FREMANTLE SARDINE COMPANY

CANNED SARDINE PROJECT REPORT

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1. Canned Sardine Project - Summary

1.1 Market Background

According to figures published in Retail World dated December 1994 the canned sardine market has an annual retail value of $2.4m. and volume of 2,500 tonnes.

Market shares were :-

King Oscar	31.9%
Brunswick	21.5%
John West	20.0%
House brand/Generic	11.1%
Other	15.5%

All product is imported.

The value of the market and particularly King Oscar's share, rose as a result of the latter's consumer campaign targeting non sardine purchasers.

The three major brands with a total share above 70% of the total market are premium products, packed in a flat (dingle) can, with ring pull top, of net weight 100-110g. King Oscar packs Norwegian sardines in single (>10 fish) or double layers (>15 fish) per can, whilst John West packs slightly larger Scottish sardines. Brunswick's Canadian sardines includes a small fish pack, but typically each can contains 5/6 fish.

The cheaper products are packed in a narrower and deeper can (club can) of similar net weight, 4 to 5 fish per can, usually of Thai origin.

Canned pilchards are also found on the supermarket shelf. The standard product is packed in tomato sauce in a round can (160g) or oval flat can (440g). The fish are large and predominantly of Korean or Japanese origin. Canned pilchards are cheaper than sardines.

The difference between a sardine and a pilchard is often a question of size. The Australian fish is sardinops neopilchardus , most commonly refereed to as a pilchard, although the juveniles are properly called sardines.

Importantly, Codex has considered the question of species in relation to canned sardines and sardinops neopilchardus is included in the list of species which may be canned. Codex limits universal use of the word sardine to the species sardina pilchardus, but allows the use of the word sardine qualified by a regional or Country label for all others listed. (Appendix 4.1)

1.2 Opportunities for Australian Canning

Catches of sardines or pilchards in Western Australia average 7,500 tonnes per annum, with the largest catch in King George Sound (5,000 tonnes), followed by Bremer Bay (1,500 tonnes) and Fremantle West Coast area (1,000 tonnes). A 10% share of the canned market would only require 500 tonnes of whole fish supply, therefore resource is not likely to be limiting.

Despite the apparent high price of the fish in the can, sardine canneries fall into one of two categories. Either they are high volume, capital intensive, automated plants, as in Norway, or more labour intensive canneries with low labour costs, as in Thailand. High labour costs caused the closure of many canneries in Japan and only an abundant source of cheap fish keeps the remaining pilchard canneries operating.

An Australian cannery would have a relatively low volume and high labour cost and, therefore, must compete at the premium end of the market. A few years ago such a venture would have been unlikely to succeed, as Australian sardines (as distinct from pilchards) were virtually unknown. Mendolia's Fremantle Sardine Company have altered that situation by supplying fresh sardines to wholesalers and restaurants across the Country. It is their belief that an opportunity now exists to further develop the Australian sardine market by introducing a canned product.

1.3 Project Brief

The primary objective was to develop three varieties of canned Australian sardines, packed in an Australian made can, which can be retailed at a comparable price to the premium sardine products in the market.

If this could be achieved, an initial 5% share of the total market in volume, equating to a 7% share in value, is considered feasible. Based on the Retail World figures this would equate to a sales value of $1.7m per annum.

The brief required detailed process, yield and labour cost calculations to determine viability of the project.

A secondary objective was to investigate the potential for a canned sardine fillet product. This was considered a possible line extension, particularly since equipment was already on site to prepare the fillets.

1.4 Summary Results and Conclusions

The primary objective was successfully completed, with the preparation of Australian Sardines in Olive Oil, Spring Water and Italian Style Tomato Sauce. The sardines are canned in an upright round can of 52mm diameter and 93.5mm height, containing 6 or 7 fish, with a net weight of 185g.

Until the canning line is completed and functioning the costings can not be confirmed, but based on the yields and process trials a retail price of $2.34 per can is expected. This will be a 24 cent per can premium over the King Oscar average price, but with a net weight 50% greater, Fremantle Sardines only cost 1.26 cents per gm compared with 2 cents per gm for King Oscar. Additionally, the Norwegian fish are packed gut in and tail on, whereas the Australian product is gut free and tail removed. By the same comparison John West product costs 1.5 cents per gm even at the recent lower shelf price of $1.65 per can.

Whilst the selection of olive oil lifts the average price of the product, it reflects the quality image and is another point of difference from the competition. The final name for the tomato product has yet to be decided. The formulation was designed to result in a distinct flavour rather than the common tomato paste and water based 'tomato sauce'.

This latter requirement was considered particularly important since, in selecting an Australian made can, the product would need to be packed in a round, rather than flat, can. A similar diameter, but different height can is used for pilchards in tomato sauce and the Australian sardines must be clearly distinguished from this pack.

It was originally intended to use a ring pull end on the can, but the internal lip that remains after opening prevented easy removal of the sardines from the can. The round can also presented difficulties over the flat can in achieving a high fish to sauce ratio, as the cans have to be filled with sardines prior to steaming. In the flat can the fish can be packed proud of the lid, allowing for shrinkage during steaming.

Heat penetrations for all three varieties were determined in the laboratory autoclave, thus allowing further quantities to be prepared with a known microbiological safety margin. These trials will need to be repeated when the process is scaled up to full production.

Details of all of the experimentation, process flows and tentative Hazard Analysis charts are included in the report.

Canned sardine fillets were also trialed, but found unsuitable for the round can packed lengthways, as shrinkage and curling of the fillets results in an unattractive pack considerably more expensive than the trunk sardine.

Stuffed or rolled fillets might be considered as a future option, but not until the other products are established.

As part of the exercise to evaluate lacquer coatings for the internal wall of the cans some sardines were packed in 74 x 112.5mm (soup) cans. These were found to pack tightly to a net weight of 400g. Since only pilchards are available in this weight can an opportunity exists for a larger retail or, more particularly, a food service pack.

2. Experimental Details

2.1. Literature Review of Process Parameters

Whilst there is little published literature on the techniques used by most modern canning plants, the basic process and the starting point for the development is described in "A Complete Course in Canning and Related Processes Book 3, 12th Edition" - A publication of The Canning Trade Inc USA.

The literature comments on :-

1. The need to ensure the freshness of fish on arrival and the maintenance of that freshness prior to processing.

2. The advantage of brining fish to remove slime, blood and toughen the skin as well as salting the fish.

3. Alternative techniques for pre-cooking the fish prior to oil addition and can seaming. Frying of the sardines is now rarely used and steaming the fish prior to canning adds to the complexity of the operation.

The literature includes information on typical process times and temperatures for various packs, but since these are flat cans they have little relevance to the proposed process.

The trials that follow were based on the principles above, but adapted to suit the fish, can size and the small volume canning operation proposed.

1st & 8th March 1994

2.2 Trial Code 1,2,3 - Preliminary

Purpose

1. Assess 3 alternative precooking techniques for suitability and ease of production
2. Prepare initial cans of product containing olive oil as bare standards for ongoing development
3. Confirm initial yield calculations.

Details

Previously frozen trunk sardines (headed and gutted) were defrosted in running water, tailed to approximate length of can, weighed, then brined in a 15% solution for 10 minutes.

Brined fish were then treated as follows :-

Trial 1 - Pack 7 fish in can, invert and steam for 20 minutes in domestic steamer. Some cans were preoiled prior to packing.

Trial 2 - Fish steamed out of the can on non-stick paper in the steamer and then cooled in the chiller prior to canning. 7 fish were packed per can.

Trial 3 - Fish fried in olive oil for 2/3 minutes, cooled in chill and packed 7 fish per can. Cans were lined with olive oil prior to filling.

All cans were seamed and processed for 1 hour upright in the pressure cooker on high (theoretically temp > 115 degrees C).

Results

Wt. of fish after removing tails 61 fish = 990g, ave. wt. 16g.

Appearance of product in can :-

Trial 1 - High oil to fish ratio, skin retention better on preoiled cans, slightly salty flavour, cloudy olive oil with some water and coagulated protein - "curd".

Trial 2 - Similar to 1, but more loss of skin.

Trial 3 - Fried flavour preferred

Discussion

A) The sardines selected were too small to give worthwhile yield results. Previous experiments that did not involve canning had given the following results :

Average wt. of fish after tailing		=	24g
" " " " "	brining	=	24.3g (2% increase)
" " " " "	steaming	=	20.8g (13% loss)

With 6 fish per can this will only give approx. 125g requiring 60gm of liquid infill. Typical sardines have at least 80% content

With 7 fish per can the weight increases to approx. 145g with 40g of liquid; close to 80%. This must be the target.

B) Steaming out of the can to precook may assist in packing 7 large fish per can, but introduces considerable process problems, particularly handling without removing the skins.

Future trials should concentrate on the in-can process.

Pre-frying was interesting, particularly given the taste comments. If the in-can steaming trials are not successful, then the option of using a Vos fryer should be considered. The Vos fryer uses an oil spray system and avoids the problem of oil contamination in standard fryer systems.

C) The pomace olive oil, whilst contributing to the overall promising flavour, gave a cloudy appearance on Day 1, which needs to be assessed over time.

Addendum

Because of the small fish size used in the trials and the identified need to pack 7 fish per can, further experiments were conducted prior to the next canning session. Fresh whole fish weights were checked at random for averages of any 10 fish and any 6 fish with results :-

Average wts.	10 fish	41g, 39g, 38g, 39g, 40g, 43g =	40g
"	6 fish	40g, 38g, 40g, 42g, 40g, 38g =	40g

Headed and gutted weights average = 26g

Any combination of 7 fish could be packed in the can prior to brining and this was considered as an optional process (brining firms the flesh potentially making packing more difficult).

After brining some blood remained in the can and was difficult to remove because of the expansion.

7 fish were also able to be packed in the cans after brining and this should be the preferred option.

15th March 1994

2.3 Trial Code 4 - Fresh Sardines

Purpose

1. Evaluate use of fresh sardines. All previous trials carried out on frozen
2. Try packing 7 sardines per can as standard
3. Pre oil cans to assess impact on skin retention
4. Evaluate canola oil as an alternative to olive oil
5. First trials with the autoclave, check operation

Details

Fresh trunks from heading and gutting line were tailed to a length of approx. 90mm. weighed as a spot check then brined for 10 minutes in a 15% concentration.
Cans were lined with canola oil, 7 fish packed head to tail with some protrusion from the end of the can, inverted and steamed for 20 minutes.
After steaming, cans filled with canola oil (now hot cans) and processed in the autoclave at a setting of 115% for 60 minutes

Results

Wt. of raw product after tail trimming - average 26.3g
Wt. of brined product before steaming - average 26.5g

2 cans opened after cooling. 1 can had excess water from the precook, not drained sufficiently. Second can had little water and curd, good overall appearance, very light colour oil. Flavour was light salt, reflecting fresh v brine chilled or brine frozen fish.

Discussion

Fresh fish packed 7 per can gave a good visual impact of sardine to oil ratio. Salt levels will need to be determined in the brining stage for each fish pretreatment.
Skin retention was better with pre-oiled cans, but further improvement would aid visual appeal.
If cans are prepacked prior to steaming retention of the cook water in the can must be prevented. Note the cans were only partially inverted to retain some oil on the internal surface and this may have contributed.
Canola oil gives a very light coloured oil - this may be preferred.
Autoclave appeared to maintain temperature variation of less than 1 degree C based on the rapid reaction of the sensors. However, the pressure dropped from about 15psi to 10psi during the cook. There was sufficient water to maintain steam for at least 1 hour.

22nd March 1994

2.4 Trial Code 5 - Various Oils

Purpose

1. Pack cans in a clear olive oil to compare with earlier pomace oil trials
2. Prepare further samples in canola oil to assess over time
3. Use a couple of cans for initial crude transit trials
4. Use a temperature probe in steam chamber of autoclave to correlate temperature read outs with actual

Details

Frozen turns prepared from previously IQF frozen fish were defrosted in running water and tailed to can length (approx 90mm). Fish were brined for 10 mins. in 15% brine, rinsed free of salt solution, oiled with canola and then packed 7 fish per can for precooking.
Precooking was carried out in the autoclave with a solid tray to collect the curd.
Temperature was controlled to prevent pressure cooking.
Precooked cans were rinsed with clean water and drained and then prepared with recipes.

A) 7 fish per can + clear olive oil
B) 7 fish per can + canola oil

Product was processed at a nominal 115 degrees C for 60 minutes.

Results

Wt. of raw product after tailing 74 fish = 2.00kg = 27g per fish
Cans were difficult to fill, suggest cutting shorter to assist filling.

Appearance on opening :-

A) Olive oil - yellow colour, little water and curd, rounded flavour, but slightly salty, some loss of skin.
B) Canola oil - slightly murky/emulsion to oil, very light colour, little water and curd, salty, some loss of skin

Product was compared with earlier samples

Code 4/15.3.94	- Canola oil - clear colour, some water cook out, good gloss with some skin loss, slightly low salt flavour
Code 1/1.3.94	- Pomace oil - steamed in can (ie. similar process) Colour now clear, was very cloudy on day of production, very good flavour.

Discussion

Despite oiling of product prior to cooking, some skin loss still occurring; need to try a better release internal lacquer on the cans.
Higher salt level in the IQF frozen fish needs to be compensated for when this fish is used.

Assessment of earlier canned product with pomace oil suggests flavour improvement over 1-2 weeks. Also oil clarifies, thus allowing it's use for production. Detailed costing required to determine whether olive oil is cost prohibitive.
1 can of each of canola and olive oil put in car boot for transit test over 2 weeks.
Autoclave temperature rose to 120 degrees C on readout from temperature probe. Pressure also dropped back over time. This problem can be compensated for when the heat penetrations are carried out.

29th March 1994

2.5 Trial Code 6 - Salting, spring water

Purpose

1. Cut fish shorter to fit 7 more easily in the can
2. Reduce salt level in brining stage when previously IQF frozen fish used.
3. Assess the impact of using a meat release can coating on the skin loss during processing
4. Prepare initial samples canned in spring water

Details

Approx 100 IQF frozen fish, trunked and refrozen were defrosted in running water, tailed to 80-85mm length; brined for 10 mins. in 10% salt solution, then rinsed in clean water prior to packing.

Fish were oiled, packed into cans and steamed at atmosphere for 20 mins, rinsed of obvious protein curd, drained and then prepared for seaming with the following variations :-

A) 450g printed anchovy can - packed flat with sardines + spring water
B) " " " " " " " " + vegetable oil
C) Standard can packed 7/can + spring water
D) " " " " + spring water + nat. hickory smoke flavour
E) " " " " + olive oil

Cans were processed for 1 hour at nominal 115 degrees C

Results

Wt. of raw product 90 fish = 2.00kg, thus 22.2g/fish
Wt. of precooked product prior to 'sauce' addition - ave. 135g

Appearance of product on opening after cooling 1/2 hr. in water :-

A) & B)	No obvious sticking to can and more skin retained. Worth trialing in standard can
C)	Water pack flavour good (salt content about right) and liquid slightly cloudy but not objectionable
D)	Smoke flavour obvious aroma but not on fish - try again after storage
E)	Good colour and gloss (though cloudy), preferred flavour

Discussion

1. Smaller cut fish packed easily in the can, however average fish weight smaller than most recent trials. Adopt the technique for future trials noting the effect with larger fish. Need to set up ongoing recording of average fish weights from catches to determine variability.
2. 10 mins. brining with 10% salt is close, will use this level in future trials until recipes finalised.

3. Meat release lacquer appears better, however cannot evaluate fully until correct can size used.
4. Spring water product has good flavour. Since liquid is drained colour perhaps not important. Smoke flavour remains an option.

8th April 1994

2.6 Initial Process Discussion

Assumption

Initial production equivalent to 100,000 cans per year with canning two days per week, 25 weeks per year. Each production batch therefore 2,000 cans.
If the 2,000 cans are produced in a half day, production capacity on a full shift per day five days a week and 44 days a year is 880,000 cans.

PROCESS

1. Defrost (if necessary), head, gut and tail

This uses existing equipment. 2,000 cans at seven fish per can, whole weight 40g. each requires :- 560 kg. whole weight fish
A heading and gutting rate of 70 fish per minute (net) (90 gross) would give 10 cans per minute, thus take 200 minutes to prepare the fish required.

2. Brining

Headed and gutted weight is 25g. per fish, thus 400 fish per 10kg.
A large brine tank is assumed into which baskets containing 10 kg. of fish are dipped for 10 minutes. One basket is produced every 5-6 minutes, thus the tank need only hold four baskets to keep up with the supply of fish.
We should need to determine how often the brine would need replacing or topping up to maintain an even concentration of salt in the fish.

3. Can Filling

After brining fish would be rinsed with fresh water, then filled into cans, seven fish per can. At present the cans or the fish are oiled prior to filling which reduces the skin loss during the steaming stage. If the meat release lacquer is successful this may be eliminated.
To match the speed of the process 10 cans per minute would need to be filled by hand. Trials are needed to determine whether it is more efficient to have one person fill each can or whether 2/3 people fill 2/3 fish each.

4. Steaming

Pre-steaming of the fish to cook and remove blood and unsightly protein curd takes appro. 20 minutes. Allowing for loading/unloading and raising the internal temperature of the steamer a capacity of 400 cans (40 minutes fish supply) would be ideal.
Assuming eight baskets are used each containing 50 cans then basket dimensions would need to be 600mm x 300mm. A one metre cube internal capacity with two baskets per shelf on four shelves would suffice.
Cans must be inverted and allowed to drain freely. After steaming the open end of the can may need to be sprayed with water to remove remaining curd.

5. Liquid Infill & Can Seaming

Although steaming is a batch process, once the first cook is completed a canning speed of 10 cans per minute will prevent backlog. Liquid infill could be a volume dispense or a "brim and tilt" infill. A hot can of fish topped with cold liquid could still be warm enough to give a vacuum in the can without steam or vacuum closing.
However, the last cans from the batch would be 40 minutes after steaming before filling and may be too cold. This will need to be determined. A continuous steam tunnel would overcome this problem and should be considered.

Retorting

Total retorting time is estimated at 1 hour 45 minutes per retort load based on 10 minutes load/come up; 70 minutes process and 25 minutes cool and unload. To prevent long standing of cans prior to retorting three cooks each of about 700 cans is assumed. This would require two retorts and leave a maximum standing time of about 1 hour 20 minutes before retorting. The effect of this on product quality also needs to be determined. Note total retorting time would exceed the four hours of production, but only one operator would be required to supervise the retort.

Labelling/Packing

It is envisaged that product would be allowed to cool and dry prior to labelling the following day. Labelling at 50 cans per minute would take less than one hour.

Labour Requirements

One Supervisor and crew as follows :-

Defrost; Head/Gut/Tail; Brine
2 operators feeding machine
1 service operator supplying fish, operating brine tank

Sardine Filling/Steaming
2 operators filling cans (5cans per minute each)
1 service operator loading baskets, operating steamer

Liquid Infill/Can Seaming/Retorting
1 operator can seamer
1 service operator supplying cans/loading retort baskets and operating retort

Labelling
4 operators total

Total Labour thus
7 operators x 4 hours
1 operator x 6 hours
4 operators x 1 hour
1 supervisor x 4 hours

Total hours = 38 operator
4 supervisor

8th April 1994

Indicative Costings - (Factory Costs Only)

A) Fish

7 fish per can x 40g whole weight = 280g/can

1. Sardines $1.40/kg @ 95% yield	= $0.413/can
2. Sardines $1.00/kg @ 95% yield	= $0.295/can

B) Liquid

7 fish after cooking = 145g; net weight 185g/can; gross weight 190g
Thus liquid infill 45g

3. Olive oil $3/litre = $3.33/kg x 45g	=$0.150/can
4. Canola oil $1.25/litre = $1.40/kg x 45g	=$0.063/can
5. Spring water 10c/litre x 45g	=$0.010/can
6. Tomato sauce $1.20/kg x 45g	=$0.054/can
(n.b. assumed price, no recipe)	

C) Packaging

Cans - $0.357 @ 98% yield	=$0.364/can
Label	=$0.030/can
Outer carton - $0.48 per 24 @ 98%	=$0.020/can
Total packaging	= $0.414/can

D) Direct Labour

38 hrs @ $11/hr /2,000 cans	=$0.209/can
4 hrs @ $13/hr/2,000 cans	=$0.026/can
Total labour	=$0.235/can

Total Costs Per Can

Sardines (Price 1) in olive oil	=$1.212
Sardines (Price 2) in olive oil	=$1.094
Sardines (1) in spring water	=$1.072
Sardines (2) in spring water	=$0.954
Sardines (1) in tomato sauce	=$1.116
Sardines (2) in tomato sauce	=$0.998

12th April 1994

2.7 Trial Code 7 - IQF fish; fish size

Purpose

1. Check the effect of larger fish compared with Trial 6 when cut shorter and packed 7 fish per can
2. Further assessment of the 10% salt 10 minute brine for previously IQF frozen fish
3. Prepare further samples canned in spring water, plus storage samples of Pomace olive oil a liquid infill.
4. Revert to pre-oiling the cans and not the fish.

Detail

Approx 100 IQF frozen fish previously trunked and refrozen were defrosted in running water, tailed to 80-85mm length, brined for 10 minutes in 10% salt solution, rinsed in clean water, then packed into cans.
Empty cans were coated in oil internally, drained and then packed with the fish, seven fish per can (n.b. it was found most easy to pack four fish head down into the can then three fish head up).
Cans were inverted and steamed for 20 minutes at atmospheric pressure. After steaming the cans were drained and washed to remove adhering curd, then filled with either spring water (coded wat.) or pomace olive oil (ol. oil).
Processing was at nominal 115 degrees C for one hour.

Results

Wt. of raw tailed product; 90 fish = 2.16kg, thus 24g per fish.
Wt. of pre-cooked product prior to liquid addition - ave. 143 g
Appearance of product on opening cans (4 hrs after canning)

Olive oil - clear yellow oil, v. little water, good skin, flavour light salt/oil
Spring water - Good clear liquid, skin mostly attached, fish needing prising apart. Lower flavour light salt.

Discussion

1. Cutting the fish shorter and packing four fish head down and three fish head up made it easier to pack seven fish per can. Some squashing still results with the larger fish, but this is preferable to packing only six fish per can.
It was also noted that the mesh on the basket holding the fish inverted during steaming is too small to allow draining of the curd and a larger mesh should be trialed - ideally 15 mm square.
2. Salt level in the fish slightly low, need to check again after storage. Good consistency of product achieved with no adverse effect of pre-oiled cans against oiled fish on skin retention of the fish. No apparent residual oil in the spring water can.

26th April 1994

2.8 Trial Code 8 - Sardine Fillets

Purpose

1. To prepare initial samples of sardine fillet packs for evaluation of appearance and taste
2. To determine an outline costing for the product

Detail

84 previously frozen shatterpack butterfly fillets were weighed, then defrosted in running water prior to brining in 10% salt solution for 3 minutes. After brining the fish were washed in water to remove any excess.
Empty cans were coated in oil, drained and then packed 8 fish per can, head to tail with the fillets folded back into the round shape, ie. skin out.
To avoid the collapsing of the fish in the can during cooking the cans were laid flat and steamed at atmospheric pressure for 10 minutes. After steaming the fish surface was rinsed with cold water to remove adhering curd and the cans drained.
Half the cans were filled with olive oil and half filled with spring water, all cans seamed and processed at nominal 115 degrees C for 1 hour.

Results

Wt. of raw butterfly fillets; 84 fish = 1.56kg, thus 18.6g each
Wt. of pre-cooked product prior to liquid addition = ave. 120g (15g each)
Appearance of oil product on opening (immediately after cooling) flavour good, but sardines shrunken, curled

Discussion

Initial comments suggest that the product in this form has no obvious advantages over the bone in product. A flat can fillet pack may be required to provide a point of difference.
The product will be costed to compare with the bone in product

Costing - 10th May

Based on 8 fish per can at a 45% yield from raw weight and olive oil addition of 70g, the factory cost of a can would be $1.23, compared with $1.10 for a can of bone in sardines.

This would make the product at least 25c per can more expensive on shelf.

10th May 1994

2.9 Trial Code 9 - Italian tomato sauce

Purpose

1. To prepare initial samples of product using a commercial Italian sauce for concept evaluation.
2. To accurately weigh fish infill and final product to determine variability

Detail

Sardine trunks prepared from IQF fish were cut to length (approx. 85mm), weighed and then brined for 10 minutes in a 10% solution

After brining the fish were rinsed with fresh water and then oiled prior to packing 6 fish per can head to tail. Only 6 fish could be packed as the sardines were particularly large (see results).

The cans were placed in the steamer on their side then steamed for about 20 minutes. There was no noticeable curd remaining after steaming so the cans were inverted and drained for one minute prior to filling with sauce.

The sauce (Leggo's Traditional Italian Sauce with Basil and Oregano) was warmed and diluted 10% with water to thin prior to adding to the cans. Cans were then seamed and processed at nominal 115 degrees C for one hour.

Results

Wt. of tailed fish initial = 2.00kg for 67 fish thus 30g per fish

Note the large size of this fish also meant that a large tail section was removed weighing on average 3.4g per sardine.

Wt of fish after brining = 2.02kg

Wt of fish after steaming = 1.62kg (24.5g per fish)

Actual wts of cans after steaming were :-

146g, 146g, 156g, 143g, 142g, 149g, 139g, 152g, 146g, 154g, 143g

Average wt = 147g

Standard deviation = 5g

Wt of final cans after sauce addition = 182-188g (35-41g sauce)

(Note tomato and onion pieces hindered flow of sauce into cans)

Temperature of fish after steaming = 75-80 degrees C

Temperature of fish and sauce prior to can seaming = 45-50 degrees C

One can opened, larger fish noticeable when compared with previous product.

Flavour of sauce good, slightly spicy, but a little watery. This could be water from the fish or breakdown of the starch. Further can to be examined after 1 week storage

1 Week Storage

Product appearance unchanged; probably caused by use of non retort stable starch.

Next trials will use our own recipe.

10th May 1994

2.10 Review of Trials

The following products were opened for evaluation by J. Mendolia, L. Mendolia, R. R. Minervini, W. Wych, P. Walsh

Trials 1/2/3	1st & 8th March 1994 All packed in olive oil, various pre-treatments of fish
Trial 4	15th March 1994 Canola Oil
Trial 5	22nd March 1994 Canola & Olive Oil - Travel trial
Trial 6	29th March 1994 Spring Water, Spring Water + Smoke Flavour, Olive Oil
Trial 7	12th April 1994 Further samples Spring Water & Olive Oil
Trial 8	26th April 1994 Fillets in Water & Olive Oil

Results

Overall impression was very favourable.
The earliest product had very good flavour suggesting oil penetration over time improving mouth feel, texture and rounding of flavour.
Few packs had noticeable water or curd in the oil, thus pre-cooking satisfactory and all the later products with higher fish infill gave a good impression of fish to 'sauce' ratio.
The smoke flavour had penetrated the fish and gave a distinctive flavour to the product packed in water. However, opinion was split between like very much and dislike.
The pomace oil had a deep yellow colour which was preferred over the alternative olive oil (trial 5) and the canola oil. However, Canola oil is considerably cheaper and the health benefits/colour of various vegetable oils to be investigated further.
Travel product was indistinguishable from standard.

17th May 1994

2.11 Heat Penetrations - Sardines in olive oil

Before refining the process further it was necessary to determine the Fo currently achieved and appropriate processing times for various temperatures.

Four cans were prepared with thermocouples in the centre using copper constantan 'T' type thermocouple wire.

Fish were brined as usual and then packed into the cans with the thermocouple junction piercing the flesh. Seven fish were packed tightly into each can and steamed horizontally for 15 minutes.

Wts of fish after steaming averaged 150g. Olive oil was added to fill completely (30-35g) and the cans seamed.

Probed cans plus a steam probe were then retorted and the retort plus can centre temperatures recorded. One can leaked but the other three cans gave consistent results. The slowest heating can was determined and the results plotted to determine Fh and j values.

RESULT

	Probes				Steam
TIME(mins)	8	9	10	11	12
0	50.1	47.0	47.2	49.5	40.0
2	49.8	46.8	47.2	49.2	47.0
4	50.2	48.2	48.5	49.5	71.0
6	53.0	51.7	55.5	50.7	95.0
8	56.0	54.5	61.5	53.0	100.0
10	60.8	59.3	67.7	56.7	104.0
12	64.7	63.6	76.8	60.9	116.0
14	86.2	73.6	97.1	68.0	116.0
16	90.8	82.0	100.0	75.7	122.0
18	92.2	98.5	105.0	81.6	123.0
20	95.5	91.8	Blown	86.6	121.0
22	98.6	97.1		91.7	121.0
24	102.1	101.2		95.5	120.0
26	105.3	104.7		98.7	120.8
28	108.3	107.5		101.7	120.0
30	110.7	109.8		104.2	120.5
32	112.1	112.0		106.5	120.5
34	113.6	113.6		108.0	120.3
36	114.8	114.8		110.0	120.8
38	115.7	115.7		111.6	120.7
40	116.6	116.6		112.8	121.3
42	117.2	117.4		114.0	121.0
44	118.6	118.6		115.2	120.5
46	118.4	118.8		116.3	121.3
48	118.7	119.1		116.8	120.8
50	119.1	119.5		117.3	121.3
52	119.7	119.8		118.0	121.1
54	119.7	120.0		118.4	120.9
56	120.1	120.2		118.9	121.4
58	120.0	120.4		119.2	121.1
60	120.1	121.5		119.4	120.9

Slowest Heating Pack = No. 11

Difference in temp (retort - pack) at various times with retort temp 121 degrees C

Time	Temp Diff
60 mins	1.6
58	1.8
56	2.1
54	2.6
52	3.0
50	3.7
48	4.2
46	4.7
44	5.8
42	7.0
40	8.2
38	9.4
36	11.0
34	13.0
32	14.5
30	16.8
28	19.3
26	22.3
24	25.5
22	29.3
20	34.4
18	39.4
16	45.3
14	53.0
12	60.0
8	68.0
4	71.0
0	72.0

RESULTS

The tabulated results, together with the graphical plot of the slowest heating can (No. 11) were used to obtain the following values :-

j	=	2.2
Fh	=	30 minutes
Initial temp	=	50 degrees C
Sterilising temp	=	121 degrees C

The Fo of this process (44 minutes) is given by :-

$$v = B/Fh - \log [j(Ti - To)/z] + 0.08$$
$$= 44/30 - \log [2.2(71)/10] + 0.08$$
$$= 1.467 - \log [15.62] + 0.08$$
$$= 1.467 - 1.194 + 0.08$$
$$v = 0.353$$

From Table 2 if $v = 0.353$ then $u = 0.092$

From Table 1 if $Ti = 121$ then $L = 0.977$

$$Fo = u \times Fh \times L$$
$$= 0.092 \times 30 \times 0.977$$

$$Fo = 2.7$$

With this data we can also calculate the process times at various temperatures to achieve an Fo = 3 minutes.

Thus to achieve an Fo = 3 at 121 degrees C
Then L = 0.977
u = Fo/(Fh x L)
= 3/(30 x 0.977)
u = 0.102

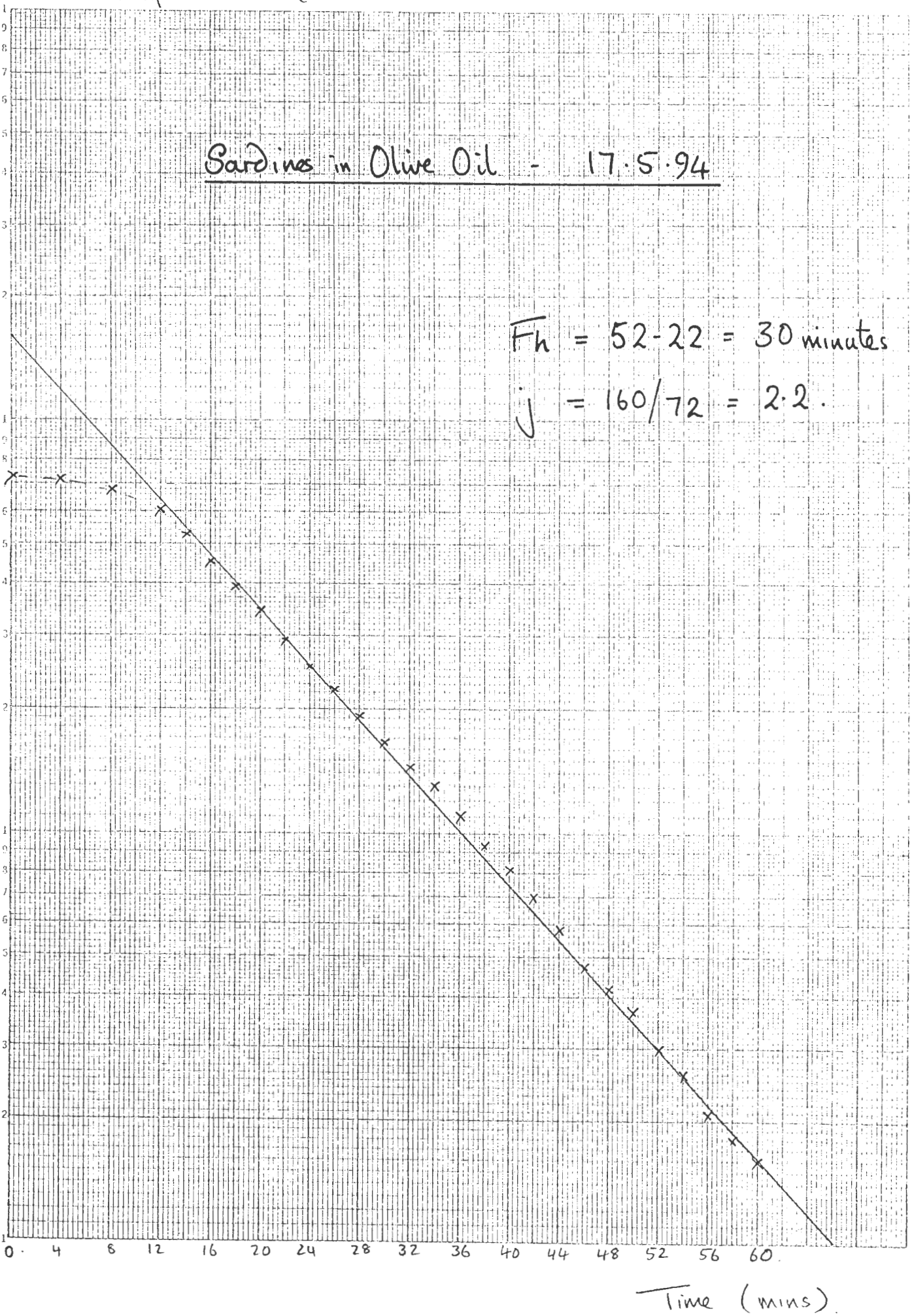
From table 2 if u = 0.102 then v = 380

B = Process Time required
B = Fh (v + log [j(Ti - To)/z] - 0.08)
= 30 (0.380 + log 15.62 - 0.08)
= 30 (0.380 + 1.194 - 0.08)
= 30 (1.494)
B = 45 minutes

Using the same calculations for other temperatures gives :-

For Fo = 3, process temp = 121 degrees C, time = 45 minutes
Fo = 3, process temp = 118 degrees C, time = 51 minutes
Fo = 3, process temp = 115 degrees C, time = 60 minutes

Steam Temp - Pack 11 ($T_1 - T_0$).



ssumed that cooling is started nmediately after heating is finished.

Values for T_O, T_I, f_h and j are eded. If j is not known, take j = 2 for nduction products and j = 1 for nvection products and count 2/3 the come-up time of the retort m 100°C to T_I as part of the ocess time B.

Although z is usually assumed to 10 Celsius degrees there may be tances where other values are ore appropriate. The value of z will etermine L since

$L = 10^a$ where $a = (T_I - 121.1)/z$

ere L is a measure of the rate of rilisation at a particular mperature; one minute at that mperature is equivalent to L nutes at the reference temperature 121.1°C.

ype I calculation

To find the process time B to attain equired F_O value:

..ter Table 1 with T_I to find L.

alculate $u = F_O/(f_h.L)$ to three ces of decimals.

ter Table 2 with this value of u to d v, interpolating to three places of ecimals.

hen

$= f_h.[v + \log[j.(T_I - T_O)/z] - 0.08]$ (2)

f j = 2 or j = 1 has been assumed, educt the come-up time correction obtain the process time B.

Type II calculation

To find the F_O value of a process of duration B:

If j = 2 or j = 1 has been assumed, add the come-up time correction to the process time B. Calculate

$v = B/f_h - \log[j.(T_I - T_O)/z] + 0.08$ (3)

to three places of decimals.

Enter Table 2 with this value of v to find u, interpolating to three places of decimals.

Enter Table 1 with T_I to find L.

Then $F_O = u.f_h.L$ (4)

AUTOMATION OF THE CALCULATIONS

The degree of automation depends to a certain extent on the number of available program steps and the size of the calculator's memory. For calculators having less than 300 program steps and a memory of less than 10 storage registers, it is possible only to automate the calculations for v and u and Table 2 must be used manually. The values in Table 1 and the associated calculations are easily handled by small calculators. Values of v and u are obtained from Table 2 by linear interpolation to three decimal places and this step is slow and may introduce errors in the calculation. The calculations were automated to the point where Table 2 was eliminated using a 600 series Wang programmable calculator. Approximately 400 program steps and ten storage registers were needed. Six storage registers were allocated to the storage of the six basic parameters of the calculation T_I, T_O, f_h, j, F_O and B.

There are about 500 values of v and u in Table 2 and this is too many for most programmable calculators. The data of the table was therefore reduced by fitting polynomials over selected portions of the plot of v *vs* u. The data was thereby reduced to six polynomials, five with a second order component and one linear. For values of v below -0.2, u and therefore F_O were set to zero. The table of coefficients for the polynomials and their appropriate ranges are described in Table 3.

These polynomials fitted the tabulated values to within 0.001 which is sufficiently accurate for all process calculations.

Calculating process time B F_O

The flow diagram for the program is presented in Figure 4. The first step in the program is to read in the data needed for the calculation, *ie* T_I, T_O, f_h, j and F_O and the register allocated for process time B is set to zero.

Table 1

Values of L for temperatures ranging from 100° C to 130.9° C in 0.1° C intervals

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
00	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.010	0.010
01	0.010	0.010	0.010	0.010	0.011	0.011	0.011	0.011	0.012	0.012
102	0.012	0.013	0.013	0.013	0.013	0.014	0.014	0.014	0.015	0.015
103	0.015	0.016	0.016	0.017	0.017	0.017	0.018	0.018	0.019	0.019
104	0.019	0.020	0.020	0.021	0.021	0.022	0.022	0.023	0.023	0.024
05	0.025	0.025	0.026	0.026	0.027	0.028	0.028	0.029	0.030	0.030
06	0.031	0.032	0.032	0.033	0.034	0.035	0.035	0.036	0.037	0.038
107	0.039	0.040	0.041	0.042	0.043	0.044	0.045	0.046	0.047	0.048
108	0.049	0.050	0.051	0.052	0.054	0.055	0.056	0.058	0.059	0.060
109	0.062	0.063	0.065	0.066	0.068	0.069	0.071	0.072	0.074	0.076
10	0.078	0.079	0.081	0.083	0.085	0.087	0.089	0.091	0.093	0.095
11	0.098	0.100	0.102	0.105	0.107	0.110	0.112	0.115	0.117	0.120
12	0.123	0.126	0.129	0.132	0.135	0.138	0.141	0.145	0.148	0.151
113	0.155	0.158	0.162	0.166	0.170	0.174	0.178	0.182	0.186	0.191
114	0.195	0.200	0.204	0.209	0.214	0.219	0.224	0.229	0.234	0.240
15	0.245	0.251	0.257	0.263	0.269	0.275	0.282	0.288	0.295	0.302
16	0.309	0.316	0.324	0.331	0.339	0.347	0.355	0.363	0.372	0.380
17	0.389	0.398	0.407	0.417	0.427	0.437	0.447	0.457	0.468	0.479
118	0.490	0.501	0.513	0.525	0.537	0.550	0.562	0.575	0.589	0.603
119	0.617	0.631	0.646	0.661	0.676	0.692	0.708	0.724	0.741	0.759
20	0.776	0.794	0.813	0.832	0.851	0.871	0.891	0.912	0.933	0.955
21	0.977	1.000	1.023	1.047	1.072	1.096	1.122	1.148	1.175	1.202
22	1.230	1.259	1.288	1.318	1.349	1.380	1.413	1.445	1.479	1.514
123	1.549	1.585	1.622	1.660	1.698	1.738	1.778	1.820	1.862	1.905
124	1.950	1.995	2.042	2.089	2.138	2.188	2.239	2.291	2.344	2.399
25	2.455	2.512	2.570	2.630	2.692	2.754	2.818	2.884	2.951	3.020
26	3.090	3.162	3.236	3.311	3.388	3.467	3.548	3.631	3.715	3.802
27	3.890	3.981	4.074	4.169	4.266	4.365	4.467	4.571	4.677	4.786
128	4.898	5.012	5.129	5.248	5.370	5.495	5.623	5.754	5.888	6.026
129	6.166	6.310	6.457	6.607	6.761	6.918	7.079	7.244	7.413	7.586
30	7.762	7.943	8.128	8.318	8.511	8.710	8.913	9.120	9.333	9.550

The values of L (Eq. 1) and m are then calculated for $z = 10$ where

$$m = \log[j.(T_I - T_O)/z]$$

A test of the register allocated for B is made and when it is zero B is calculated by evaluating u, where

$$u = F_O/(f_h.L)$$

The value of u determines the appropriate coefficient to be used (Table 3) and v is calculated from the equation

$$v = \{-b + \sqrt{[b^2 - 4.a.(c-u)]}\}/2.a$$

except where the value of u is greater than 2.8 where v is calculated from the equation

$$v = u + 0.613$$

B is then given by

$$B = f_h.(v + m)$$

and the answer is printed.

Calculating sterilising value Fo

Values for T_I, T_O, f_h, j and B are placed into the appropriate registers and the register for F_O is set to zero. F_O is calculated by first evaluating v, where

$$v = (B/f_h) - m$$

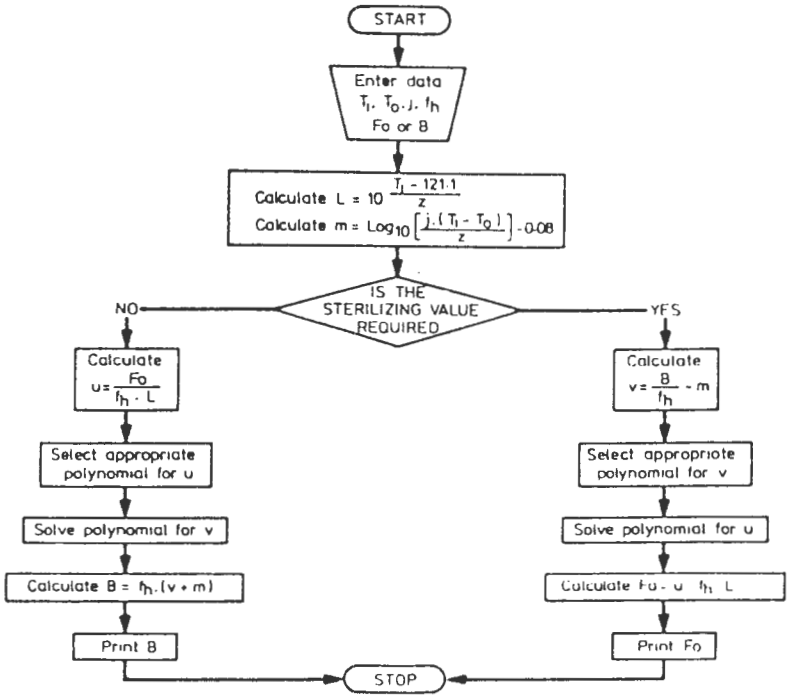


Figure 4. Flow diagram of the program of thermal process calculations.

Table 2
Values of u for v ranging from -0.2 to 3.49

v	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-0.2	0.003	0.003	0.003	0.003	0.004	0.004	0.005	0.005	0.005	0.006
-0.1	0.006	0.007	0.008	0.008	0.009	0.010	0.010	0.011	0.012	0.013
0.0	0.014	0.015	0.016	0.017	0.019	0.020	0.021	0.022	0.024	0.025
0.1	0.027	0.029	0.030	0.032	0.034	0.036	0.038	0.040	0.042	0.044
0.2	0.047	0.049	0.051	0.054	0.057	0.059	0.062	0.065	0.068	0.071
0.3	0.074	0.077	0.080	0.084	0.087	0.091	0.094	0.098	0.102	0.106
0.4	0.110	0.114	0.118	0.122	0.126	0.131	0.135	0.140	0.144	0.149
0.5	0.154	0.159	0.164	0.169	0.174	0.179	0.184	0.190	0.195	0.201
0.6	0.206	0.212	0.218	0.223	0.229	0.235	0.241	0.247	0.253	0.260
0.7	0.266	0.272	0.279	0.285	0.292	0.298	0.305	0.312	0.318	0.325
0.8	0.332	0.339	0.346	0.353	0.360	0.368	0.375	0.382	0.390	0.397
0.9	0.404	0.412	0.419	0.427	0.435	0.442	0.450	0.458	0.466	0.474
1.0	0.482	0.490	0.498	0.506	0.514	0.522	0.530	0.538	0.546	0.555
1.1	0.563	0.571	0.580	0.588	0.597	0.605	0.614	0.622	0.631	0.639
1.2	0.648	0.657	0.665	0.674	0.683	0.692	0.700	0.709	0.718	0.727
1.3	0.736	0.745	0.754	0.763	0.772	0.781	0.790	0.799	0.808	0.817
1.4	0.826	0.835	0.844	0.853	0.863	0.872	0.881	0.890	0.900	0.909
1.5	0.918	0.927	0.937	0.946	0.955	0.965	0.974	0.984	0.993	1.002
1.6	1.012	1.021	1.031	1.040	1.050	1.059	1.069	1.078	1.088	1.097
1.7	1.107	1.116	1.126	1.136	1.145	1.155	1.164	1.174	1.184	1.193
1.8	1.203	1.212	1.222	1.232	1.241	1.251	1.261	1.270	1.280	1.290
1.9	1.300	1.309	1.319	1.329	1.339	1.348	1.358	1.368	1.378	1.387
2.0	1.397	1.407	1.417	1.426	1.436	1.446	1.456	1.466	1.475	1.485
2.1	1.495	1.505	1.515	1.524	1.534	1.544	1.554	1.564	1.574	1.584
2.2	1.593	1.603	1.613	1.623	1.633	1.643	1.653	1.662	1.672	1.682
2.3	1.692	1.702	1.712	1.722	1.732	1.742	1.751	1.761	1.771	1.781
2.4	1.791	1.801	1.811	1.821	1.831	1.841	1.851	1.860	1.870	1.880
2.5	1.890	1.900	1.910	1.920	1.930	1.940	1.950	1.960	1.970	1.980
2.6	1.990	2.000	2.009	2.019	2.029	2.039	2.049	2.059	2.069	2.079
2.7	2.089	2.099	2.109	2.119	2.129	2.139	2.149	2.159	2.169	2.179
2.8	2.189	2.199	2.209	2.219	2.229	2.239	2.248	2.258	2.268	2.278
2.9	2.288	2.298	2.308	2.318	2.328	2.338	2.348	2.358	2.368	2.378
3.0	2.388	2.398	2.408	2.418	2.428	2.438	2.448	2.458	2.468	2.478
3.1	2.488	2.498	2.508	2.518	2.528	2.538	2.548	2.558	2.568	2.578
3.2	2.588	2.598	2.608	2.618	2.628	2.638	2.648	2.658	2.668	2.678
3.3	2.688	2.698	2.708	2.718	2.728	2.738	2.748	2.758	2.768	2.778
3.4	2.788	2.797	2.807	2.817	2.827	2.837	2.847	2.857	2.867	2.877

24th May 1994

2.12 Trial Code 10 - Alternative oils

Purpose

To evaluate alternative oils to pomace olive oil following the 10th May review. This review agreed that the deeper yellow colour of pomace olive oil was preferred over virgin olive oil and canola from trials to date. However, consideration also needs to be given to health benefits and price.

Three oils were selected to compare with the pomace :-

1. Meadow Lea 'Sunola' - high mono unsaturated sunflower oil
2. Meadow Lea 'Canola' - lowest saturated fat rape seed oil
3. Soya Bean Oil - chosen for deep colour

Detail

Previously frozen trunk sardines were defrosted, tailed and brined for 10 minutes in 10% salt solution. The sardines were oiled then packed 6 or 7 per can and the cans steamed whilst horizontal for 15 minutes at atmospheric pressure.

Cans were rinsed of obvious curd, drained and then filled with the various oils to fill weight 185g (180g net). After seaming the cans were processed for 60 minutes at nominal 115^{o}C.

Results

Wt. of frozen trunks 99 fish	= 2.87kg	= 29g each
Wt of defrosted tailed trunks	= 2.62kg	= 26.5g each
Wt. of tails	= 0.16kg	= 1.6g each
Wt. of trunks after brining	= 2.73kg	= 27.6g

Can infill weights after steaming

6 fish per can 140g, 149g, 159g, 156g, 147g, 142g, 161g, 153g, 148g, 133g
Ave = 149g

7 fish per can 150g, 148g, 166g, 154g, 163g
Ave = 156g

All cans filled to 185g net, thus average wt. of oil = 34g

Comments on Product Evaluation

The various products were opened and evaluated by J. Mendolia, R. Minervini, W. Wych, S. Pratley (FRDC) and P. Walsh.

The olive oil was preferred for overall flavour and colour. Closest in colour was the soya oil and this yellow colour is also found in Norwegian sardines canned in sild oil. Soya, however, has no perceived health benefits.

The canola and sunola were similar in colour - pale yellow/green, almost colourless. Of the 2 canola is the most well known and has "healthy" connotations.

At this stage both olive oil and canola to be developed further for taste panel evaluation. P.W. to check a) whether canola can be prepared with a more yellow colour

b) whether the use of olive oil would prevent the use of Product of Australia on the label

14th June Answer to both questions "No".

14th June 1994

2.13 Trial Code 11 - Tomato sauce

Purpose

To prepare samples of sardines in a heat stable tomato sauce for initial evaluation. These samples would determine further direction.

Detail

Sardine trunks prepared from IQF fish were cut to length (approx 85mm) weighed then brined for 10 minutes in a 10% solution.
After rinsing and oiling the fish were packed 6 per can head to tail (large fish) and then steamed horizontally at atmospheric pressure for about 20 minutes.
Cans were drained and inverted prior to filling with sauce prepared as a cold mix to the following recipe.

400g tomatoes - canned
50g tomato paste
1/2 teaspoon basil (dried)
1/4 teaspoon oregano (dried)
5g sugar
20g onion
5g Colflo 67 in 50g water

The mix was found slightly thick to pour and a few cans were prepared where the whole mix was diluted 20% with water.

Results

Wt. of fish after tailing 75 fish total 2.4kg thus 32g per fish
Actual wts. of cans after steaming :-
143g, 150g, 142g, 148g, 152g, 155g, 141g, 131g, 149g, 148g, ave = 146g
standard deviation = 7g
Wt. of cans after sauce addition = 185g thus 40g sauce added.
Temp of fish and sauce prior to canning = 50^{o}C.
Immediately on opening the diluted sauce had good viscosity whilst the thicker sauce had separated into water and 'lumpy' parts.
The diluted sauce will be used as the base for further trials

21st June 1994

2.14 Trial Code 12 - Alternative tomato sauce

Purpose

Prepare further samples of sardines in various tomato based sauces for evaluation

Detail

Previously frozen IQF trunks were defrosted, brined for 10 minutes in a 10% solution and steamed in pre-oiled cans prior to filling with sauce. By steaming slightly tilted from the horizontal the cans drained well with little residual curd.
Four sauce recipes were prepared as follows :-

Mix A	400g Tomatoes (canned, liquidised) 60g Tomato paste 150g Water 5g Colflo (blended in water) 20g Onion (fine chopped) 2g Basil 1g Oregano 5g Sugar
Mix B	As Mix A but add 5g crushed garlic
Mix C	As Mix A but add 5g crushed garlic and 2g crushed chilli
Mix D	As Mix A but add 10g crushed garlic and 4g crushed chilli

Results

Smaller fish than most recent trials used. Average weight in can after steaming was 133g for 7 fish. This required 50g sauce to achieve declared net weight of 180g. Initial appearance on opening - 1 can each of A and D (processed on their side) were opened after cooking. Sauce was slightly thin and flavours not strong. All products to be tried again after storage for two weeks. Note the cans were processed vertically then inverted to store.

5th July 1994

2.15 Trial Code 13 - Use of natural flavours

Purpose

Continued development of tomato based sauces using natural fried flavours to replace the onion and garlic. This will allow comparison with the "boiled" garlic and onion from previous trials.

Detail

Previously frozen IQF trunks were used as the base material and the cans prepared in the same way as for Trial 12.
Two recipes were made up with the following ingredients :-

Mix A	400g Tomatoes (canned, liquidised)
	70g Tomato paste
	150g Water
	7g Colflo (blended in water)
	2g Basil (dried)
	6g Sugar
	3g Salt
	2g Nat. fried onion flavour
	1g Nat. fried garlic flavour
	1g Italian spice mix
Mix B	To 300g Mix A was added
	extra 2g Nat. fried onion flav.
	1g Italian spice mix
	1g Nat. fried garlic flav.

Results

Samples opened immediately after cooling showed no separation, but some variation in sauce viscosity. Basil particle size small - add last to mix. Flavours acceptable, but more detailed assessment required after storage. Two samples from Trial 12 opened again - sauce now thicker and less separated (cans stored upside down) and flavour differences more obvious. All tomato sauce products to be reviewed.

19th July 1994

2.16 Trial Code 14 - Baader 134 process

Purpose

1. Trial the Baader 134 to prepare fish headed, gutted and cut to can length
2. Prepare further samples of sardines in olive oil using the above fish

Detail

Previously frozen IQF whole fish were defrosted in fresh water and then prepared through the Baader. Cut length of the tail section was adjusted to give a trunk slightly shorter than the length of the can. Over 100 fish were cut, brined (10% for 10 minutes), steamed (20 mins; horizontal) and canned as previously

Results

The sardines were unusually large, resulting in probably a worst case yield loss on cutting.

Average weight of whole fish - 50g

Average weight of trunks - 30g

Yield 60%

The 8th April costing assumed a 40g sardine and a 62.5% yield. This also assumed 7 fish per can 280g whole weight compared with 6 fish x 50g = 300g whole weight.

After steaming infill weights for 6 fish averaged 155g with range 140-170g and S.D. = 9g. Again, the 8th April costing assumed a 145g infill with a corresponding higher sauce weight.

It was also noted that cans rinsed and drained after steaming and stored for a couple of minutes could be drained of a further 7g of water prior to filling with oil. This needs to be considered in the process design.

On opening immediately after cooking product was difficult to remove from the new ring pull cans. Although removing the product stripped skin from the fish skin was also adhering to the can wall from being tightly packed during steaming.

Further consideration of ring pull cans and release coated lacquer is required.

Flavour and overall appearance (apart from skin retention) was good

One can opened 2/8 - olive oil slightly cloudy. The can was cold ($< 20^{o}C$) and this may be a temperature effect (to be checked). Flavour was good

2nd August 1994

2.17 Trial Code 15 - Commercial tomato sauce

Purpose

To prepare samples of sardines in tomato using a local commercial sauce preparation from Triou Foods. Two products were supplied; Italian style and base Salsa

Detail

Previously frozen IQF whole fish from Bremer Bay had been defrosted in fresh water and were being trunked using the Baader 134. These trunks were used with the tails hand cut to the length of the can.
The fish were brined for 10 minutes in 10% salt solution, rinsed, packed into pre-oiled cans (6 fish per can), steamed for 20 minutes horizontally, drained and filled with the sauce before seaming and retorting at 115^{o}C for 60 minutes.
Ingredient declarations for the sauces were :-

Natural Italian Sauce - Crushed tomatoes, tomato paste, onions, capsicum, carrots, salt, sugar and selected spices
Fresh Salsa - Tomatoes, salt, sugar

Results

Average weight of the trunks prior to brining = 25g
Average weight of 6 fish after steaming = 125g (21g each)
Infill weight of sauce; average 55g

Note: the salsa was more finely chopped and filled without difficulty; the Italian sauce was too chunky for machine filling as the pieces would prevent the cans from filling completely

2nd August 1994

2.18 Trial Code 16 - Spring water

Purpose

Prepare further samples of sardines in spring water using the most recent standard process

Detail

Previously frozen IQF whole fish from Bremer Bay were used and prepared in the same way as for Trial Code 15, except that 7 fish per can were packed prior to steaming.

After steaming the cans were stood for a few minutes prior to draining and filling with spring water. Less than 10g liquid per can were drained on average. If "cook water" remains in the cans when topped up with spring water the finished product will be less attractive when emptied from the can.

Processing was again 115^{o}C for 60 minutes

Results

Average weight of the trunks prior to brining = 25g

Average weight of the 7 fish after steaming = 148g (21g)

Infill weight of spring water (Summit) average 37g

12th August 1994

2.19 Product Review - Tomato sauce

J. Mendolia, R. Minervini, W. Wych, P. Walsh

1. Ring Pull Cans

A difficulty had been noted with the ring pull cans where the lip formed on removal of the end prevented easy removal of the sardines.

This was tested with a number of packs containing oil, water and tomato. In all cases the sardines were hard to remove. A major cause of this is the tight packing of sardines into the cans to give the highest sardine to sauce ratio possible.

A decision was taken not to proceed with the use of ring pull cans. Some of the cost saving may be spent on a gold lacquered end to improve the image on shelf.

2. Tomato Sauce Recipes

Trial codes 12, 13 and 15 were evaluated. Trial code 15 used commercial sauces from Triou Foods. The base salsa was too bland and the Italian style not as good as Code 12 or 13. The option of using Triou Foods to prepare the sauce can be looked at once we have a preferred recipe.

There were some differences noted between the various recipes under Codes 12 and 13 with overall Code 13 Mix A or B considered good enough to evaluate further with more consumers. A larger batch to be prepared and costed.

3. Olive Oil

Trial Code 14 was re-evaluated as the oil in a can opened previously had been cloudy. Whilst the oil was thick and slightly opaque this is probably a temperature effect. Flavour and texture was good.

4. Spring water

Trial Code 16 was examined. Good clear water with little debris from the sardines was found. Skin retention was only moderate

2.20 Trial Code 17 - Further alternative tomato sauce

Purpose

1. Prepare a further batch of sardines in tomato sauce using trial code 13 recipes
2. Evaluate an alternative tomato sauce recipe using fresh parsley and fresh onion.

Detail

Previously frozen IQF trunks were defrosted, brined for 10 minutes in a 10% solution and steamed in preoiled cans for 20 minutes prior to filling with sauce.
The cans were steamed horizontally with a slight slope to drain liquid and then allowed to stand five minutes before filling.

Mix A Recipe	400g Canned Tomatoes - liquidised
	70g Tomato Paste
	150g Water
	7g Colflo (blended in water)
	2g Basil (dried)
	6g Sugar
	3g Salt
	2g Nat. fried onion flavour
	1g Nat. fried garlic flavour
	1g Nat. Italian spice mix
Mix B Recipe	370g Tomato Sauce (J. Mendolia)
	1/2 onion chopped fine
	3 tbsp parsley chopped fine
	4g Colflo

Results

Average wt. of trunks prior to steaming = 23g
Average wt. of 7 fish in can prior to sauce addition = 137g (S.D. = 8g)
Average wt. per fish = 19.6g
Sauce added to 185g total wt. - ave. = 52g

One can of each mix assessed on 6th September. Mix A very similar to previous product, good strong flavour, some variation in viscosity of sauce within pack.
Mix B much thinner with light flavour - to be assessed by J. Mendolia

Recipe Cost - Tomato Sauce Code 17A

			$/Batch
Canned Tomatoes	400g	@ 1.20/kg	0.480
Tomato Paste	70g	@ $1.80/kg	0.126
Water	150g		
Colflo	7g	@ $1.80/kg	0.013
Basil (dried)	2g	@ $15/kg	0.030
Sugar	6g	@ $0.70/kg	0.004
Salt	3g	@ $0.30/kg	0.001
Fried Onion Flavour	2g	@ $20.87/kg	0.042
Nat Fried Garlic Flav	1g	@ $56.55/kg	0.057
Nat Italian Spice Mix	1g	@ $28.25/kg	0.028
	645g		0.781

Sauce Cost/kg = $1.21

9th September 1994

2.21 Trial Code 18 - Use of meat release lacquer

Purpose

Evaluate the effectiveness of meat release lacquer coating in the can on the amount of skin removed during the process.

Detail

The closest available size was a 74 x 112 mm can and therefore this was used for the trial.

Previously frozen IQF trunks (same batch as Trial 17) were defrosted, brined and packed into the cans 15 or 16 fish per can.

The cans were steamed for 15 minutes horizontally with a slight slope to drain the liquid and then filled with spring water or vegetable oil. Seamed cans were processed for 70 minutes at 118^{o}C.

6 cans were prepared with the following combinations :-

1 can pre-oiled + spring water
1 can pre-oiled + veg oil
2 cans no pre-oiling + spring water
2 cans no pre-oiling + veg oil

Results

Average weight of fish prior to steaming 24g. (Note only the tail fins were cut to fit the can)

Code 18 (Additional)

Cans opened 30/9/94. Sardines had lost skin adhering to the beading of the can wall giving a striped effect. Whilst the use of the meat release lacquer did not prevent skin from being removed where in contact with the can wall, there was little difference between the pre-oiled cans and the others.

If we could achieve the same quality as currently without pre-oiling cans this would be a benefit. If possible the next batch of trial cans should be made with this lacquer and without ring pull ends.

Since the sardines pack well into the 74 x 112.5mm can with just the tail removed this offers another can size option for the Food Service.

15th September 1994

2.22 Trial Code 19 - Heat penetrations; sardines in spring water

Purpose

1. Determine process parameters by heat penetrations for sardines in spring water
2. Prepare further sample cans of sardines in spring water

Detail

6 cans were prepared with copper constantan thermocouples soldered at the junction and araldite glued through the can wall close to the centre of the cans (as previously). IQF frozen sardine trunks were defrosted, cut to length and brined for 10 minutes in a 10% solution. After washing these were packed 8 to a can with a fish pierced by the thermocouple in each can. A further 6 plain cans were also packed with 8 fish per can.

All cans were steamed horizontally, drained of liquor and then filled with spring water before seaming and retorting.

Results

The detailed results from the heat penetration experiment are tabulated below.

Average weight of fish prior to brining = 21g

8 fish were packed per can, thus 168g per can pre-steaming.

Average weights after steaming were 140g (17.5g per fish)

Results - Heat Penetration Sardines in Spring Water

Time(mins)	Probe 1	Probe 3	Probe 4	Probe 5	Probe 6	Steam
0	35.6	35.7	35.7	36.7	35.0	38.0
2	35.8	36.0	36.0	-	-	60.7
4	50.2	-	42.3	37.6	42.6	72.6
7	77.6	58.7	83.6	54.5	66.7	89.3
10	91.6	89.9	88.9	74.8	81.8	99.8
12	-	-	-	84.7	-	105.0
13	106.2	102.6	104.2	92.6	-	113.3
16	114.0	-	113.0	106.8	-	117.5
18	-	112.7	-	109.9	113.2	117.4
21	114.6	-	115.1	113.2	114.9	118.0
24	116.8	115.3	115.6	115.2	116.8	117.4
26	117.1	115.0	115.4	115.6	117.1	117.6
28	-	115.5	115.4	115.8	117.3	117.0
31	117.3	-	115.7	116.6	117.3	117.6
33	-	115.8	-	116.8	-	118.0
36	117.6	116.3	116.1	117.0	117.7	118.4

Probe 2 was blown, therefore no data recorded. Crude plots of the data indicated Probe 5 to be the slowest heating pack.

Steam temperature of 118°C was taken and the difference in temperature between the steam and probe 5 ($T_1 - T_0$) calculated.

Time	T_1-T_0	Time	T_1-T_0
0	81.3	18	8.1
4	80.4	21	4.8
7	63.5	24	2.8
10	43.2	26	2.4
12	33.3	28	2.2
13	25.4	31	1.4
16	11.2	33	1.2
		36	1.0

The log plot of this data shows a broken heating curve. The safest calculations, therefore, give

j	=	1.4
Fh	=	28 minutes
Initial temp	=	37°C
Sterilising temp	=	118°C

The process was continued for 45 minutes
Fo for this process is given by

$$v = B/Fh - \log [j(T_1-T_0)/z] + 0.08$$
$$= 45/28 - \log [1.4(81)/10] + 0/08$$
$$= 1.607 - \log [11.34] + 0.08$$
$$= 1.607 - 1.055 + 0.08$$
$$= 0.632$$

From tables $v = 0.632$ then $U = 0.224$
$T_1 = 118$ then $L = 0.490$

$Fo = U \times Fh \times L$

$= 0.224 \times 28 \times 0.490$

$Fo = 3.1$ minutes

From this data process times at various temperatures can be determined to achieve an Fo = 3 minutes.

Thus, to achieve an Fo = 3 at 121°C
Then $L = 0.977]$
$U = Fo/Fh \times L$
$= 3/28 \times 0.9777$
$= 0.110$

From tables if u = 0.110, v = 0.375

B = Process time required

$B = Fh((v + \log [j(T_1-T_0)/z] - 0.08)$

$= 28((0.375 + \log [1.4(84)/10] - 0.08)$

$= 28((0.375 + \log 11.76) - 0.08)$

$= 28((0.375 + 1.07) - 0.08)$

$= 38.22$ minutes

Using the same calculations for other temperatures gives

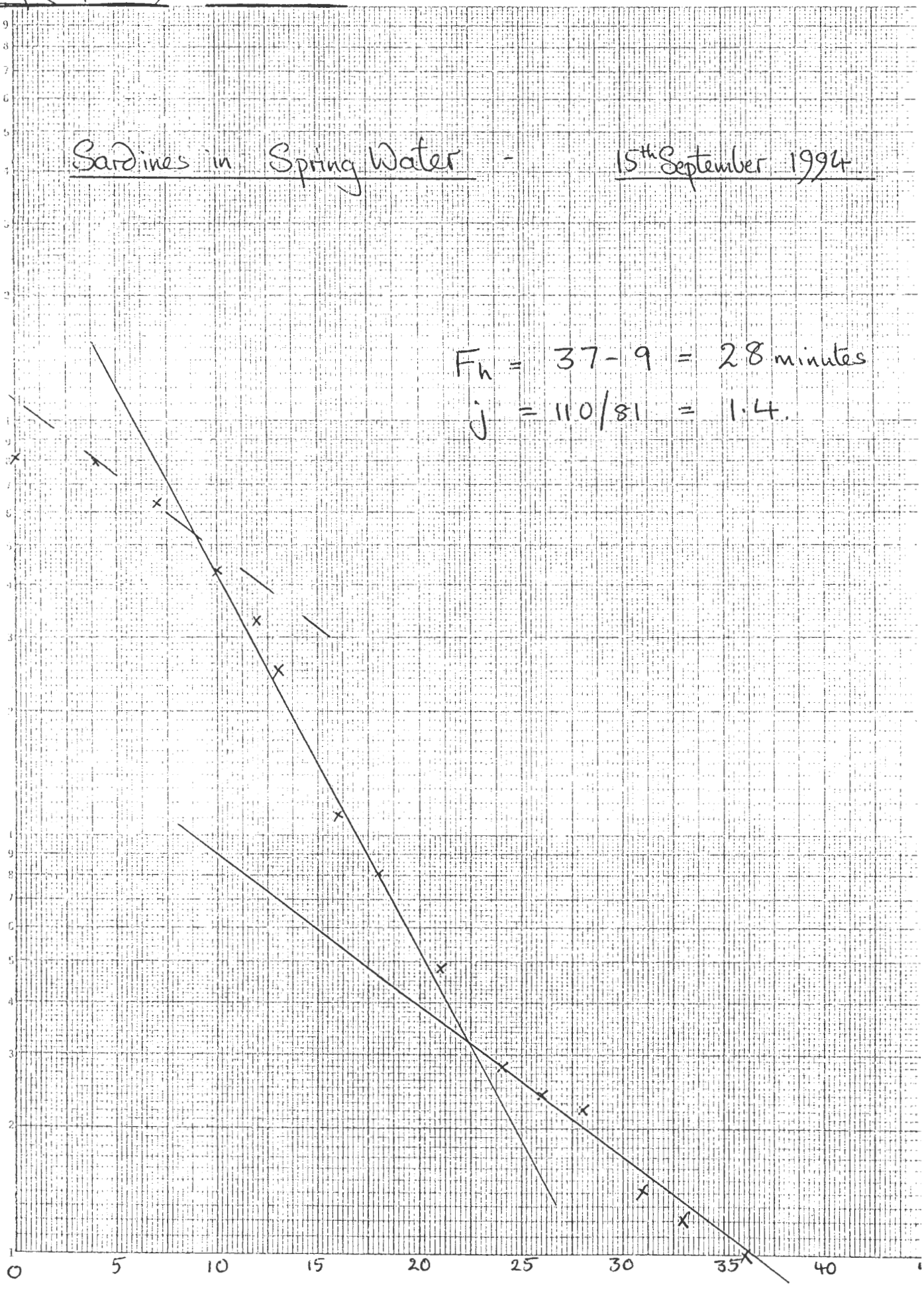
For	Fo = 3,	process temp =	121°C,	time	= 39 minutes
	Fo = 3		118°C,		= 45 minutes
	Fo = 3		115°C,		= 54 minutes

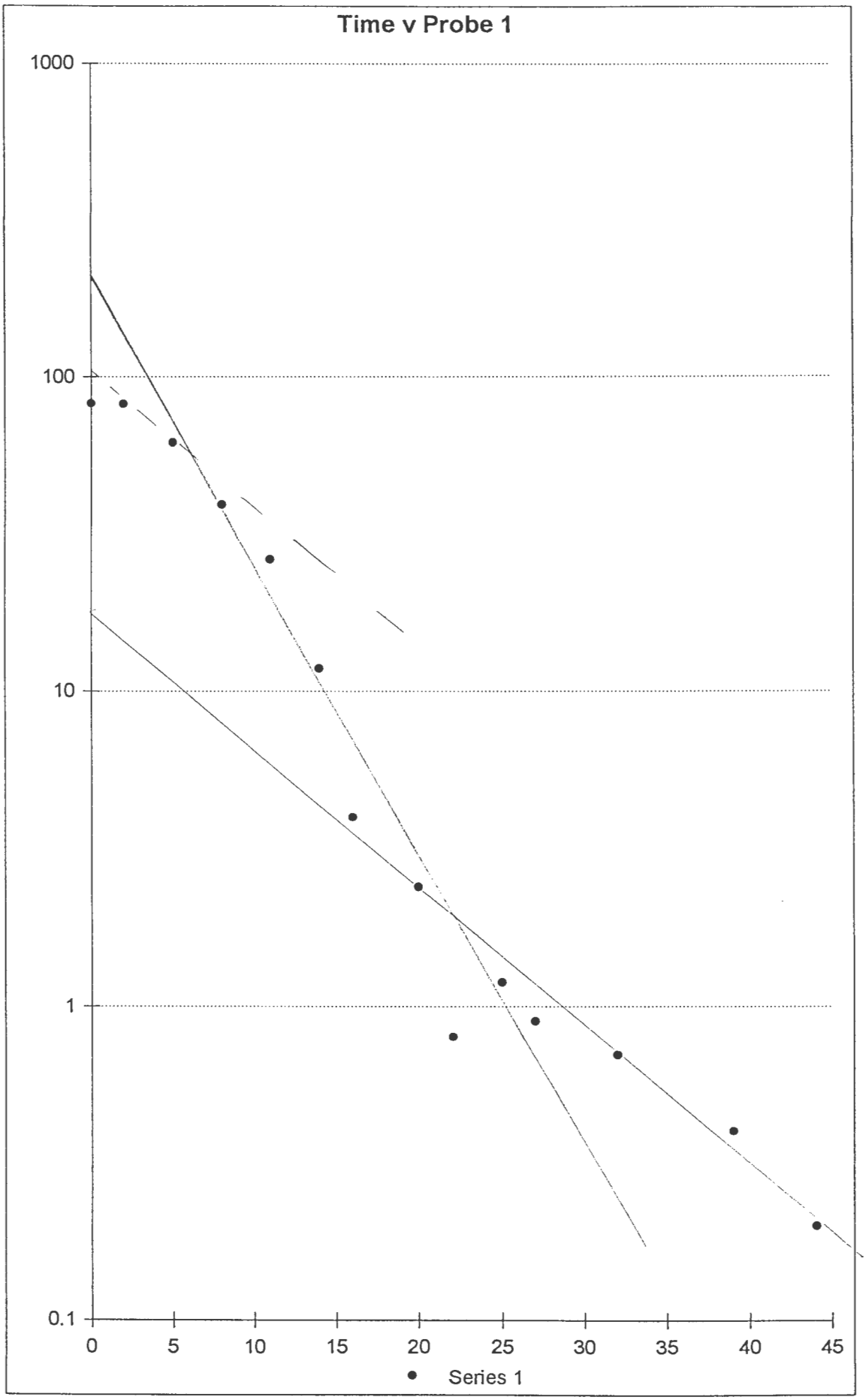
Can Code 19 - (Additional)

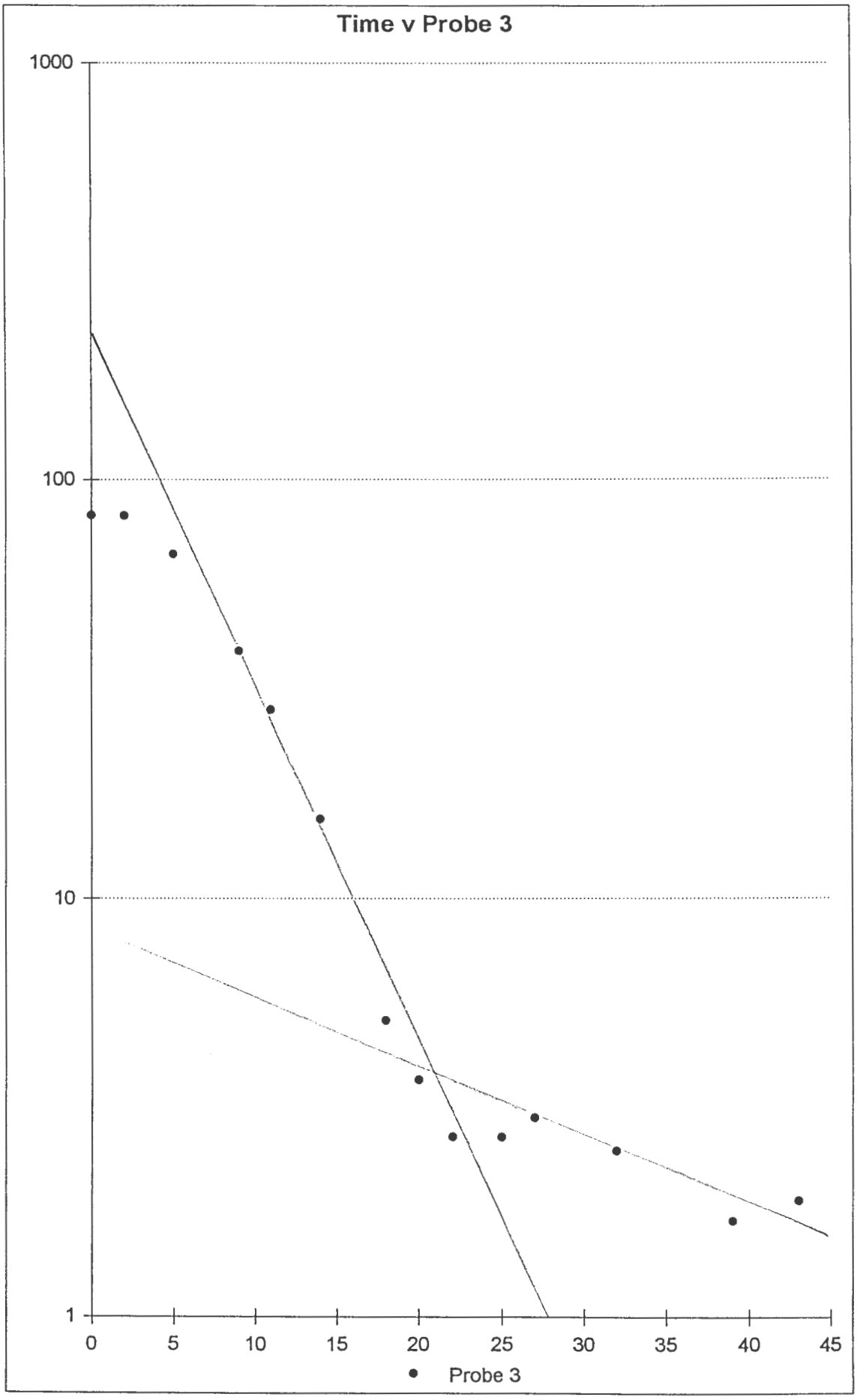
Two cans of spring water were opened on 30/9. Flavour, texture and appearance were to standard. The spring water contained some small fish particles which detracted from appearance, but since this is likely to be discarded on opening it may not influence customer opinion.

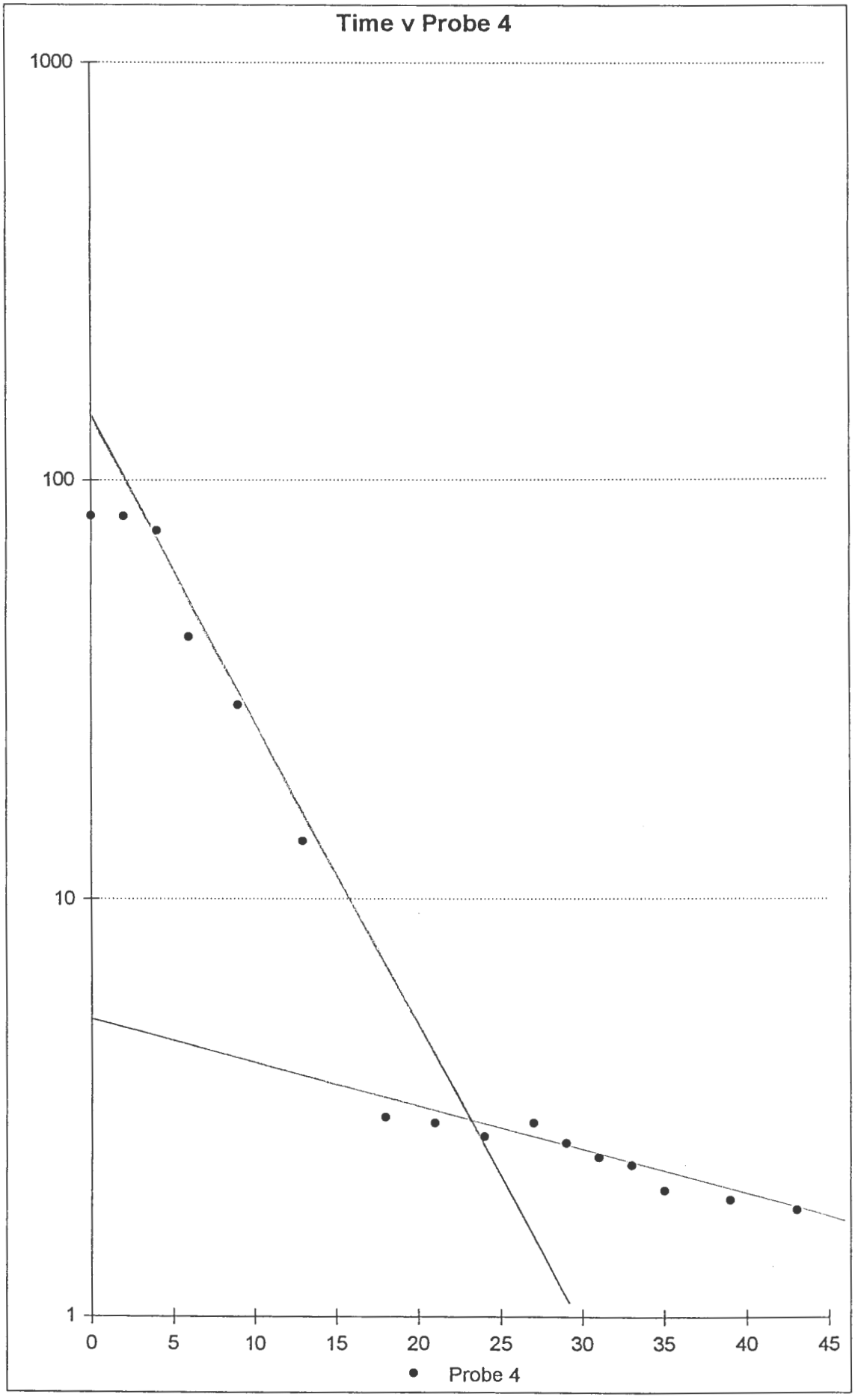
The cans from the heat penetrations were opened. All were in good condition

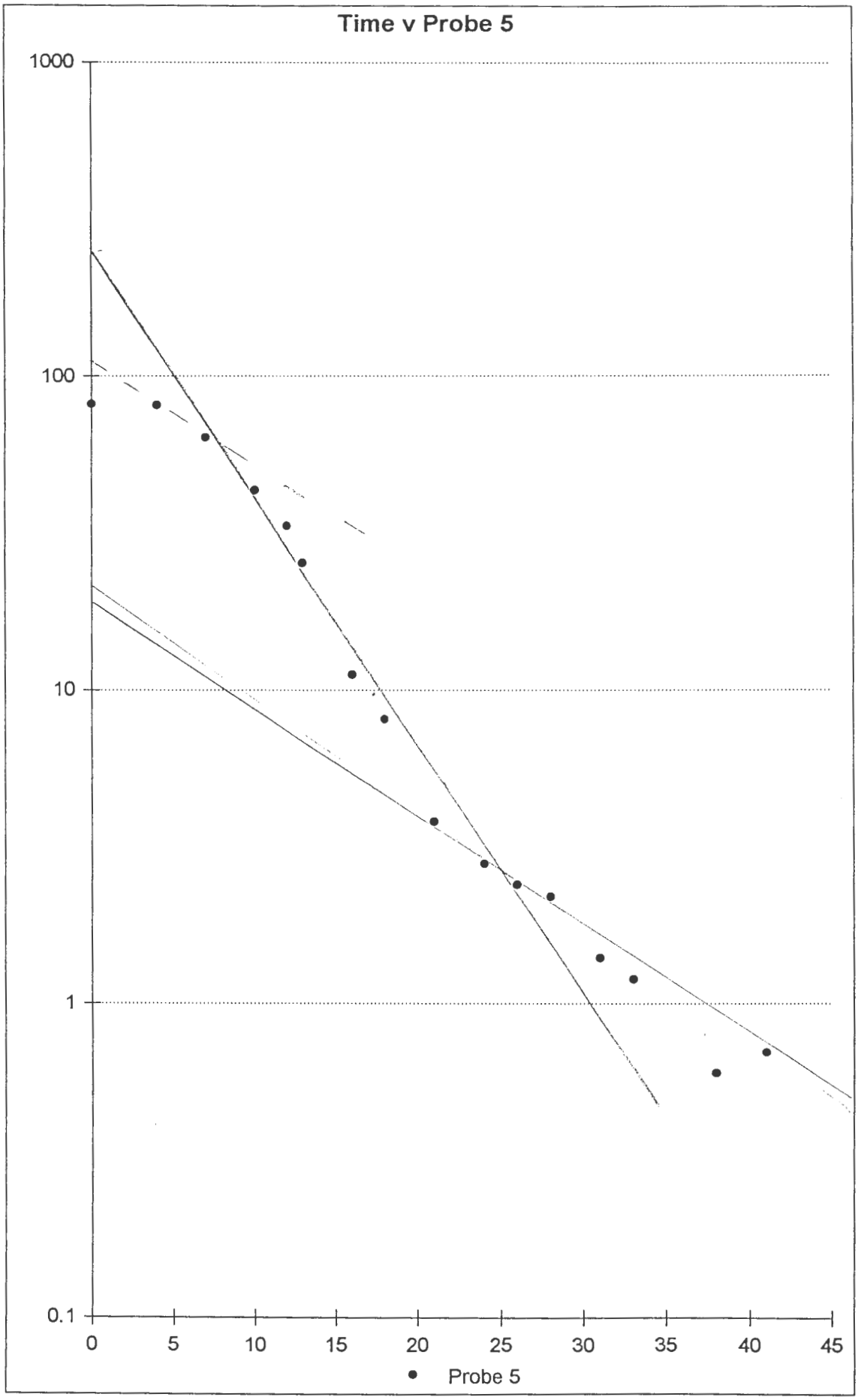
Temp $(T_1 - T_0)$ - Probe 5.

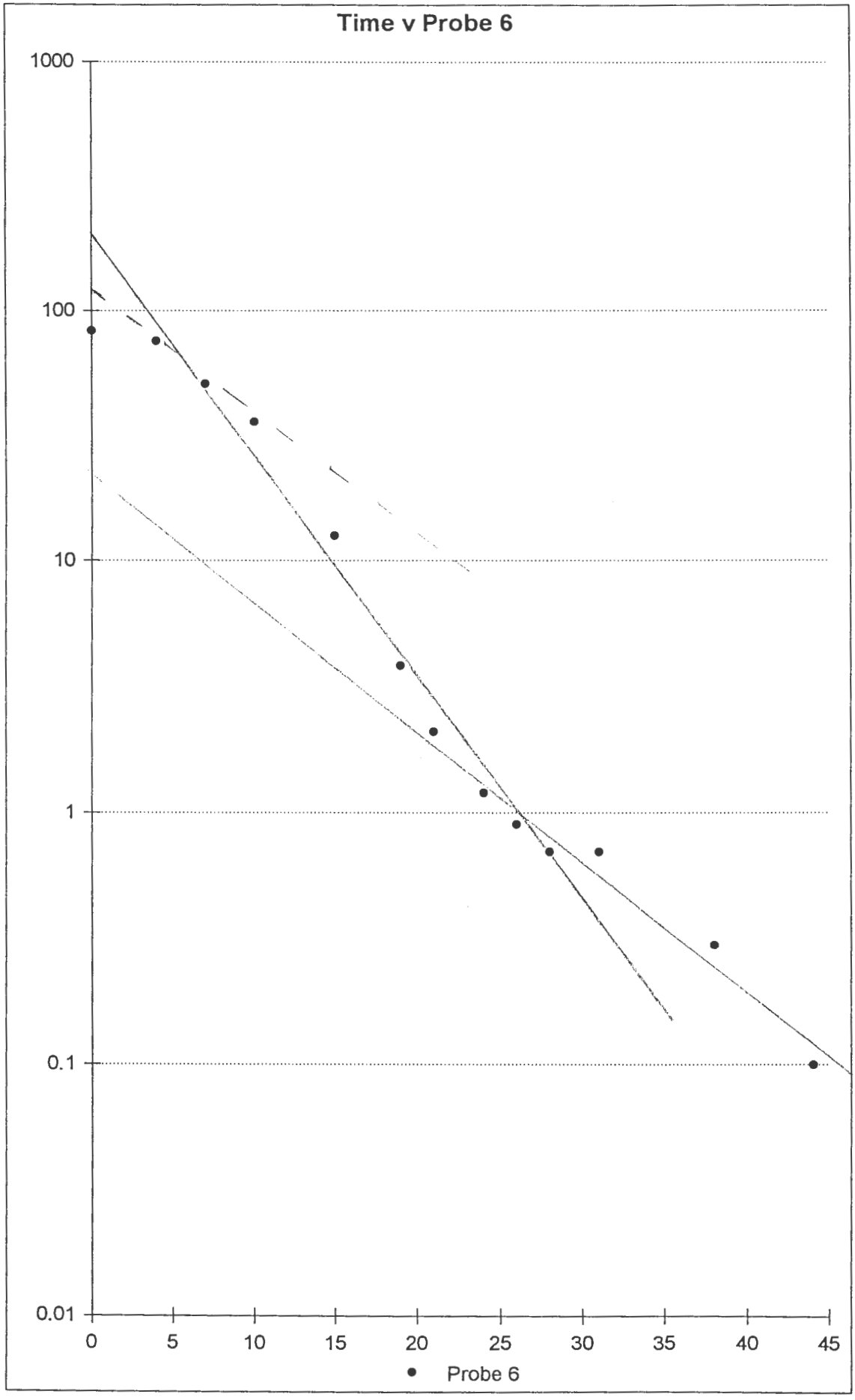



Time v Probe 1
1000
100
10
1
0.1
0
5
10
15
20
25
30
35
40
45
Series 1


Time v Probe 3
1000
100
10
1
0
5
10
15
20
25
30
35
40
45
Probe 3


Time v Probe 4
1000
100
10
1
0
5
10
15
20
25
30
35
40
45
Probe 4


Time v Probe 5
1000
100
10
1
0.1
0
5
10
15
20
25
30
35
40
45
Probe 5


Time v Probe 6
1000
100
10
1
0.1
0.01
0
5
10
15
20
25
30
35
40
45
Probe 6

30th September 1994

2.23 Trial Code 20 - Mexican Express tomato sauce

Purpose

Evaluate alternative commercial tomato sauces from "Mexican Express" for suitability in canning.

Method

Previously frozen IQF trunk sardines were defrosted in running water, cut to the length of the can and then brined in a 10% salt solution for 10 minutes.
The brined fish were rinsed and then packed into oiled cans, head to tail, 6 fish per can.
The cans were steamed at atmospheric pressure for 15 minutes horizontally, then rinsed, drained and filled with one of three sauce variants :-

a) Mexican Express Salsa Mk1 with salt
b) Mexican Express Salsa Mk 11 with salt and garlic
c) Mexican Express Salsa Mk 111 with salt, garlic and coriander.

The cans were seamed and processed for 60 minutes at 115^{o}C.

Results

Initial weight of trunk and tailed sardines 24.7g
Final weight of sardines after steaming = 21g; 126g per can
Approx. 60g of each sauce added per can

All three sauces were thicker than could be filled on line and therefore diluted by one third with water before filling. All products were acceptable in flavour, with the Salsa Mark 11 preferred.

18th October 1994

2.24 Trial Code 21 - Further assessment of sardine fillets

Purpose

To further evaluate the canning of sardine fillets in oil processed to minimise the curling of the fillets during canning.

Method

In the previous trial (Code 8) the cans were steamed in a horizontal position, but processed vertically. In this second trial the fish were steamed and processed horizontally and then left to cool in that horizontal position.
Frozen butterfly fillets were defrosted, brined and then packed carefully in the cans folded back into the natural fish shape.
The cans were steamed horizontally for 10 minutes, drained, filled with olive oil and then seamed before returning the cans to the horizontal for processing ($115^{o}C$ for 1 hour)

Results

Although the cans were left on their sides until opened, there was still an obvious curl and the fillets shrunken and aggregated together.

Discussion

Clearly this method of packing sardine fillets is unsuitable. It is possible that the fillets could be packed in a round shape, stuffed and processed in a sauce without pre-steaming, but this would require considerable development.

Since sardine bones are soft they have little impact on the eating quality and the decision was taken not to continue this canned fillet development at this time.

2.25 Trial Code 22 - Heat penetrations; sardines in spring water

Purpose

Carry out heat penetrations on cans of sardines in tomato sauce to determine accurate process times and temperatures.

Method

6 empty cans were fitted with copper/constantan thermocouple wires in the centre and the wires araldite glued into place.
A tomato sauce containing added thickener (trial code 17A) was made up to give the worst case 'conduction' sauce.
Sardine trunks were prepared as usual and packed tightly (6 large fish, 175g/can), with the thermocouple wire embedded in the flesh of one fish.
The cans with the sardines were steamed, drained, filled with tomato sauce to 190g net weight and then seamed.
The 6 thermocouple wires, together with a spare wire to measure the steam temperature, were connected to a Eurotherm multi channel thermometer and the temperatures monitored during the processing.

Results

			Probe Temperatures				
Time (mins)	1	2	3	4	5	6	Air
2	45	44	44	46	48	46	72
4	46	45	44	47	49	46	82
6	48	47	46	50	50	48	94
8	53	51	49	55	53	51	99
10	58	57	54	61	58	56	107
12	64	63	59	67	63	63	114
14	65	70	66	74	69	80	118
16	72	78	74	80	76	89	118
18	79	84	80	85	82	94	116
21	83	90	86	91	88	92	116.4
23	89	94	91	96	92	99	116.7
25	92	98	96	99	97	103	116.2
27	96	101.6	99.2	102.3	99.9	105	117
29	98.3	104.5	102.5	105.2	103.1	107.7	116.8
31	102.1	107.1	105.5	107.8	106.5	111.2	117.5
33	104.6	109.3	107.5	109.8	108.1	112.3	117.6
35	105.6	111	109.7	111.2	110	112.5	117.8
37	107.1	112.5	111.4	112.6	111.6	113.6	118.6
39	109.8	114	113.1	114.1	113.2	114.6	119
41	111	115.1	114.2	115.2	114.5	115.6	118.6
43	111.7	116.1	115.5	116.1	115.6	116.2	118.3
45	112.3	117	116.5	116.9	116.5	116.8	118.8
47	113.2	117.7	117.4	117.9	117.3	117.6	118.8
49	114	118.2	117.8	118.2	117.8	118	118.5
51	114.8	118.7	118.5	118.7	118.4	118.5	118.7
53	115.4	118.8	119	119	119	118.8	119.2
55	115.6	119	119	119	119.1	119.1	119.3

Average Retort Temp = 118°C (T_1)
Slowest Heating Probe = No. 1

Difference in Temp between Probe (T_o) and Retort (T_1) :-

Time	$T_1 - T_o$
2	73
4	72
6	70
8	65
10	60
12	54
14	53
16	46
18	39
21	35
23	29
25	26
27	22
29	18.7
31	15.9
33	13.4
35	12.4
37	10.9
39	8.2
41	7.0
43	6.3
45	5.7
47	4.8
49	4.0
51	3.2
53	2.6
55	2.4

Conclusion

The tabulated results, together with the graph plot of the slowest heating probe (No. 1) were used to obtain the following values :-

j	=	2.1
Fh	=	31 minutes
Initial Temp	=	$45^{o}C$
Sterilising Temp	=	$118^{o}C$
z	=	10

To achieve an F_o = 3 minutes at $121^{o}C$

L	=	0.490
u	=	Fo/(Fh x L)
	=	3/(31 x 0.49)
	=	0.197

From tables if u = 0.197 then v = 0.584

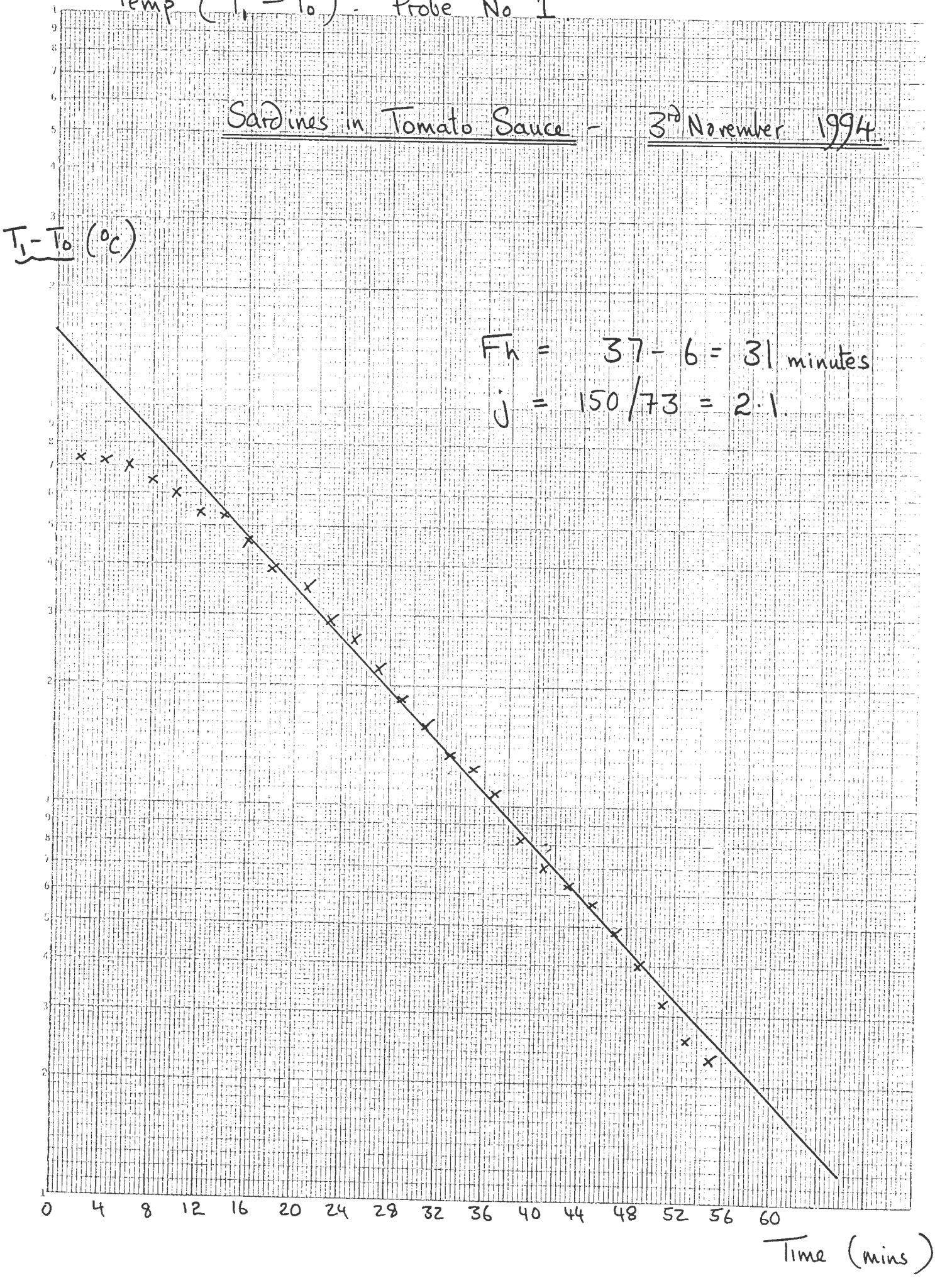
B	=	Process time required
B	=	$Fh\ (v + \log\ (j(T_1-T_o)/z) - 0.08)$
	=	31 (0.584 + 1.185 - 0.08)
	=	31 (1.689)
	=	52 minutes

Using the same calculations for other temperatures gives :-

Fo = 3, process temp = $121^{o}C$, time = 46 minutes
Fo = 3, process temp = $118^{o}C$, time = 52 minutes
Fo = 3, process temp = $115^{o}C$, time = 61 minutes

Temp ($T_1 - T_0$) - Probe No 1

Sardines in Tomato Sauce - 3rd November 1994.



22nd December 1994

2.26 Trial Code 23 - Baader 134 yields

Purpose

1. To further evaluate the efficiency of the Baader 134 in removing heads, gut and tail of sardines
2. To determine yields and labour requirements for final costing of the process.

Method

Approx 30kg of sardines were weighed and then headed, gutted and tailed on the Baader under controlled conditions. The resulting product was weighed, graded for size and also assessed for defects.

By timing the operation a labour cost and throughput was established for use in the final product costing. The time for stripping and cleaning the machine after production was also included.

Results

Weight of whole fish - start	=	30.5kg
Weight of trunked fish	=	19.7kg
Yield	=	64.6%

Average wt. of 10 whole fish before processing = 350g, 350g, 340g, 340g, 360g

Average wt. of 10 trunked fish = 250g, 220g, 220g, 210g, 210g

Thus average whole wt. = 34.8g

Average trunk wt. = 22.2g

Length of trunked fish (20 fish)		
	70-75mm	1
	75-80mm	3
	80-85mm	8
	85-90mm	8

50 fish were examined for defects, such as gut in, tail on, etc. A total of 3 fish or 6% were defective.

Labour/Throughput 1 person fish supply, removal of trunks & waste

2 persons feeding Baader

Total time taken = 6.5 minutes

Instantaneous throughput thus = 60/6.5 x 30.5

= 280kg/hr

Cleaning time (1 person) = 10 minutes

Discussion

The 8th April costings assumed a 95% recovery of fish and a trunk yield of 62.5%. The previous Baader trial with very large fish gave a 60% yield. This latest experiment, under factory conditions, gave a 94% recovery and a 64.5% yield. Since some of the defect fish will be gut in, which can be removed, a recovery of 96% from whole fish is a reasonable expectation.

35-40g whole fish is the most common and would be the target size fish for canning, therefore a 64% yield could be assumed for costing.

The original costing also underestimated the instantaneous throughput at 216kg/hr, compared with 280kg in this trial, with 35g fish or 320kg/hr for 40g fish. An 80% efficiency will give a net throughput of 224kg to 256kg per hour.

Note the efficiency of the Baader in cutting fish to the correct length is also important. In this trial 80% of fish were to target length, which is acceptable. A longer trial will be necessary to determine if this varies over time as operator concentration wanes.

22nd December 1994

2.27 Trial Code 24 - Labour cost can filling

Purpose

To determine the throughput and thus labour cost associated with hand filling of cans with sardines.

Method

10kg of trunks from trial 23 were accurately weighed, then brined for 10 minutes in a 10% salt solution. After brining the fish were rinsed, drained, re-weighed and then packed into cans.

The actual time taken to fill the cans was accurately recorded and in this experiment each person packed each can with the 7 fish.

Results

Wt of fish before brining	=	10.0kg
" after "	=	10.15kg
Yield	=	101.5%

Average fish wt. = 22.5g

Average filled can wt thus = 7 x 22.5g = 157.5g

Labour = 3 persons x 6.5 mins to fill 65 cans

Thus 1 person can fill 3.3 cans per minute or 200 cans per hour

Discussion

The 8th April costing assumed 5 cans per minute per person. This trial indicates that assumption to be optimistic and whilst practice will increase the instantaneous speed from the 3.3 cans per minute calculated, when overall efficiency is considered this rate seems realistic.

200 cans per person per hour will thus be used for the final costing

3. Process Summary and Product Costing

This section covers a description of the process , an updated product costing , an outline Factory layout and a Hazard Analysis and Critical Control Point (HACCP) analysis. The step numbers in the description relate to the steps in the Process Flow [3.4]. The HACCP Audit Tables are to be used as the basis of the production control documentation.

3.1 Description of Process

Step1. Fish Receival

The quality and shelf life of canned sardines is critically dependent upon the freshness of the fish used for the canning operation. Since Fremantle Sardines supply chilled sardines for the restaurant market their existing quality standards will be sufficient. All fish must be received iced (or be less than 4 hours old) and examined for signs of deterioration.

If necessary fish can be IQF frozen for later use.

To ensure the trials were representative of 'average' quality, most often previously IQF frozen fish ,frozen for the second time after heading and gutting was used. Canned product almost 12 months old is now available and shows no signs of rancidity.

The presence of scales would lead to customer complaints. Luckily sardines descale themselves on capture and handling, whilst visual assessment and handling throughout the process should ensure any remaining scales are removed.

Step 3. Head/Gut/Tail using Baader 134

This machine is in constant use preparing trunk sardines or butterfly fillets. Only one further operation is necessary to remove the tail and limited experimentation indicates a 96% recovery of clean head, gutted and tailed sardines can be achieved.

Since the instantaneous throughput of 300kg whole fish per hour is likely to be faster than later stages in the process the trunks must be re-iced or stored in chill until used.

Step 4. Brine Soaking

This step in the process has a number of functions.

a) Soaking in brine allows the salt uptake into the fish, thus improving the flavour and preventing the need to add salt with the sauce, which is particularly difficult for oil packs.

b) Brine also helps to remove slime and blood, whilst cleaning the gut cavity and thus eliminating a risk of off flavour notes in the final product.

c) The brine firms the flesh, making the fish easier to handle, whilst increasing the fish weight by up to 2%.

Concentrations and times of brine soaking found to give satisfactory flavour were for fresh fish - 15% brine and 10 minute soak, for IQF frozen then defrosted fish - 10% brine and 10 minutes.

The literature also suggests that brining may increase the adhesion of the skin. Since skin removal during cooking detracts from the appearance of the fish a couple of trials with alternative times and concentrations were trialed without obvious difference, but further work in this area may be justified.

On a small scale, the brine has been discarded after soaking, but in production 2 x 200 litre brine tanks are envisaged, each capable of holding 4 x 10kg baskets of fish with the first tank used until 100kg of fish have been brined and then the second tank used whilst the first is replenished with fresh brine.
It may be possible to top up the tanks with brine or soak more than 100kg of fish per charge. However, given the importance of this step a conservative standard has been set.
Once brined the fish are dipped in fresh water or thoroughly hosed and drained before being filled into cans.

Step 7. Fill Cans with Sardines
The baskets of sardines are supplied to the packers located either side of a slowly moving conveyor containing empty rinsed cans.
The packers fill the cans tightly with sardines (6 or 7 depending upon the size) with the fish packed head to tail for ease of fit.
Early trials required the cans or fish to be oiled to minimise skin loss. The use of a meat release lacquer on the inside of the can is likely to be sufficient, but can not be proven until the appropriate cans are available.
Since this is potentially a rate limiting and labour intensive step in the process considerable attention to efficiency improvements will be required in production.
The Baader will produce 200kg per hour of trunk sardines, which can be matched in the brining process. At an average weight of 25g per fish, 200kg equates to 8,000 fish, or about 1,200 cans (6 or 7 per can).
Trials indicate one person is capable of packing 200 cans per hour, therefore to maintain the throughput 6 or 7 packers will be required. The process is designed around 800 cans per hour hand filling ,thus 4 packers.

Step 9. Batch Steam
Whilst ultimately a continuous steaming process would be the preferred option, initially batch steaming will be adequate. A vertical atmospheric steamer, fitted with front opening doors, racks and perforated stainless steel baskets of sufficient capacity to hold about 800 cans would be required.
The filled cans are loaded onto a frame, the inverted steamer basket placed over the top and the whole turned over so that the cans drain. Each basket should hold no more than 60 cans.
Steaming time of 20 minutes, followed by a draining time of 5 minutes, is envisaged with removal of the cans being a reverse process using separate equipment (prevent raw and cooked contamination).

Step 10. Sauce Addition
Tomato sauce is made separately on site or bought in prepared under contract. All sauces are dispensed from an adjustable volumetric liquids filler. A simple air pump and level detector on the filler tank can be used to transfer liquids.
The filler is timed to the seamer. An operator maintains weight control and monitors filler operation.

Step 11. Can Seaming

The hand seamer currently used is not connected to a vacuum line, yet a partial vacuum has been maintained by seaming quickly after filling the hot cans with cold sauce. Steam closure on line should, therefore, be sufficient and vacuum closing not required.

The can seamer operator will regularly examine the visual seams with tear-down checks carried out off line.

The seamer/filler combination will operate at about 60 cans per minute. It is important that once filled and seamed the cans are processed as quickly as possible. It is envisaged that the filler/seamer combination will operate in bursts of about 1,600 cans at a time (2 steam batches). Three retort baskets are filled with the cans for Processing.

Step 12. Retorting

Process time is 60 minutes or less giving a total cycle time under two hours. Initially, therefore, only one retort is required. An option is the use of a retort for the steaming, thus when production volumes justify the continuous steamer two retorts are available.

A trained and certified retort operator is necessary to ensure the safety of the process. The necessary services, ie. boiler, cooling water tank and chlorination system, have not been included in the Factory Layout.

Steps 14/15. Labelling and Cartoning

The crates are left to cool overnight before labelling, thus minimising any risks of post process spoilage. Labelling and cartoning at 80 cans per minute using an automatic labeller and hand packing of cartons will require three people. The same staff can be used to run the filler, seamer and retort.

Summary Throughput

Initial calculations indicate that a target throughput of 4,800 cans per day will be a cost effective target.

Fish preparation and brining will take four hours for three people, whilst filling requires four people for six hours. One service operator would also be needed.

Six steam batches only require four hours steaming time, but with loading and unloading take two people six hours.

Filling and seaming only takes 1 1/2 hours, split into three sessions, with labelling taking a similar time allowing for setting up and carton stamping.

Three retort batches will require one person for six hours, but not continuously.

Assuming an 8 a.m. start for fish processing, the first steaming batch would commence at 10 a.m., filling and seaming at 11.30 a.m. and retorting at 12 noon. All operations, apart from the final retort cook, would be complete by 4 p.m., requiring 80 man hours, plus supervision.

3.2. Product Costing

Based on the premise of 4,800 cans per day output and using the yield figures given previously, the following factory costs are derived.

A). Fish Cost

a) Sardines @ $1.00/kg

Recovery 96% = $1.042/kg
Yield 64% = $1.628/kg

Average wt. of trunks	=	25g
7 fish per can	=	175g x $1.628/kg
	=	$0.285/can

b) Sardines @ $1.40/kg = $0.399/can

B). Liquid

Average wt. of Steamed Sardines	= 147g/can
Target wt.	= 190g/can
Thus liquid infill	= 43g/can
Yield 95%	= 45g/can
i) Olive Oil @ $3.50/kg x 45g	= $0.158/can
ii) Tomato Sauce @ $1.21/kg x 45g	= $0.054/can
iii) Spring Water @ 10c/kg x 45g	=$ 0.010/can

C). Packaging

Cans $0.335 @ 98%	= $0.342/can
Labels	= $0.030/can
Outer Carton $0.70 per 12 @ 98%	= $0.059/can
Total Packaging	= $0.430/can

D). Direct Labour

80 hrs @ $14/hr/4,800 cans	= $0.233/can
7.5 hrs @ $16/hr/4,800 cans	= $0.025/can
Total Labour	= $0.258/can

TOTAL COSTS PER CAN

Sardine Price a) $1.00/kg; b) $1.40/kg

	(a)	(b)
Sardines in Olive Oil	$1.132	$1.246
Sardines in Tomato Sauce	$1.028	$1.142
Sardines in Spring Water	$0.984	$1.098

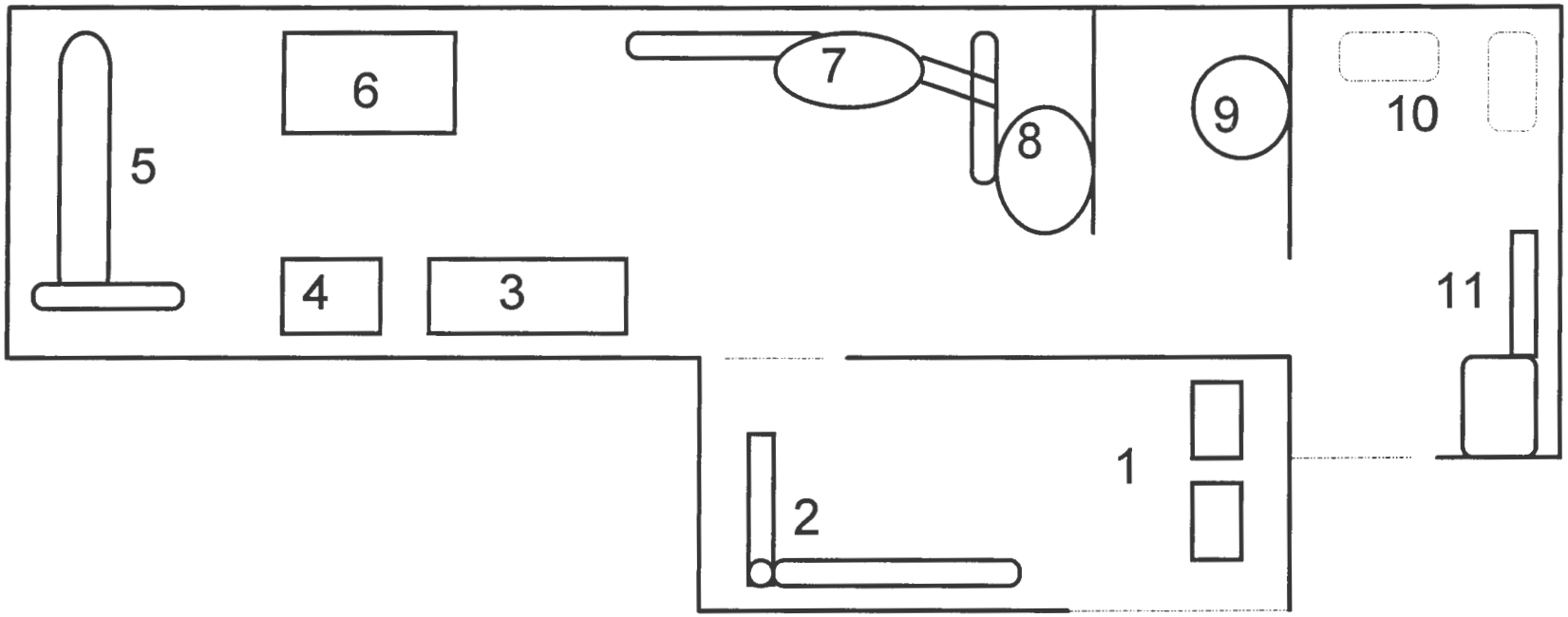
The sardine price range of $1.00/kg to $1.40/kg is based on the current prices depending upon the season.

Assuming an average price of $1.20 and assuming a sales balance of 60% olive oil; 25% tomato sauce; 15% spring water, gives an average factory cost of **$1.14/can.**

Assuming a 50c/can overhead and margin and retailer margin of 30% on sell price, gives an on shelf price of **$2.34/can**

3.3 FACTORY LAYOUT

(outline diagram not to scale)



1. **Fish receival tanks.**
2. **Baader 134; sardine head; gut; tail.**
3. **Brine tank.**
4. **Wash tank.**
5. **Filling of cans with sardines.**
6. **Steaming sardines.**
7. **Sauce dispensing.**
8. **Can seaming.**
9. **Retorting.**
10. **Cooling of cans.**
11. **Labelling and packing.**

3.4 PROCESS FLOW CHART

Product: **Canned Sardines**

Date: ***12/12/94***

Step Number	Step Name
1	Fish Receival
1(A)	IQF Freeze - [if required]
2	Ice Addition -[defrost if reqd].
3	Head/Gut/Tail - [Baader 134]
4	Transfer to Brining area.
5	Batch Brine
6	Rinse and clean
7	Fill Cans with sardines
8	Transfer to steamer
9	Batch Steam
10	Sauce Addition
11	Can Seaming
12	Retorting
13	Cool cans
14	Label
15	Pack in cartons
16	Store under quarantine
17	Release for sale

3.5 Hazard Audit Table [Page1]

Product: **Canned Sardines**

Date: ***12/12/94***

Critical Step	Potential Hazard	Critical Control Point	Monitoring Procedures	Target Level &Tolerance	Corrective Action
1.Fish Receival	Contamination ; wrong species ; spoilage	Visual assesment ; temperature	Supervisor examines fish against specification and checks temp.	Temp. < 5 C; < 5% wrong fish ; spec tolerances not exceeded	Reject if outside tolerances ; re-ice if necessary to bring temp. below 5 C.
3.Head/gut/tail Baader134	Contamination ; Gut in ; wrong fish	Visual assesment	Operators reject wrong fish before heading and monitor efficiency of Baader.	No tolerance - wrong fish ; < 2%gut in	Adjust Baader if required to reduce gut-in ; sort fish to remove gut.
5. Batch Brine	Spoilage ; Insufficient/excess salt	Temperature; Brine conc./time	H/G/T fish to be stored in chiller until brined. Brine make-up & dip time recorded on production record.	Temp < 5C before brining ; brine tolerances on prod. record	Reject for bait any fish out of temp or out of spec brined.
6.Rinse & Clean	Contamination	Visual Assesment	Operator rinses fish in clean water ; removes any obvious gut ;drains basket.	Water replaced every 5 baskets.	Reject damaged fish ; rinse again if necessary.
7. Fill Cans with Sardines.	Contamination ; Spoilage ; Underweight	Visual Assesment ; Time ; Check weigh	Operators check cans undamaged & rinsed clean; brined fish filled immediately; filled cans check weighed half hourly	No damaged/unclean cans used ;fish chilled if not filled< half hour; informs supervisor if cans full but u/weight	Reject damaged cans & rinse if unclean: ice fish if necessary; adjust sauce fill to compensate for low fish weight.
9. Batch Steam	Contamination : Insufficient/excess steam	Visual; Time/Temp	Operator ensures trays are clean & follows steaming procedure	Trays cleaned between use ; steaming instructions complied with.	Reject any contaminated or over/under steamed fish

3.5 Hazard Audit Table[Page2]

Product: **Canned Sardines**

Date: ***12/12/94***

Critical Step	Potential Hazard	Critical Control Point	Monitoring Procedures	Target Level &Tolerance	Corrective Action
10. Sauce Addition	Under/over filled ; Wrong Sauce ;	Check weigh ; recipe control	Operator monitors product weights as procedure; checks sauce correct for production plan	Product net wt ave =>declared;no pack<95% of declared- upper ave wt. not exceeded;saucematches can code	Re-adjust sauce weight; hold product back to last check for c/weigh. or sauce type error
11. Can Seaming	Product Spoilage ; Incorrect codes.	Seam checks ; Can code checks	Can seams monitored according to procedure ; can code checked at start of production.	As detailed in seam check procedure ;no tolerance on code	As procedure ; change code.
12. Retorting	Bacterial Growth [underprocess] Quality defect [overprocess]	Temp/Time	Retort Op. ensures crates have thermal tags applied and retorted in accordance with procedure.	Tolerances specified in procedure	Product held for Q.A. assesment
13. Cool Cans	Contamination	Time ;Visual Assesment	Operator transfers crates to cooling area; cans left overnight before labelling when cool & dry.	No tolerance	If cans labelled early; require 21 days incubation & 100% sort for defects
14/15; Labelling & Cartoning	Wrong Label/Carton; Wrong carton codes	Visual Assesment	Operator checks labels, cartons, can codes & carton codes match	No tolerance	Hold product for relabelling/cartoning as appropriate.
16/17. Quarantine / Release	Bacterial Growth	Incubation test & production records	Q.A. assesses product after incubation of samples at 37C for 10 days;checks records before release	Product must meet all standards before release	Sort / further incubate / or destroy product as required

SECTION4.1

APPENDIX XII

DRAFT REVISED STANDARD FOR CANNED SARDINES AND SARDINE-TYPE PRODUCTS
(CODEX STAN. 94-1981)
(At Step 8 of the Procedure)

1. SCOPE

This standard applies to canned sardines and sardine-type products packed in water or oil or other suitable packing medium. It does not apply to speciality products where fish content constitute less than 50% m/m of the net contents of the can.

2. DESCRIPTION

2.1 Product Definition

2.1.1 Canned sardines or sardine type products are prepared from fresh or frozen fish of the following species:

- *Sardina pilchardus*
- *Sardinops melanostictus, S. neopilchardus, S. ocellatus, S. sagax S. caeruleus,*
- *Sardinella aurita, S. brasiliensis, S. maderensis, S. longiceps, S. gibbosa*
- *Clupea harengus*
- *Sprattus sprattus*
- *Hyperlophus vittatus*
- *Nematalosa vlaminghi*
- *Etrumeus teres*
- *Ethmidium maculatum*
- *Engraulis anchoita, E. mordax, E. ringens*
- *Opisthonema oglinum*

2.1.2 Head and gills shall be completely removed; scales and/or tail may be removed. The fish may be eviscerated. If eviscerated, it shall be practically free from visceral parts other than roe, milt or kidney. If ungutted, it shall be practically free from undigested feed or used feed.

2.2 Process Definition

The products are packed in hermetically sealed containers and shall have received a processing treatment sufficient to ensure commercial sterility.

2.3 Presentation

Any presentation of the product shall be permitted provided that it:

(i) contains at least two fish in each can; and
(ii) meets all requirements of this standard; and
(iii) is adequately described on the label to avoid confusing or misleading the consumer;
(iv) contain only one fish species.

3. ESSENTIAL COMPOSITION AND QUALITY FACTORS

3.1 Raw material

The products shall be prepared from sound fish of the species listed under sub-section 2.1 which are of a quality fit to be sold fresh for human consumption.

3.2 Other Ingredients

The packing medium and all other ingredients used shall be of food grade quality and conform to all applicable Codex standards.

3.3. Decomposition

The products shall not contain more than 10 mg/100 g of histamine based on the average of the sample unit tested.

3.4 Final Product

Products shall meet the requirements of this Standard when lots examined in accordance with Section 9 comply with provisions set out in Section 8. Product shall be examined by the methods given in Section 7.

4. FOOD ADDITIVES

Only the use of the following additives is permitted.

Additive	Maximum level in the packing medium
Thickening or jellifying agents (for use in packing medium only):	
- Sodium carboxymethyl cellulose (CMC)	20 g/kg singly or in combination in the packing medium
- Pectins	
- Agar agar	
- Carrageenan	
- Guar gum	
- Carob bean gum	
- Alginic acids and its calcium, potassium and sodium salts	
- Xanthan gum	
Modified Starches (Chemically)	
- Acid-treated starches (including white and yellow dextrins)	Singly or in combination 60 g/kg
- Alkali-treated starches	
- Bleached starches	
- Distarch adipate, acetylated	
- Distarch glycerol	
- Distarch glycerol, acetylated	
- Distarch glycerol, hydroxypropyl	
- Distarch phosphate	
- Distarch phosphate, acetylated	
- Distarch phosphate, hydroxypropyl	

- Monostarch phosphate	}	Singly or in combination
- Oxidized starch	}	60 g/kg
- Starch acetate	}	
- Starch, hydroxypropyl	}	
Acidifying agents:		
- Acetic acid	}	Limited by Good
- Citric acid	}	Manufacturing
- Lactic acid	}	Practices
Natural flavours, e.g.		
- Spice oils	}	Limited by Good
- Spice extracts	}	Manufacturing Practices
Smoke flavours		
(natural smoke solutions and their extracts)	}	Limited by Good Manufacturing Practices

5. HYGIENE AND HANDLING

5.1 The final product shall be free from any foreign material that poses a threat to human health.

5.2 When tested by appropriate methods of sampling and examination as prescribed by the Codex Alimentarius Commission (CAC), the product:

(i) shall be free from micro-organisms capable of development under normal conditions of storage; and

(ii) no sample unit shall contain histamine that exceeds 20mg per 100 g; and

(iii) shall not contain any other substance including substances derived from microorganisms in amounts which may represent a hazard to health in accordance with standards established by the CAC; and

(iv) shall be free from container integrity defects which may compromise the hermetic seal.

5.3 It is recommended that the products covered by the provisions of this standard be prepared in accordance with the following codes:

(i) the appropriate sections of the Recommended International Code of Practice - General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 1);

(ii) the Recommended International Code of Practice for Canned Fish (CAC/RCP 10-1976);

(iii) the Recommended International Code of Hygienic Practice for Low-Acid and Acidified Low-Acid Canned Foods (CAC/RCP 23-1979).

6. LABELLING

In addition to the provisions of the Codex General Standard for the Labelling of Prepackaged Foods (CODEX STAN 1-1985) the following specific provisions apply:

6.1 Name of the Food

The name of the product shall be:

6.1.1 (i) "Sardines" (to be reserved exclusively for *Sardina pilchardus* (Walbaum)); or

(ii) "X sardines" of a country, a geographic area, the species, or the common name of the species in accordance with the law and custom of the country in which the product is sold, and in a manner not to mislead the consumer.

6.1.2 The name of the packing medium shall form part of the name of the food.

6.1.3 If the fish has been smoked or smoke flavoured, this information shall appear on the label in close proximity to the name.

6.1.4 In addition, the label shall include other descriptive terms that will avoid misleading or confusing the consumer.

7. SAMPLING, EXAMINATION AND ANALYSES

7.1 Sampling

(i) Sampling of lots for examination of the final product as prescribed in Section 3.3 shall be in accordance with the FAO/WHO Codex Alimentarius Sampling Plans for Prepackaged Foods (AQL-6.5) (Ref. CAC/RM 42-1977);

(ii) Sampling of lots for examination of net weight and drained weight where appropriate shall be carried out in accordance with an appropriate sampling plan meeting the criteria established by the CAC.

7.2 Sensoric and Physical Examination

Samples taken for sensoric and physical examination shall be assessed by persons trained in such examination and in accordance with Annex A and the "Code of Practice for the Sensory Evaluation of Fish and Shellfish" (under development).

7.3 Determination of Net Weight

Net contents of all sample units shall be determined by the following procedure:

(i) Weigh the unopened container.

(ii) Open the container and remove the contents.

(iii) Weigh the empty container, (including the end) after removing excess liquid and adhering meat.

(iv) Subtract the weight of the empty container from the weight of the unopened container. The resultant figure will be the net content.

7.4 Determination of Drained Weight

The drained weight of all sample units shall be determined by the following procedure:

(i) Maintain the container at a temperature between 20°C and 30°C for a minimum of 12 hours prior to examination.

(ii) Open and tilt the container to distribute the contents on a pre-weighed circular sieve which consists of wire mesh with square openings of 2.8 mm x 2.8 mm.

(iii) Incline the sieve at an angle of approximately 17-20° and allow the fish to drain for two minutes, measured from the time the product is poured into the sieve.

(iv) Weigh the sieve containing the drained fish.

(v) The weight of drained fish is obtained by subtracting the weight of the sieve from the weight of the sieve and drained product.

7.5 Procedure for Packs in Sauces (washed drained weight)

(i) Maintain the container at a temperature between 20°C and 30°C for a minimum of 12 hours prior to examination.

(ii) Open and tilt the container and wash the covering sauce and then the full contents with hot tap water (approx. 40°C), using a wash bottle (e.g. plastic) on the tared circular sieve.

(iii) Wash the contents of the sieve with hot water until free of adhering sauce; where necessary separate optional ingredients (spices, vegetables, fruits) with pincers. Incline the sieve at an angle of approximately 17-20° and allow the fish to drain two minutes, measured from the time the washing procedure has finished.

(iv) Remove adhering water from the bottom of the sieve by use of paper towel. Weigh the sieve containing the washed drained fish.

(v) The washed drained weight is obtained by subtracting the weight of the sieve from the weight of the sieve and drained product.

7.6 Determination of histamine

AOAC 977.13 (15th Edition, 1990)[1]

8. DEFINITION OF DEFECTIVES

A sample unit will be considered defective when it exhibits any of the properties defined below.

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[1] Subject to endorsement by the Codex Committee on Methods of Analysis and Sampling.

8.1 Foreign Matter

The presence in the sample unit of any matter, which has not been derived from the fish or the packing media, does not pose a threat to human health, and is readily recognized without magnification or is present at a level determined by any method including magnification that indicates non-compliance with good manufacturing and sanitation practices.

8.2 Odour/Flavour

A sample unit affected by persistent and distinct objectionable odours or flavours indicative of decomposition or rancidity.

8.3 Texture

(i) Excessively mushy flesh uncharacteristic of the species in the presentation.

(ii) Excessively tough or fibrous flesh uncharacteristic of the species in the presentation.

8.4 Discolouration

A sample unit affected by distinct discolouration indicative of decomposition or rancidity or by sulphide staining of more than 5% of the fish by weight in the sample unit.

8.5 Objectionable Matter

A sample unit affected by Struvite crystals - any struvite crystal greater than 5 mm in length.

9. LOT ACCEPTANCE

A lot will be considered as meeting the requirements of this standard when:

(i) the total number of defectives as classified according to section 8 does not exceed the acceptance number (c) of the appropriate sampling plan in the Sampling Plans for Prepackaged Foods (AQL-6.5) (CAC/RM 42-1977);

(ii) the total number of sample units not meeting the presentation defined in 2.3 does not exceed the acceptance number (c) of the appropriate sampling plan in the Sampling Plans for Prepackaged Foods (AQL-6.5) (CAC/RM 42-1977);

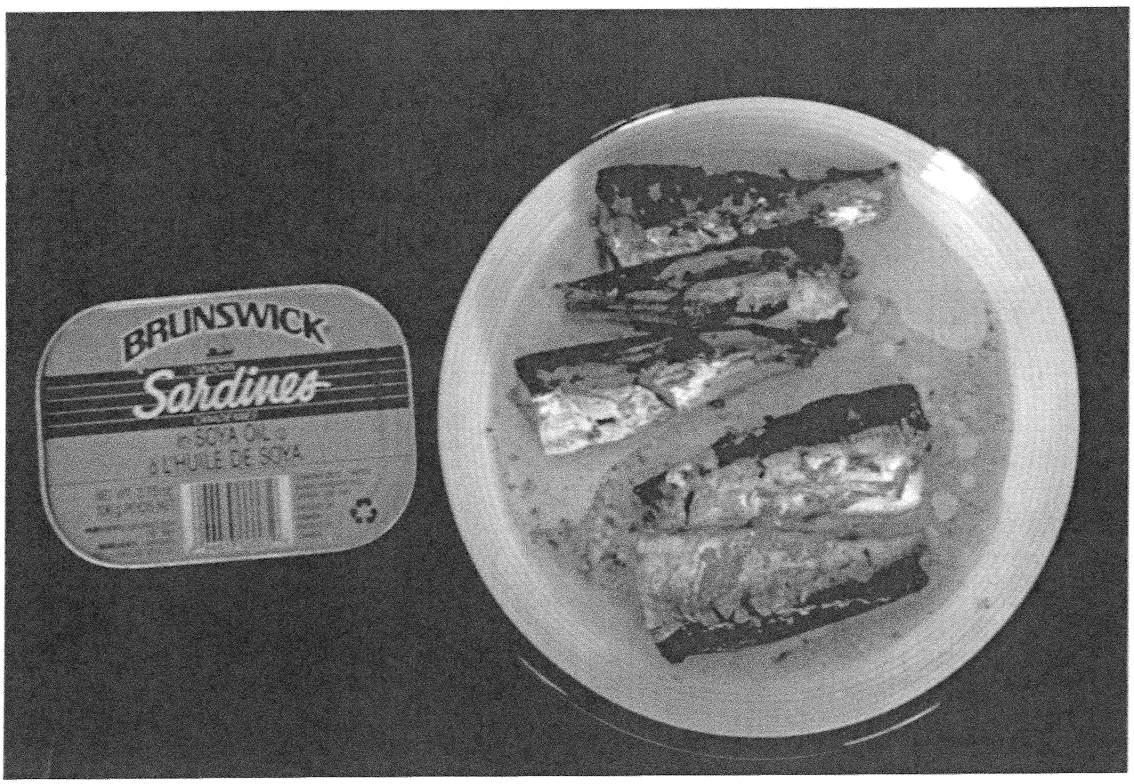
(iii) the average net weight or the average drained weight where appropriate of all sample units examined is not less than the declared weight, and provided there is no unreasonable shortage in any individual container;

(iv) the Food Additives, Hygiene and Labelling requirements of Sections 3.3, 4, 5.1, 5.2 and 6 are met.

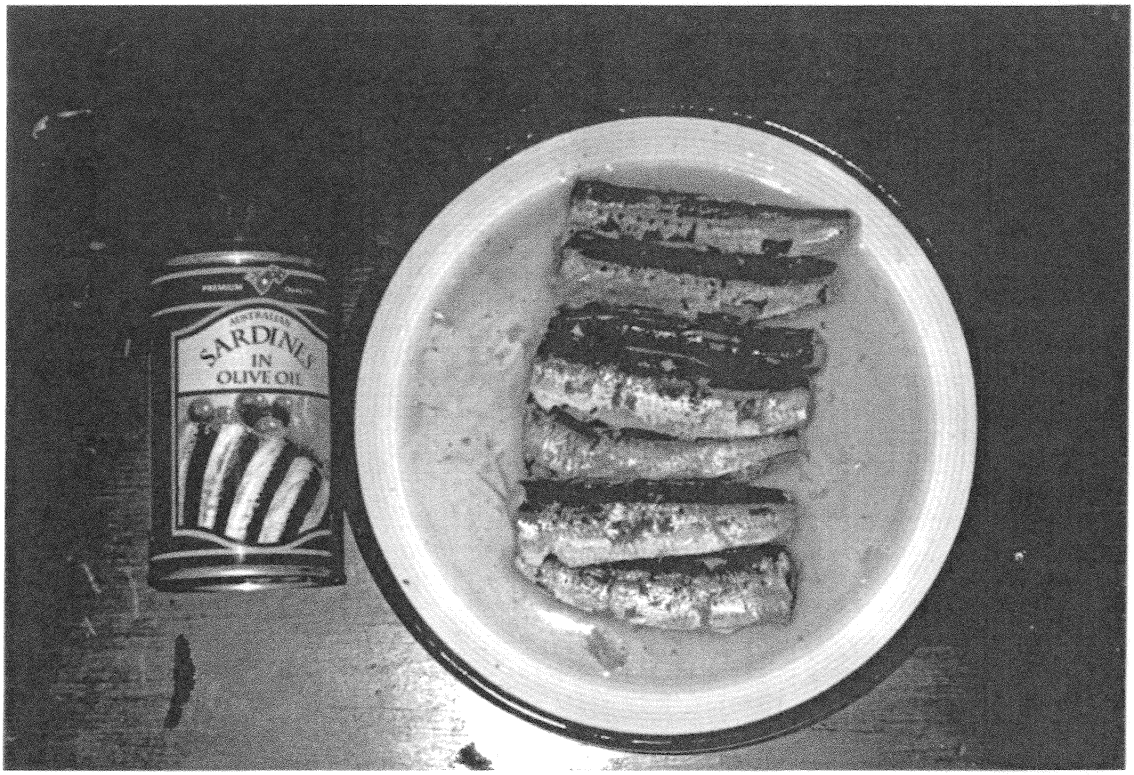
4.2 King Oscar Sardines in Sild Oil

4.3 John West Sardines in Vegetable Oil

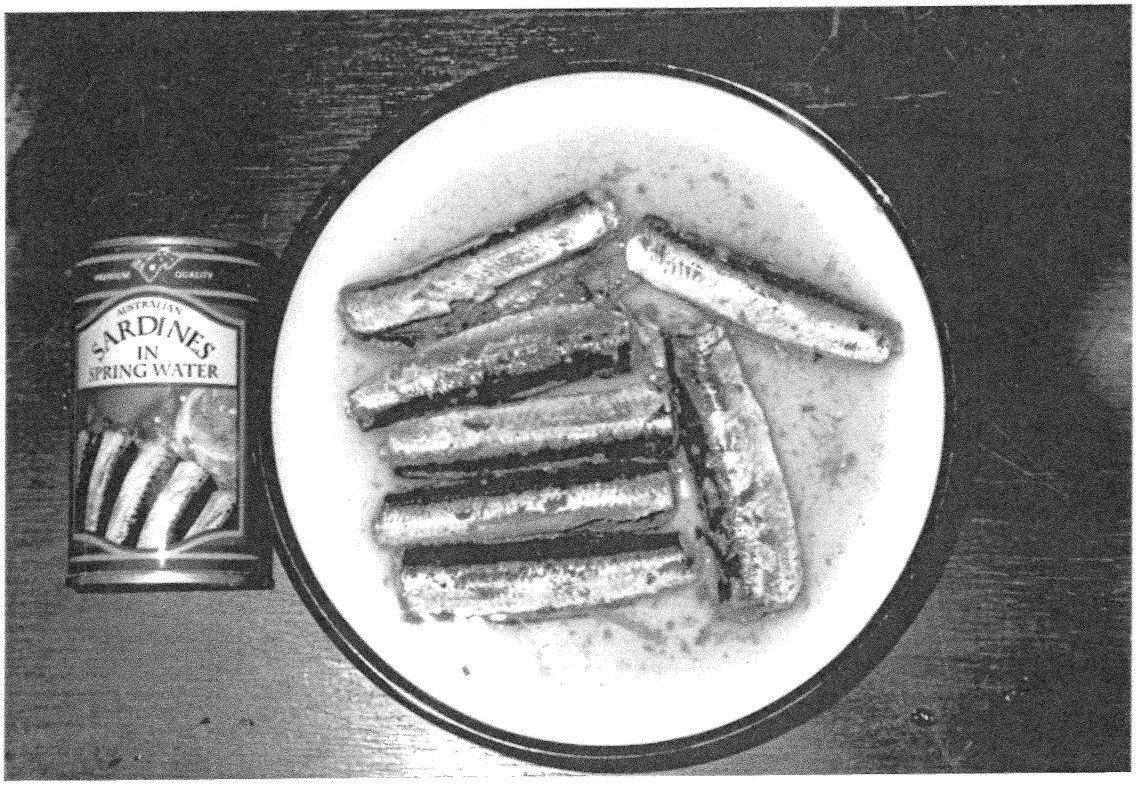
4.4 Brunswick Sardines in Soya Oil



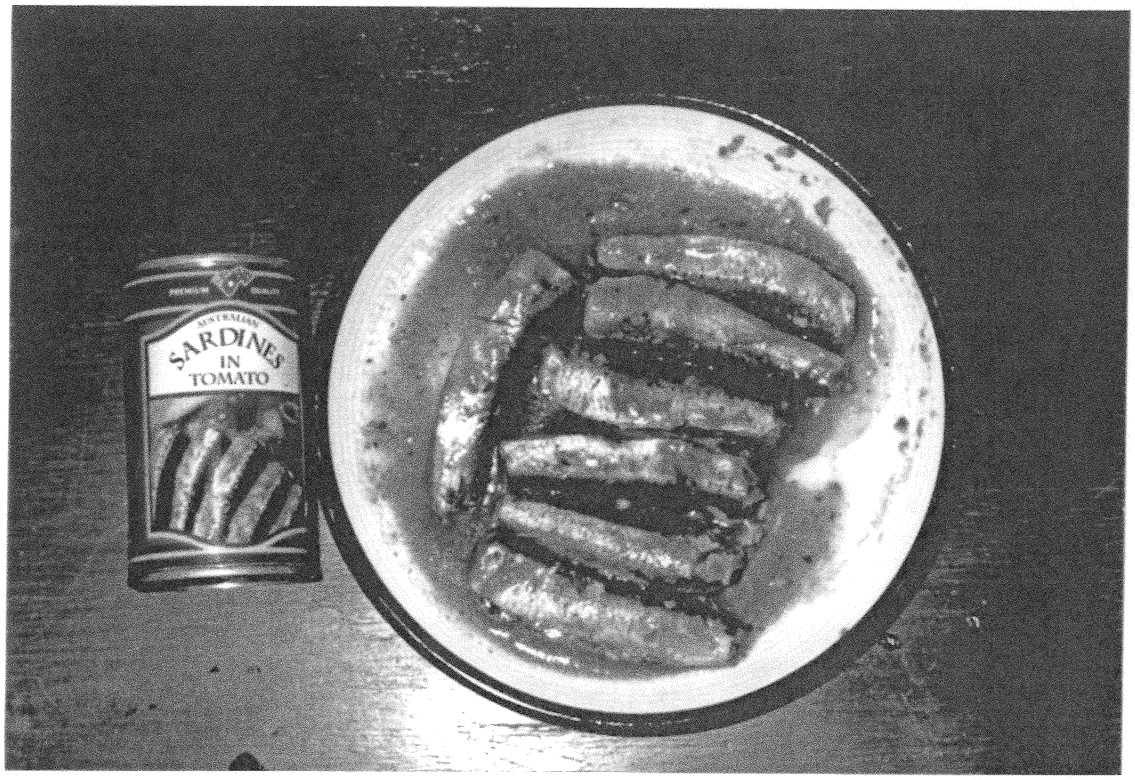
4.5 Fremantle Sardines in Olive Oil



4.6 Fremantle Sardines in Spring Water



4.7 Fremantle Sardines in Tomato Sauce



4.8 Fremantle Sardines (Whole Raw)