

ORIGINAL: ENGLISH

Title: Processing Novel Tuna Products in the Pacific

Introduction

The Fisheries Programme's involvement in developing novel tuna processing opportunities in the Pacific now spans a period of nearly five years. The stated objective of this project is to help establish small to medium scale operations within isolated Pacific Island countries that would be income generating, provide employment and utilise the region's single most important and abundant natural marine resource: tuna.

Commercial activities of various kinds are now or have been operating for a number of years in at least three Pacific Island countries. The main product format is a marinated dried tuna which is often called Tuna Jerky. It has now become quite common to see other oceanic fish species such as marlin, swordfish and shark made into similar dried products.

This paper attempts to evaluate the achievements of the project to date, outlines the problems that have been encountered, and finally invites constructive comments as to where to focus future activities to more widely achieve its goal.

Part A - Review of project activities

Background

Tuna fisheries are of crucial importance to many Pacific Island economies and for several, one of the largest earner of foreign exchange. The annual commercial catch for tuna harvested in the SPC statistical area in 1992 was in excess of one million tonnes, of which 67% was skipjack tuna and 24% yellowfin tuna.

In the subsistence fishery, particularly on the more isolated islands, more tuna is often harvested than can be consumed that day. Much of this excess catch is given away to neighbours, relatives and friends. Some is processed by rudimentary curing methods mainly by sun drying or salting/drying. What is left over may be fed to the animals. Cured products are stored and consumed when the weather is too rough and fishing is difficult. So much of the cured fish accumulates that it is sent to relatives and friends in places where fish is less abundant. The quality and visual appeal of these cured products is usually poor, and only those who are familiar with cured fish appreciate eating them. In such communities it is rare to exchange fresh or cured fish for cash, even though fishermen have bought fuel to run an outboard engine to get out to the fishing ground and incurred other fishing related expenses.

Many isolated island communities traditionally made their living from processing copra. Copra prices on the world market have been low for many years and this is having its obvious adverse effect on the local population. Some Pacific Island countries have therefore seen the potential benefits of processing locally caught tuna as an alternative activity that could create employment, to generate revenue from a resource that in many places had no traditional cash value, and to encourage the more isolated communities to become less dependant on outside financial assistance. One of the first to take up this opportunity was Tokelau. They set up a small trial commercial tuna processing operation on one of their three atolls in October 1990 with technical assistance provided by SPC.

Tokelau atoll community post-harvest fisheries processing and marketing trial

Tokelau's tuna processing facility on the atoll of Atafu, which is called Kileva Fisheries, comprises three small buildings, each designed to carry out different functions in the processing of marinated dried tuna. The first building houses a small block ice plant and a non-refrigerated insulated store. Yellowfin tuna caught early in the morning are stored here on ice until processing is ready to start. The second building is where the fish are cut up into thin slices and the sliced meat marinated. It is also here that the dried product is cut up into its final format, sealed into retail packs and placed in cartons ready for shipment. The third building is used for storing the dried product until ready for shipping.

Natural sun-drying takes place outside, adjacent to the buildings, by placing the marinated tuna flesh on plastic mesh trays which are in turn set on table-like supports. It usually takes one full day plus half the following morning for the product to dry.

Because of Tokelau's close ties to New Zealand, the decision was taken to start the marketing trial there. These were conducted by the South Pacific Trade Office (SPTO), Auckland. It took twelve to fourteen months of continued and persistent effort before the SPTO was able to persuade a local company to place an order for 200 kg of Tokelau's Teriyaki Tuna. From January 1992 Tokelau's marinated dried tuna product appeared on the shelves of the New Zealand Produce Shop at the international airport in Auckland. It sold well for many months primarily to Japanese tourists and travelling Chinese businessmen. A second company soon displayed its interest in the product, being prepared to purchase all that Kileva Fisheries could produce. However the company required modifications to be made to the flavour of the product to meet the requirements of its potential Asian customers. This same company has also expressed a desire to developing a joint venture partnership between themselves and Kileva Fisheries.

Unfortunately at the end of 1992 Tokelau authorities were forced to temporarily suspend manufacturing of the marinated dried tuna due to the lack of funds to keep subsidising the operation through its trial marketing phase. Despite the fact that Tokelau's project has not achieved its full objective of economic viability, it has demonstrated that the potential still exists for it to realise its commercial ambitions. During the two year period that Teriyaki Tuna was being processed at Kileva Fisheries much has been learned about processing and marketing tuna in communities as isolated as Tokelau's.

The project experienced difficulties at a number of levels. On the production side, erratic catches of yellowfin tuna resulted in irregular supplies of product, and there was often inconsistency in the quality of product. On the marketing front buyers were demanding different flavoured products (e.g. sweeter versions, curry and chili flavours) which staff at Kileva Fisheries could not respond to because of the lack of research facilities, funds to carry out the research and technical knowledge. Furthermore buyers were interested in purchasing larger volumes of product than Tokelau would ever be able to supply.

In hindsight it is recognised that the project would have benefited from greater understanding and participation of the local community on Atafu, and training provided in business and management skills. Kileva Fisheries requires further outside technical assistance to help respond to the expressed market demands for modified products, especially diversification into different product flavours and to boost production by utilising the more abundant skipjack tuna as a raw material.

SPC/ACIAR collaborative project on the processing of novel tuna products in small Pacific Island countries for the domestic and export market

It was in response to the needs described above that in 1991 SPC made an approach to the Australian Centre for International Agricultural Research (ACIAR) to work in collaboration on developing a project on the processing and marketing of novel tuna products in the Pacific. The project set out to address some of the technical problems that Kileva Fisheries was facing while including other interested countries within the project's framework. These additional countries consisted of Tuvalu and Kiribati.

To set the collaborative project in motion ACIAR funded a meeting to evaluate the feasibility of the project concept. The meeting was held in Sydney in October 1991 and was attended by a selection of experts (post-harvest specialists, sociologist, marketing expert, donors (AIDAB and ACIAR) and project development officers). As a result of this meeting ACIAR funded two desk studies to help provide further information on the feasibility of the project. The two studies were completed in May 1992. The following two reports were submitted:

- **Processing of novel tuna products in the Pacific Islands: Desk study on the Market.** By Richard O'Neill, Excelink-Pacific.
- **A desk study on the type and range of novel tuna products that can potentially be developed and manufactured in the Pacific Islands.** By Souness/Buckle, University of New South Wales.

The market desk study surveyed markets in Australia, New Zealand, Asia and the Pacific Islands. It was generally optimistic about the marketing potential of a tuna jerky type products but provided cautionary comments about the high demands of the market place or quality products, and in particular noted the need to identify and focus on the product's *Sustainable Competitive Advantage* (a measure of the long term viability of a product). The study looked at similar products made from beef currently on sale in the market-place and to the concept of pet food treats. Examples were given of different brands of beef jerky retailing for between US\$ 60.00 to 190.00/kg at duty free stores in Australia. The study made suggestions about focusing on markets within the Pacific such as duty free outlets and the snack business on regional airlines. Recommendations were also given on portraying a strong Pacific image on high quality packaging formats.

The second study on potential product concepts investigated a range of product ideas that included: minced fish snacks, tuna jerky, fish flavoured condiment, Japanese dried fish sticks and import replacement products. The study was enhanced by the fact that the two groups worked closely on their respective projects and were therefore in agreement with each others conclusions and recommendations. A product development study on minced tuna snack was the main recommendation of this report.

Following a review of the two reports by ACIAR and SPC, a decision was made to commission two product development studies. The first was undertaken by the Seafood Group at the International Food Institute Queensland (IFIQ), who worked on an improved versions of the Tokelau marinated dried tuna product. The second study was assigned to the Department of Food Science and Technology, UNSW on the manufacture of dried flavoured tuna product made from minced skipjack tuna. This was considered to be a valuable exercise that would help to establish whether an acceptable product could be made from this oilier and darker fleshed species which is more abundant in the Pacific. The two studies were completed at the end of 1993. The following reports were submitted for review:

- **Refinement of Techniques for the Production of Tuna Jerky in Remote Pacific Island Countries.** By B Goodrick, R Smith, D Milne and S Grauf (IFIQ). January 1993.
- **Product Development Study on Dried Minced Tuna Products.** By R A Souness, T R Fettmann and K A Buckle (UNSW). January 1993.

IFIQ successfully made a number of improvements to the processing procedures being followed at Kileva Fisheries in the manufacture of teriyaki tuna. The most significant modification was to reduce the marinating time from twelve hours to just ten minutes. As a result, large savings to the processing cost was achieved by reducing the quantity of marinade used. The short marinade step meant that it was possible to recycle the marinade from one batch of sliced tuna meat to the next. A saving of about 60% in the volume of marinade and about 10% in production cost was expected. Techniques were also developed for improving the slicing of tuna loins. The resulting products had a more consistent thickness. Salt levels in the marinade were adjusted to eliminate a problem of "salting out" that was a common feature of Tokelau's Teriyaki Tuna. Finally, a range of new flavours were developed (soy, chili/teriyaki and curry) in response to a buyer's specific needs.

UNSW demonstrated that minced tuna flesh can be transformed into a dried product. The methodology requires mincing, mixing, forming of flat sheets, drying, cutting into standard pieces and packaging. The advantage to this process is that other ingredients such as sugar, salt and herbs/spices can easily be mixed into the mince allowing for efficient and uniform flavour incorporation. The skipjack product had a better dark colour when compared to the paler yellowfin tuna product. However the processing procedure is more complicated than tuna jerky production, requiring more precise handling and processing techniques. For example, once skipjack tuna is minced and sugar and salt are added the mince develops an elastic property. If left too long the elastic property becomes so strong that the mixture can not be formed into a thin layer for drying. In conclusion it was clear that further research would be needed to overcome a number of technical problems before an acceptable minced product could be made available.

A further meeting took place in February 1993 between the various technical and development specialists and representatives of the project's initial target countries which included Tokelau, Kiribati and Tuvalu. A representative from the Marshall Islands also attended the meeting. The meeting reviewed the product development work and considered the future direction of the project. Based on these discussions a plan of action was developed for the remainder of the year.

Under the action plan an informal Working Group was established as a consultative and advisory body to provide direction to future project activities. Action plan activities completed or are in progress include:

- mercury content analysis of products from Kiribati, Tokelau and IFIQ's studies showed that these products are well within import regulation limits in force in Australia;
- advisory visit to Kiribati to evaluate the two tuna processing operations there – a visit was made by a research technologist from IFIQ in April 1993;
- new packaging format and an attractive label was developed for the Outer Island Fisheries Project, Kiribati. Marketing studies at retail outlets in Australia were completed but the results were disappointing;
- a socio-economic study on Atafu, Tokelau to establish the constraints to tuna processing at the community level was completed at the end of the year; and.

SPC's leaflet on Home Made Recipe for Dried Marinated Tuna updated to include modified processing procedures (see attachment 1).

Update on current in-country activities in tuna processing

Tokelau:

The plan of action currently being followed is to put into place as many of the necessary conditions that would ensure improved chances of the project succeeding. In this respect two FADs were successfully deployed off Atafu in August 1993 with assistance from the SPC's Capture Section. It is hoped that these FADs will improve the volume of yellowfin tuna being caught and consequently alleviate the supply problem that has plagued the project in the past. At the same time a socio-economic study of the community on Atafu was undertaken by an SPC staff member (Vaine Wichman - Economist/Rural Development), in relation to the establishment of the tuna processing facility on the atoll. The report will be used to provide an essential guide as to how to best reactivate the project.

Future activities that will need to be considered in light of this study and FAD deployment are linked to the introduction of the new procedures for tuna jerky processing that were developed by IFIQ; improved management and business skills; and, developing a more successful marketing strategy either through negotiating the joint venture proposal with the company in New Zealand, or, by targetting more appropriate marketing outlets such as duty free shops visited by Japanese and Asian tourists (e.g. Nadi, Sydney, Brisbane, Cairns).

Kiribati:

Two processors are active in jerky production in Tarawa:

- **Outer Island Fisheries Project (OIFP)** is producing about 50 Kg of product per month under the brand name Paradise Tuna (see information paper 21). This is successfully sold on the local market in Tarawa. The SPC/ACIAR collaborative project has provided direct assistance to OIFP in the area of improved packaging technology aimed at selling the product overseas. Marketing trials were also conducted in Australia, but these have proven to be inconclusive.
- **Teikabuti Fishing Company (TFC)** also produces jerky for the domestic market and are currently selling about 25 kg of product per week. TFC has made more headway in identifying potential overseas markets in countries such as Australia, New Zealand, Hawaii and Japan. The company's tuna jerky product has appeared at a number of food exhibitions in Australia and New Zealand. The present production capacity is limited. However TFC over the next few months is expanding its facilities with the aim of processing up to 800 Kg of fish per day. This company has also introduced a number of innovative procedures such as using dried marinade ingredients imported from Australia; utilising a heat pump drier to improve product consistency and quality; incorporating a new type of oxygen scavenger in the package to reduce rancidity problems, etc.

Marshall Islands

Recent information indicate that the production of dried salted fish has made a resurgence in one of the outer islands of Marshall Islands. Fishermen and their families on the atoll of Ailinglaplap are making salted dried fish and selling them on the local market and to other atolls of the Marshalls. This resurgence is coinciding with the introduction of fish jerky as a novel product made from tuna and shark meat. The project is supported under Saltonstall-Kennedy (S-K) funded grant and is lead by a fish jerky producer in Majuro. SPC in 1993 provided some training assistance in improved processing of salted dried fish and in the area fish jerky production.

About twenty individuals on Ailinglaplap have invested in a simple solar drier (costing about US\$ 175 each) and produce jerky using marinade prepared by the project leader in Majuro. The jerky is very popular on the local market on Ailinglaplap, selling for about 50 to 80 cents per ounce (about US\$ 20 per kg). Three traders are actively exporting jerky and dried salted fish to other island in Marshall Islands, in particular Ebey. In Majuro two jerky manufacturers are in competition on the local market. It is interesting to note that acceptable jerky products are being made from shark meat.

Part B - Further technical considerations on the processing of Tuna Jerky

What is Tuna Jerky?

A visual inspection of a tuna jerky product is one that does not inspires many people with thoughts of a gourmet food or to imagine that the product can be sold to some markets for as much as US\$ 40 per kg. In fact anyone totally unfamiliar with dried fish products will readily draw up a list of unflattering terms to describe it.

Tuna jerky comes in a range of shapes and sizes depending on the manufacturer's preferences (flat sticks, bits and pieces, etc). The product has a dry, grainy, leathery appearance and the universal colour is medium to dark brown. A wide range of flavours are now available (teriyaki, soy, chili, curry, etc). These flavours are sufficiently strong that they mask the mild fishy taste of yellowfin tuna flesh. The savoury flavour usually makes an instant impression in the mouth that encourages mastication. The product must not be tough and sinewy, but sufficiently chewy so that each bite lasts some time.

From a technical view point jerky is a preserved food because sufficient water has been removed from the flesh so that spoilage by bacteria, moulds and yeasts can not take place. Even enzymes in the flesh of the fish are rendered inactive under these dry conditions. Salt and sugar in the flesh contributes to the preserved status of the product. These humectants are not only flavour enhancers they help tie up or bind free water in the meat that would otherwise be available for microorganisms grow.

An inverse relationship exists between the amount of water to be removed and the quantity of salt and sugar in the flesh. The more salt/sugar that has penetrated into the flesh during the marinating process the less water that must to be removed in the drying process. This is an advantage when a product is sold by weight, because the more water that can be retained in the product the heavier it is, resulting in a better yield. However, this has to be balanced by the flavour of the product. Obviously too much salt and sugar will render the product inedible.

The preserved status of dehydrated foods can be established by measuring its *water activity* (A_w). This measures the combined effect of humectants in the flesh and the amount of free water available. On a scale of zero to 1 a product with an A_w of 0.75 or lower is considered to be preserved. All bacteria and mould of concern are not viable at an A_w figure below this. All jerky products must fall within this A_w range for them to be considered preserved.

It is important to maintain a low A_w throughout the marketing and distribution chain. If products are stored exposed to the atmosphere or the packaging breaks down they will easily pick up moisture from the air. Under these conditions the A_w will rise. It is then possible for mould to grow on the product. Small white or cream spots are the first signs of trouble. These rapidly grow and spread all over the sample. This has been a common problem that has occasionally affected products from Tokelau, Kiribati and Marshall Islands. The problem is

usually solved by upgrading the plastic packaging material to one with high moisture and oxygen barrier properties.

Properly dried, packaged and stored jerky does not require refrigeration. It will keep for many months even when held at ambient temperatures in a cool dark room away from direct sunlight. It is light-weight, compact and durable. It can therefore withstand a reasonable degree of mishandling.

How is tuna jerky made?

The key to successful manufacture of jerky is to aim for the highest, most consistent quality product and to ensure a reliable supply to the purchaser. These are essential components of any thriving export operation. Businesses in the Pacific often fail to reach the mark in these two key areas. To achieve these principles careful consideration must be given to all aspect of the processing procedure from raw materials, each step in processing, packaging and finally distribution:

The raw materials:

- **Tuna**

The tuna species of choice is yellowfin tuna. The flesh of the fish is low in fat and is easy to cut into thin slices. The flesh recovery rate is also high. The larger the fish the higher the rate of recovery. A large yellowfin tuna of over 30 Kg should have a loin yield of over 50%. Skipjack tuna on the other hand has very dark, soft flesh that is difficult to slice. The fat content is relatively high and this imparts a noticeable fishy flavour to the final product that is not so well masked by the added flavours of the marinade. The yield of flesh is lower than yellowfin. However, this is offset by lower purchasing prices. Other low fat fish species will produce good jerky products too. These include marlin, swordfish, and shark. It may however be necessary to modify the marinade because a marinade formula that works for one species may not be acceptable when used with another.

A quality conscious operator will always ensure that only fresh or well frozen fish is used for making export standard jerky. Consistent quality products can only be made from fish that are themselves of a consistent quality. Doubts about the freshness of an individual fish should lead it to be rejected immediately. Instilling in staff the responsibility for maintaining quality has become a standard practice for a manufacturer of any produce. This should be a practice introduced to every tuna jerky processing operation.

- **Marinade**

The flavour of the jerky depends on the marinade that is used. Many marinades are made with soy sauce as the base ingredient. There are many different types of soy sauce on the market and the quality is very variable. Changing from one soy sauce brand to another can change the character of the marinade and therefore the jerky product. It is essential to find a good consistent brand. Once established as a basis of a product it will be important to stay with that brand. This is also true of all the other ingredients that are used in the marinade.

Because of the potential difficulties of maintaining a consistent marinade from one week to the next or from month to month buying a commercially formulated marinade could be considered for avoiding inconsistent flavour problems. These products will probably cost more, but will simplify the process. Some suppliers are able to provide marinade as a powder which is reconstituted at the fish processing site. The obvious advantage is the reduced cost of shipping marinade ingredients.

The drying process:

The marinated tuna meat is an easy product to dry. The flesh is sliced to a thickness of only 4–5 mm. Under ideal conditions (good sunshine, plenty of wind and low humidity) the product dries in less than one and a half days. However, two options are available: natural sun drying and artificial drying.

- **Natural sun drying**

This is the cheapest drying method. However drying is totally dependant on the weather and precautions need to be taken to make allowances for short and long periods of rain. A second problem are flies. Food exposed to the atmosphere always attract flies. Little can be done to completely stop flies landing on drying marinated fish, but the numbers of flies can be kept to a minimum by keeping the fish drying area and the area surrounding it clean. Fly traps installed around the drying racks are effective in keeping numbers down.

Flies are not considered to be a major technical or health problem. They are not able to lay eggs on thin fish slices that dry so quickly and because the product is dry bacteria deposited on the fish can not grow. However, aesthetically, consumers may become concerned about the product if they became aware of the fact that flies had landed on it. It is usually this factor that has convinced a number of jerky processors to use artificial drying techniques.

- **Artificial drying**

The common feature of artificial driers is that they are specially constructed devices that require some technical knowledge to operate properly. These include solar dryers, agrowaste dryers and forced convection dryers powered by electricity. Electric powered driers are the most efficient driers. They are also the most expensive to purchase and operate. They will however allow a much greater degree of control over the drying process resulting in products with a high degree of consistency. These driers can be operated 24 hours a day irrespective of weather conditions. It may be of interest to note here that the Teikabuti Fishing Company in Kiribati is investing in an energy efficient heat pump drier to allow the processing operation the greatest possible control over the quality and consistency of product.

Solar driers are commonly used by jerky processors around the Pacific. They come in a range of shapes and sizes and made from different materials such as plastic sheets, corrugated hard plastic sheets and Perspex. The common design feature is to build a chamber utilising any of these materials in which the fish are placed for drying. When left in the sun the temperature of the air inside the chamber will rise helping the drying process. There is a need to ensure that there is a reasonable air flow through the chamber to remove moist air.

Solar driers can be difficult to use. Maintaining a consistent drying environment throughout the chamber is a major problem. Fish at the top of the drier may dry quicker than fish at the bottom. Temperature variation from one day to the next will also affect product consistency.

Packaging:

Retail plastic bags for jerky must have high barrier properties to water/moisture and oxygen. Dried products will very quickly take up moisture from the atmosphere and can become mouldy in plastic bags that allow moisture to pass through it. Everyday domestic plastic bags are not suitable. Bags used for vacuum packing foods are generally acceptable. This type of plastic is usually a laminate of three different types of plastic material heat moulded together.

An oxygen barrier package is required to avoid fat oxidation. It has become a standard feature to include an oxygen scavenger sachet with the product inside the sealed bag. These cost about 10 cents each. This serves to absorb any remaining oxygen inside the bag. Oxygen scavengers have an added negative effect on mould growth by creating an oxygen free environment.

To succeed in the market place emphasis has to be given to the visual appeal of the package. Richard O'Neill (marketing specialist) strongly supports the view that it is the package that will sell the product. In fact technical considerations which are by now fairly well established, are likely to play a secondary role in the future. There is a greater need to concentrate on promoting the product by utilising attractive packaging and developing effective marketing techniques.

Much can be learned from the way beef jerky is marketed in Australia. Printed plastic packaging of a very high standard was the most common method for retailing the product. Although this type of package can still be found it has become more common for beef jerky to be packed in small highly coloured and carefully designed cartons. To develop such a high standard of packaging would require a large financial investment. This could be beyond the means of many tuna jerky businesses in the Pacific.

Economic considerations

Tuna jerky is often compared to beef jerky which has now become an established product very commonly seen in duty free stores all over Australia. Beef jerky is also a well established product in the USA. As a marketing ploy it would appear that tuna jerky products that meet similar quality standards and packaging standards could successfully compete with beef jerky.

Retail prices of beef jerky on a price per kg basis are surprisingly high. Richard O'Neill in his marketing study report quoted retail prices ranging from US\$ 60 to 190 per kg. Recent communications with Teikabuti Fishing Company in Kiribati suggest that quality tuna jerky products supplied from the islands can fetch up to AUD 40.00 in Australia and US\$ 45.00 in Hawaii. These figures can be compared to the price calculation for Tokelau's Teriyaki Tuna shown in Table 2 (see end). Although these figures are about two years out of date it can still be deduced that the profit margin that can be applied to tuna jerky products is very high. If the prices above still hold a profit margin of 200 to 300% could be applied to Tokelau's product.

Attachment 1. Updated recipe for a home-made marinated dried fish

HOME-MADE RECIPE FOR MARINADED DRIED FISH

Introduction

Marinated fried fish is a simple product to make. The product is a dry savoury fish that can be eaten as a snack, like chips or peanuts, and served up in bars and parties to go with drinks. It may also be cooked, for example with tomatoes, onions and coconut milk.

It can be made from tuna (yellowfin is the best), wahoo (king fish), marlin, swordfish and many other fish species. Oily fish are not so good. To produce a high quality product you must use fresh fish.

Processing procedure

It is best to use medium and large fish (more than 2 Kg or 4 lbs) so that sizeable fillets or loins can be cut from which thin pieces of flesh can be sliced.

Method: Fillet or loin the fish, remove the skin, and carefully trim away the dark red muscle. Cut thin slices of fish flesh along the length of the fillet to a thickness of approximately 5 mm (1/4 inch). Wash the fillets in lightly salted water, then place them in a marinade previously prepared. Either use a plastic container with a good sealed lid or put the mixture of fish and marinade in plastic bags, one inside the other. Secure with a knot or an elastic band.

Marinade

To make approximately one litre of base marinade, mix the following ingredients together, ensuring that the sugar and salt are all dissolved:

- 1 litre (2 pints) soy sauce
- Juice from 5-6 lemons
- 150 g (6 oz) of sugar
- 50 g (2 oz) of salt

Other ingredients that can be finely ground and added according to taste include garlic, pepper, chillies, ginger, mixed spices, etc.

The fish slices must be completely covered by the marinade and left to soak for about 20 to 30 minutes with occasional mixing. If a stronger flavour is preferred leave the fish to soak in the marinade for a longer period.

Remove the marinated fish after the time has elapsed. Lay the flesh out on a mesh tray and place in a sunny and windy spot for one or two days. The time it takes for the product to dry will depend on the weather. An alternative method is to dry the fish in a warm oven with a fan switched on to produce good air circulation, at a temperature no greater than 40°C (100°F). Turn the fish strips over regularly.

The marinated dried fish is ready when the flesh is completely dry and has a reasonably tough and chewy texture.

Storage

Store in sealed plastic containers, bags or glass jars, in a cool place. The product is preserved and therefore requires no refrigeration. It should keep like this for many weeks or months.

Table 1a. ANNUAL OPERATING COSTS (November 1991) based on the production of 5,500 kg of dried tuna product per annum

Item	Unit cost	Full cost
Purchase of 24,000 Kg of tuna at NZ\$ 1.00/Kg	24,000	24,000
6,000 l of marinade:		14,715
3,600 l of soy sauce	10,800	
200 Kg of salt	172	
600 Kg of sugar	420	
360 l lemon juice concentrate	3,323	
Salaries:		23,902
Manager	6,000	
Processing supervisor	4,000	
Ice plant operator	3,000	
Processors (x 4) at 42.80/week each	8,902	
Casuals at 0.79c/hr - 2,531 hrs	2,000	
Packaging materials	6,750	6,750
Fuel for generator (2.5 l per hr @ NZ\$ 0.86 per l working 14 hrs/day x 5 x 52)	7,830	7,830
Water		
Lease (NZ\$ 1 per sq m x 1500)	1,500	1,500
Other consumables (detergents, stationery, etc)	3,500	3,500
Maintenance and repairs	3,000	3,000
Liaison Officer operating costs in Apia: communications, local travel, etc	1,500	1,500
TOTAL (NZ\$)		86,697

Table 1b. ANNUAL OPERATING COSTS (November 1991) based on the production of 5,500 kg of dried tuna product per annum

Item	Unit cost	Full cost
Purchase of 24,000 Kg of tuna at NZ\$ 1.00/Kg	24,000	24,000
2,400 l of marinade:		5,886
1,440 l of soy sauce	4,320	
80 Kg of salt	69	
240 Kg of sugar	168	
144 l lemon juice concentrate	1,329	
Salaries:		23,902
Manager	6,000	
Processing supervisor	4,000	
Ice plant operator	3,000	
Processors (x 4) at 42.80/week each	8,902	
Casuals at 0.79c/hr - 2,531 hrs	2,000	
Packaging materials	6,750	6,750
Fuel for generator (2.5 l per hr @ NZ\$ 0.86 per l working 14 hrs/day x 5 x 52)	7,830	7,830
Water		
Lease (NZ\$ 1 per sq m x 1500)	1,500	1,500
Other consumables (detergents, stationery, etc)	3,500	3,500
Maintenance and repairs	3,000	3,000
Liaison Officer operating costs in Apia: communications, local travel, etc	1,500	1,500
TOTAL (NZ\$)		77,868

PRICE CALCULATION		
Item	NZ\$	US\$
A. Annual operating cost	77868	45423
B. Annual recovery costs - depreciation	15338	8947
Total	93206	54370
Cost per Kg	16.95	9.89
PLUS 25% mark-up	21.18	12.36
Price per Kg	21.18	12.36
price per 200 g pack	4.24	2.47
price per 100 g pack	2.12	1.24
price per 50 g pack	1.06	0.62

Table 2. Price calculation for Tokelau's Teriyaki Tuna with the new short marinading procedure