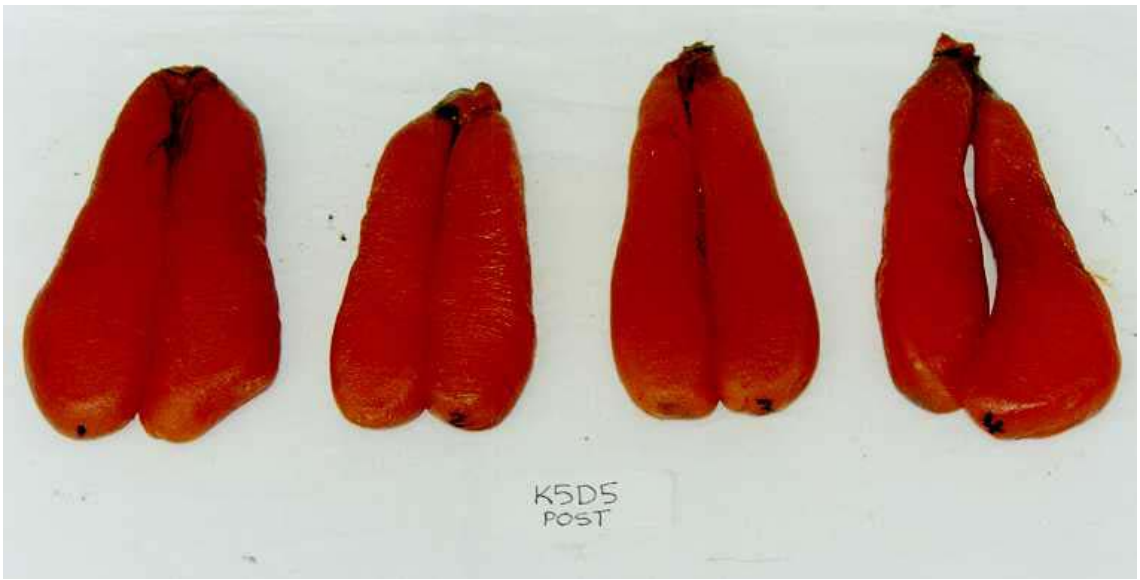
1 2 3 4 5 6

APPENDIX 7: SMOKER

APPENDIX 8: HOT SMOKE TRIAL COLOUR COMPARISONS

2 HOUR HOT SMOKE
PRE SMOKING

2 HOUR HOT SMOKE
POST SMOKING



APPENDIX 9: COLD SMOKE TRIAL COLOUR COMPARISONS

2 HOUR COLD SMOKE
PRE SMOKING

2 HOUR COLD SMOKE
POST SMOKING

APPENDIX 10: EXECUTIVE SUMMARY OF CONSUMER ACCEPTANCE

The Sensory and Consumer Science Unit at the Centre for Food Technology to investigated the consumer acceptability of two karasumi products: a new smoked karasumi product and an existing unsmoked karasumi product.

Forty-two consumers of Japanese origin who had previously eaten karasumi were recruited. The testing was completed in two sessions on the 22 and 23 February 2000. The consumers assessed the karasumi samples for acceptability of appearance, odour, texture, flavour and overall liking as well as the level of saltiness and smokiness (smoked karasumi product only).

For each sample, the consumers selected descriptors for appearance, odour, texture and flavour as well as adding any extra comments. The propensity to buy each sample was also established. In addition the consumers answered a series of demographic style questions.

Both products had high acceptability scores for appearance, odour, texture, flavour and overall liking. However, the smoked karasumi product scored consistently higher for all of these attributes. On the 'just right' scales, both products were considered to be slightly too salty and the smoked karasumi product was slightly too smoky. The results indicated that the consumers would be more likely to buy the smoked karasumi product over the unsmoked karasumi product.

Females comprised 69% of the consumers who were mostly aged between 25 and 50. Ninety-percent of the consumers had been in Australia for more than 12 months. Consumers generally eat karasumi from several times per year to once every 1-3 years. Karasumi was frequently received as a gift and eaten with beer, sake and rice. Generally, the consumers indicated that smoked karasumi was a good idea.

These results indicate that both karasumi products were well liked and could therefore have potential as export products to Japan.