The Effect of Product/ Process Variables on the Textural Quality of Formed Portions and Consumer Acceptability of Portions Formed from Low Cost Raw Material

MAFF Commission
Technical Report No. 273
December 1985

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SEA FISH INDUSTRY AUTHORITY
Industrial Development Unit

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SUMMARY

Previous work has shown the technical feasibility of producing formed portions of a variety of accurately controlled sizes and shapes from underutilised or undervalued white fish species. The process and product were shown to have distinct production and marketing advantages, the tight control of portion weight being particularly advantageous to the catering trade, but there was adverse comment from the trade on the "rubbery" texture of the portions produced.

This project was to determine the cause of and to rectify the problem of texture, and to investigate the acceptability to the consumer of portions formed from low cost raw material of various white fish species.

During production trials based in the Shetland Isles a large number of samples were produced with each of the production/product variables altered in sequence to determine their effect on texture. With the assistance of TRS the samples were then assessed by expert tasters. It became clear that by sensible control of these variables a product of satisfactory texture can be readily produced (in fact extreme "rubberyness" was never encountered). The most significant factor determined was the requirement for good product packaging and cold storage practice. A modification to the forming machine was also devised which significantly improved product texture.

In a hall test in North West England consumers assessed portions formed from whiting fillet, coley fillet, and 50/50 haddock fillet/mince against control samples of cod fillet sawn from laminated block. Although limited in scale this trial in a traditionally cod favouring area revealed surprisingly little difference in consumer preference between all products. Overall preference was for 50/50 haddock fillet/mince portion on a par with the sawn portion of cod fillet. The texture of the 50/50 fillet/mince portion was rated highly, indicating that consumer regard for texture characteristics is in any case highly subjective.

Overall it is concluded that portions formed from low cost raw material, provided it is of good quality, should achieve consumer acceptability.

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1 INTRODUCTION

Previous work by the Sea Fish Industry Authority[1/] and Torry Research Station has shown the technical feasibility of producing a fish portion by means of a forming process utilising small gadoids of low marketable value as the raw material.

Haddock and whiting size grades 3 and 4 often go unsold when landings are high leading to the dumping of what is good quality raw material. Lack of demand is attributed to the limited market for small fillets and the high costs of hand filleting.

The forming process enables portions of any desired size and form to be produced irrespective of the size grade of raw material used. Compared with the production of laminated-block sawn-portions the process involves less

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1/ Production and Marketing Assessments of Formed Composite Fillets/Portions made from Small Gadoids Technical Report No. 242 October 1984

labour and does not suffer the saw-loss associated with the cutting process. The product can be styled attractively and is not restricted to straight-line saw cuts, thereby giving a more natural appearance. Portion control achieved by the forming process is excellent.

In catering market trials with samples produced commercially by a Shetland Company the response to the product varied from genuine commercial interest to outright rejection. The major criticism made of the formed product was with regard to texture which was considered by many as being too dense or rubbery and lacking in flakiness, although the level to which this was regarded a series consideration varied depending on the type of caterer and the quality and nature of their existing supply.

Consumer research[2/] conducted by means of hall-testing the product against IQF fillets and sawn laminated block portions positioned the formed portions overall between IQF fillets and sawn laminated block portions measured on taste, texture and appearance.

The catering market in which it was thought formed portions might compete well is extremely price sensitive, particularly in the institutional sector (hospitals, schools, social services etc.) where a penny or a fraction of a penny per lb. can determine the successful award of a supply contract. Competition however is strictly within well defined product specifications and savings in the order of 10p/lb or greater can be achieved by species substitution or alternative product form (IQF fillet, shatter-pack, laminated block, mince block).

2/ Report on three Hall Tests comparing Composite Fillets with Laminated Block and IQF Fillets, Motivation and Marketing March 1984

The substantial price differences are believed to reflect production/material costs rather than an order of consumer preference.

The work described in this report was carried out under MAFF Commission D2 and concerns the investigation of 2 main areas: (a) the effect of product/process variables on product texture and (b) the relative acceptability to the consumer of formed portions manufactured from low cost raw material of various species.

2 OBJECTIVES

2.1

To determine how raw material and process parameters affect the product quality, particularly texture, of portions manufactured by a forming process so that improvements might be achieved by their control.

2.2

To determine the relative consumer acceptability by means of hall-testing of formed white fish portions produced from various low-priced raw materials.

3 THE EVALUATION OF RAW MATERIAL AND PROCESS PARAMETERS ON PRODUCT QUALITY

3.1 The Production Process

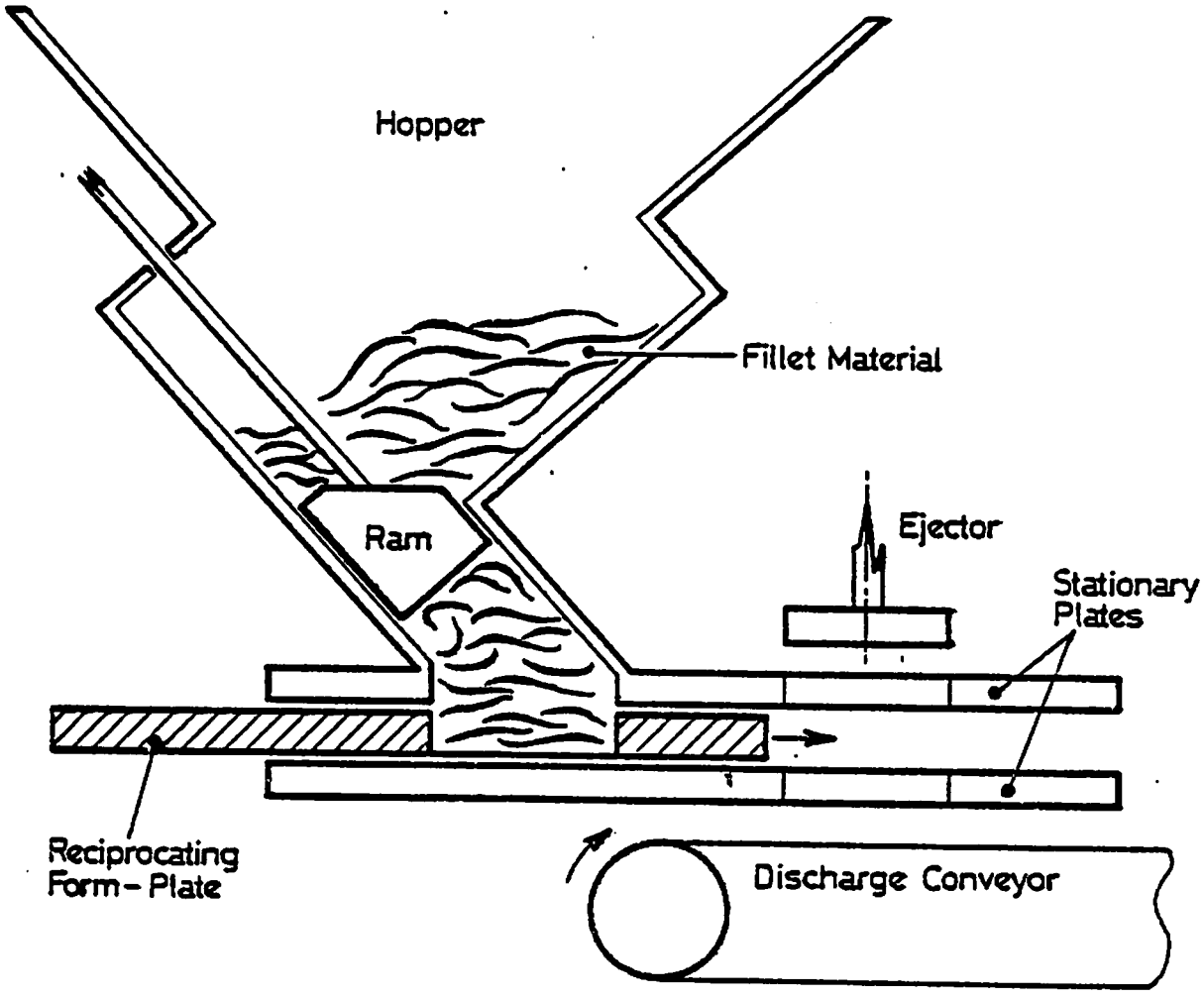
Production of formed fillets is achieved by a sequence of: filleting, skinning, phosphating (optional), forming and freezing. If a coated product is desired then the forming process is followed by enrobing and flash-frying prior to freezing and packaging.

The raw material for formed portions may consist solely of skinned fillets or may contain varying proportions of recovered flesh (mince). Polyphosphate added prior to forming acts as a binding agent and also makes the fillets slippery which helps in feeding the mould. It is not essential to the process. The food former used in the trials was the VM400 manufactured by Koppens Machinefabrick B.V. of Holland. The machine consists basically of a feed hopper, a ram that feeds fillet material to a reciprocating form plate incorporating moulds, and a mechanism that ejects the formed portions onto a discharge belt. The principle of operation is illustrated in Figure 1 overleaf.

In the process of feeding raw material in the hopper to the reciprocating form plate some degree of pulverization of the raw material occurs between the rear of the ram head and the hopper face to which the head retracts in operation.

3.2 Process Variables

In an effort to determine what affect, if any, process or raw material parameters might have on product texture



Principle of Operation of the Food Former

Fig.1

trials were undertaken in which those parameters considered as having possible affect were individually varied and the resulting product texture assessed.

The parameters that were considered as having a possible bearing on product texture were:

- phosphate treatment
- feed ram pressure
- form plate thickness
- shape of mould
- raw material species
- raw material size grade
- raw material freshness
- form of raw material
- cold storage of product.

Form plate thickness and the shape of the mould were considered because of the different degrees of working of the raw material required in the forming process. A further variation in the process was introduced by modification to the hopper design as described in the following section.

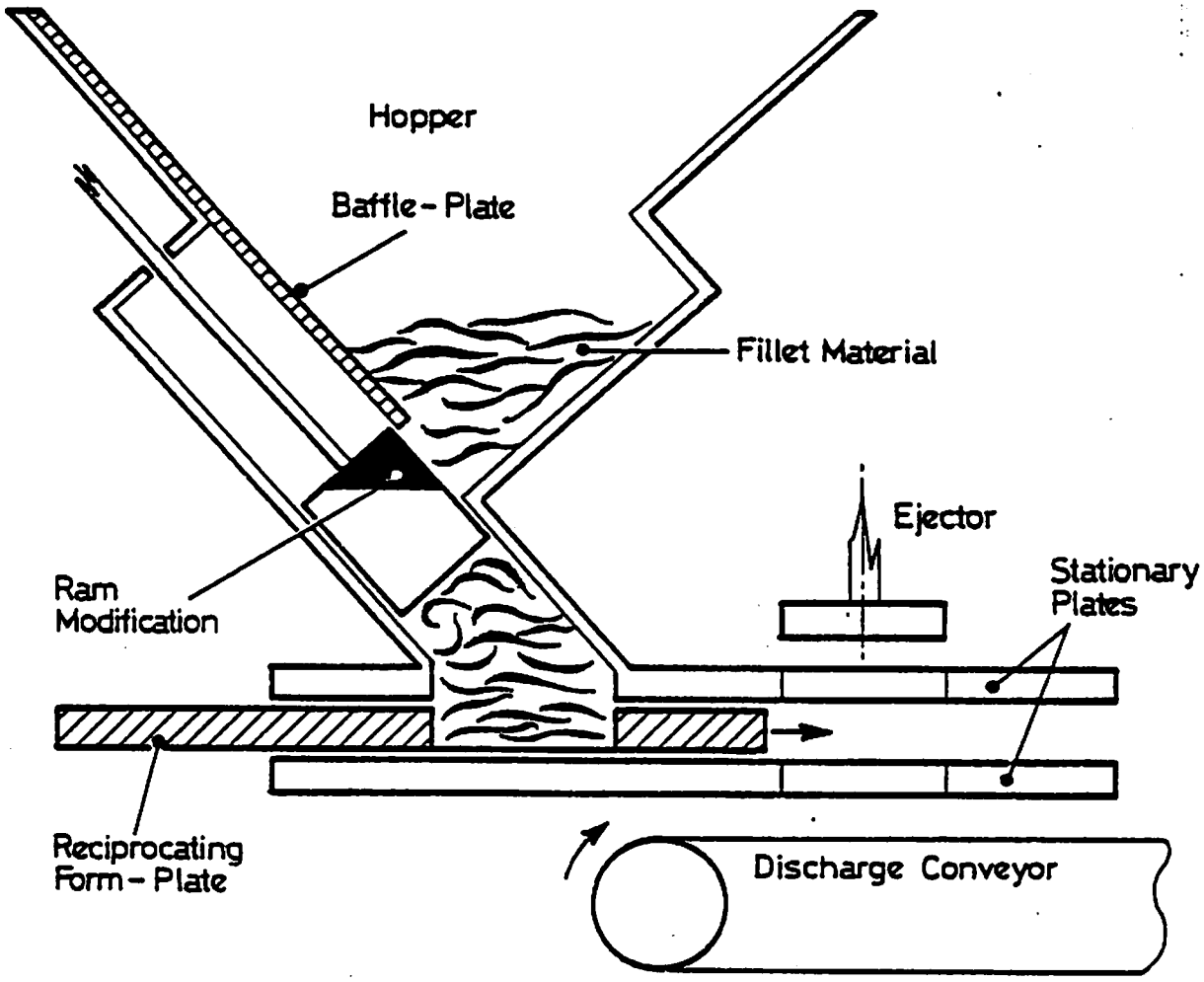
3.3 Production and Storage Trials

During February 1985 production of formed portions was undertaken at a Shetland factory under normal working conditions in which thirty-two production batch runs were completed in which the processing variables previously mentioned were altered within the ranges detailed below.

species	haddock, whiting, coley
size grade	EEC grades 4 and 2 (haddock and whiting)
polyphosphate	with or without treatment at 4% pickup of 11% solution
plate thickness	9, 12 or 14 mm
ram pressure	20, 40, 50, 60, 70 or 80 bar
shape	3 shapes defined by moulds (as shown in Appendix 1)
raw material freshness	TRS score 8½ and 7
flesh size	100% whole fillets, 50% whole fillets and 50% mince, 100% mince, chopped fillet ½" square and 1" square pieces
machine modification	use of baffle plate in attempt to reduce damage in feed hopper
cold storage	1, 10 and 20 weeks at -20°C

Approximately 40lb of skinned raw fillet material was processed per batch. Raw material of the same freshness quality was used throughout except where it was deliberately aged prior to processing. A summary of the variables for each batch is given in Appendix 2.

The modifications to the machine comprised of a baffle plate designed to prevent fillet material in the hopper being pulverised between the rear of the ram head and the stepped construction of the hopper on the retraction stroke of the ram as shown in Figure 2. To enable a wide enough gap for feeding at the neck of the hopper but to prevent material from getting behind the ram head it was necessary to build up the back face of the ram head.



Modified Hopper Arrangement

Fig.2

The product samples and control samples of the fillets (used for comparison) were blast frozen, coded and bulk packed in an unglazed state.

The samples were assessed in two batches. The first batch of samples from 19 production runs was sent to Torry Research Station for assessment of texture profile by an experienced panel. The second batch of 13 samples was sent to the Industrial Development Unit of the SFIA in Hull for assessment by similarly qualified staff.

Texture was assessed by profile analysis of the initial characteristics of a piece of cooked flesh on the first bite followed by secondary characteristics detectable on chewing. Details are given in Appendix 3. The characteristics were as follows.

Initial	-	Wateriness
	-	Firmness
	-	Springiness
Secondary	-	Fibrousness
	-	Toughness
	-	Succulence

As the above characteristics do not include an assessment of the geometric structure of fish (other than fibrousness) a further characteristic was included (second batch only) that defined structure as having extremes described as flaky at one end and pasty at the other.

Portion control and portion composition was also investigated in the case of the second batch of samples. Composition was determined by thawing samples, and separating and weighing identifiable discrete pieces of flesh. Pieces less than 1gm were weighed as a total.

The effect of cold storage on texture was investigated by storing samples at $-20^{o}C$ for assessment after one week, ten weeks and twenty weeks.

3.4 Results of the Effect of Process Variables on Product Texture

A summary of the texture profile analysis results is given in Appendix 4.

3.4.1 Species

The texture of formed portions is known to be dependent upon the intrinsic textural properties of the raw material used, which varies according to species and condition, but it was also considered possible that different species might react differently to the forming process. Table 1 overleaf shows that this is largely not the case and that the three species used in the trials reacted to the forming process in broadly the same manner. The differences in the texture of formed portions produced from the three species was attributed to intrinsic properties of the raw material.

TABLE 1

FACTOR	Haddock		Whiting		Coley	
	Control	Formed Portion	Control	Formed Portion	Control	Formed Portion
Wateriness (0 - 5)	1.9	2.5	1.7	2.5	2.8	2.8
Firmness (0 - 5)	2.8	2.8	1.9	2.1	2.3	2.7
Springiness (0 - 5)	2.4	2.6	1.5	1.7	2.5	2.3
Fibrousness (0 - 5)	2.3	2.5	2.0	1.9	8.3	3.3
Toughness (0 - 10)	5.4	5.5	3.8	3.8	4.5	5.5
Succulence (0 - 5)	2.2	2.1	2.2	2.8	3.3	2.9

Whiting portions were generally softer, less springy, less fibrous, and less tough than haddock portions or coley portions.

3.4.2 Size Grade of Raw Material

Only two production runs using larger haddock (EEC grade 2) were undertaken in the trials as the intended raw material for the forming process is the smaller size grades 4 and 3, but certain differences did emerge. Table 2 shows that portions from the grade 2 haddocks were firmer, more springy and tougher than those from the grade 4 fillets. These effects were the same for both polyphosphated and un-polyphosphated samples.

Table 2

Texture Factors	Un-phosphated		Phosphated	
	Haddock Size 4	Haddock Size 2	Haddock Size 4	Haddock Size 2
Wateriness (0-5)	2.4	2.5	2.3	2.4
Firmness (0-5)	2.7	3.2	2.5	2.8
Springiness (0-5)	2.3	3.0	2.1	2.6
Fibrousnous (0-5)	2.5	2.8	2.2	2.6
Toughness (0-10)	5.2	6.7	4.8	6.1
Succulence (0-5)	2.1	1.8	2.1	2.0

3.4.3 Polyphosphate Treatment

To evaluate the effect of polyphosphate treatment on characteristics of texture treated and untreated samples were assessed. To negate the effect of other product/process variables paired samples from eighteen production runs only were used in the analysis.

Table 3 below shows that phosphated samples were less watery, firm, springy, fibrous and tough but more succulent, although not to a marked degree.

Table 3

Characteristic	Untreated	Treated
Wateriness (0-5)	2.6	2.4
Firmness (0-5)	2.8	2.2
Springiness (0-5)	2.4	2.0
Fibrousness (0-5)	2.4	2.1
Toughness (0-10)	5.3	4.2
Succulence (0-5)	2.2	2.5

3.4.4 **Plate Thickness/Shape**

Analysis of the results for portions produced under conditions in which other variables were the same showed that no discernable and consistent effect could be attributed to thickness or shape of mould in the range 9mm to 14mm.

3.4.5 Ram Pressure

The effect of increasing ram pressure on the characteristics of texture is shown in Table 4. The table shows that the product structure rating is significantly reduced (less like a natural fillet) at

increased ram pressures (greater than 40 bar). For other characteristics of texture there are less discernible affects that can be attributed to ram pressure although the samples produced at 20 bar were noticably more succulent and less tough and firm than those produced at higher pressures.

Table 4

Characteristic	Ram Pressure (bar)				
	20	40	50	60	80
Wateriness	2.3	2.6	3.3	2.3	2.0
Firmness	2.4	2.9	3.1	2.8	2.7
Springiness	2.4	2.7	3.1	2.5	2.2
Structure	7.0	7.3	5.7	4.0	-
Fibrousness	2.9	2.9	2.9	2.5	2.2
Toughness	4.5	5.4	5.5	5.3	5.5
Succulence	2.9	2.3	1.9	2.0	2.1

3.4.6 Raw Material Freshness

Table 5 indicates that the aged fish of freshness score 7 produced a formed product of decreased firmness, springiness, toughness and fibrousness but increased succulence compared to that produced from raw material of freshness score 8½.

Table 5

Texture Factors	Non-Polyphosphated		Polyphosphated	
	Fresh	Stored	Fresh	Stored
Wateriness	3.4	2.5	3.1	3.4
Firmness	3.0	2.5	3.1	2.6
Springiness	3.2	2.0	2.9	2.2
Structure	4.8	6.0	6.5	5.3
Fibrousness	2.7	2.4	3.2	2.3
Toughness	5.5	4.0	5.5	3.3
Succulence	2.0	2.7	1.8	3.3

3.4.7 Raw Material Flesh Size

3.4.7.1 Mince Inclusion

The inclusion of mince in the raw material for forming tends to reduce firmness, springiness, structure, fibrousness, toughness and succulence of the portions as shown in Table 6.

TABLE 6

Texture Characteristics	IQF Control Fillet (not reformed)	Formed Fillet From 100% Fillet Material	50% Mince	100% Mince
Wateriness	3.8	2.9	3.4	2.9
Firmness	3.3	2.9	2.9	1.8
Springiness	3.0	3.0	2.3	1.9
Structure	7.0	7.3	4.0	3.7
Fibrousness	2.0	3.4	1.9	1.7
Toughness	7.0	5.8	4.5	3.7
Succulence	3.0	2.4	1.8	1.4

3.4.7.2 Chopped Fillet

Chopping of the raw material into pieces ½" and 1" square produced similar results to mincing of the flesh but to less degree, as shown in Table 7, springiness, structure, fibrousness, toughness and succulence were reduced.

Table 7

Characteristic	IQF Control Fillet	Formed Portion from Whole Fillets	1" dice	½" dice
Wateriness	2.3	2.3	2.5	3.5
Firmness	2.3	3.3	2.5	2.5
Springiness	2.3	3.3	2.3	2.8
Structure	7.0	6.0	7.0	4.5
Fibrousness	2.5	3.0	3.0	3.0
Toughness	3.5	5.0	4.0	4.0
Succulence	2.5	2.5	2.5	2.8

3.4.8 Cold Storage

Tables 8 and 9 show the effect of cold storage on characteristics of texture for phosphated and unphosphated samples assessed after one week, ten weeks and twenty weeks storage.

The tables show a marked increase in toughness even after ten weeks with increases also in firmness and springiness. Structure tended to decrease with storage. The effect was similar for phosphated and un-phosphated samples.

Table 8

Sample 2

Bulk Packed, Unglazed Phosphated Haddock Portion

Characteristics	Storage at -20°C		
	1 week	10 weeks	20 weeks
Wateriness	3.1	2.8	3.7
Firmness	3.1	3.3	3.4
Springiness	2.9	3.0	3.5
Structure	6.5	6.5	5.3
Fibrousness	3.2	4.0	3.5
Toughness	5.5	7.0	7.2
Succulence	1.8	2.0	1.5

Table 9

Sample 9

Bulk Packed, Unglazed, Unphosphated Haddock Portion

Characteristics	Storage at -20°C		
	1 week	10 weeks	20 weeks
Wateriness	2.9	3.0	3.3
Firmness	2.9	3.7	3.7
Springiness	3.0	3.0	3.6
Structure	7.3	6.5	5.0
Fibrousness	3.4	3.5	3.8
Toughness	5.8	8.0	7.2
Succulence	2.4	1.3	1.0

3.4.9 Machine Modification

The effect of the modification to the hopper, in an attempt to minimise pulverisation of the raw material in the hopper by means of a baffle plate would appear to have been largely successful as shown by Table 10.

Table 10

Product Code	% of the Portion Weight (85 gms) of discrete pieces of flesh in the following weight ranges:-				
	< 1gm	1-5gm	> 5-10gm	> 10-20gm	> 20gm
A	1	20	32	47	-
B	77	12	11	-	-
C	-	5	10	35	50
D	22	41	23	14	-
F	1	9	10	11	69
G	-	20	23	37	20
I	-	22	18	32	28
K	-	5	14	51	30
N	25	18	16	-	41
* O	14	30	7	49	-
P	8	29	37	26	-
R	-	18	20	62	-
1	3	6	8	58	25
2	6	-	-	52	42
3	12	16	19	18	35
4	17	16	7	13	47
5	24	9	-	20	47
6	21	4	27	48	-
7	100	-	-	-	-
8	8	-	9	45	38
9	38	48	14	-	-
10	8	-	12	15	65
*11	7	-	7	21	65

The table shows the degree to which the fillets are broken down by the process of forming by an analysis of the discrete component pieces of flesh within the samples. The production run with the modified hopper is coded '11' in the table and is directly comparable with the run coded '0' which was without the modification.

3.5 Discussion of Results

The results of the trials would suggest that the degree of 'rubberiness' and 'denseness' of the formed portions, criticised previously by caterers, was not so pronounced in these trials, and that within the range that they were investigated none of the product or process variables were singularly or jointly responsible for the previously encountered high measure of rubberiness or denseness, although a number did contribute to changes in texture as shown by the results.

The use of texture profile analysis measured by skilled panel assessment is not without difficulty as the profile is designed for use with natural fillets. An alternative texture profile is available for mince products but the texture of a formed product is in essence something between that of a natural fillet and a mince product due to the high degree of breakdown of the fillet caused by the forming process. The 'rubberiness' and 'denseness' criticised by caterers previously is probably best identified by extremes of the characteristics of 'springiness', 'firmness' and possibly 'toughness' within the profile analysis.

It would appear that the nature of the forming process itself, particularly the feeding of fillets to the form plate, produces a more dense and rubbery product than the natural fillet from which it is produced, possibly through compaction and working of the raw material.

Of the product/process variables investigated that of most significance to texture change was cold storage which was shown clearly to increase the toughness, firmness and springiness of product. It should be noted however that the samples were stored unglazed and uncoated in bulk packs and that the quality of the packaging material used by the manufacturer was poor and prone to splitting. Evidence of freezerburn was noticed.

The intrinsic properties of the raw material also had some affect with smaller and fresher fish producing tougher, more springy and firmer portions. Chopping or mincing of the raw material had the opposite affect with a reduction in firmness, springiness and toughness.

Operation of the former at the minimum ram pressure consistent with acceptable portion forming generally reduced product firmness and toughness and significantly improved the structural characteristic of the product (i.e. made it more like the natural fillet).

The problem of pulverisation of fillets in the hopper caused by the feed ram leads to inconsistent product texture quality as smashed product forms in rolls behind the ram head and falls intermittently into the neck of the hopper to be formed into product. The modification described previously would appear to eliminate or greatly reduce the damage caused by this effect. In addition to the damage caused in the forming process the tumbling process of phosphating is also a significant factor in the breakdown of fillet material as can be seen by an analysis of Table 10 and reference to

Appendix 2. For example products coded A and B, (and C and D....) are paired production runs in which the only difference is that the second of the products was phosphated prior to forming. In this respect it is questionable whether the phosphate treatment is desirable in the manufacture of formed portions.

4 CONSUMER TRIALS OF ECONOMY FORMED PORTIONS

4.1 Products Tested

The products tested were as follows:

i) formed portions from whiting fillets

ii) formed portions from coley fillets

iii) formed portions from 50% haddock fillets and 50% haddock mince.

As a benchmark a laminated block cod portion by Ross/Youngs was included making four products in total.

All portions were assessed with regard to freshness and found to be within half a point of each other on the TRS freshness scale.

4.2 Method

Consumer testing was conducted in-hall, in St. Helens, on the 17th - 18th May 1985. All respondents tried three of the four products, the order of serving of which was rotated to eliminate bias. All pieces of fish were fried in a light crumbed coating and cut to a similar shape so that they appeared the same.

In total 144 interviews were achieved, with 108 tastings of each product. Demographic quotas were set to obtain a balanced sample of respondents who were all current eaters of some kind of fish product.

The interviews were to:

i) Discover consumers' opinions of the different products

ii) Identify any negative reaction toward texture

iii) Ascertain consumers' preference.

The hall testing and analysis of results was undertaken by Survey Research Associates Ltd., (SRA), on behalf of the SFIA. A copy of their submitted report is held by the Library of the Industrial Development Unit, Hull.

4.3 Results

4.3.1 Product Liked Best

Table 11 shows the percentage of respondents that liked a particular product best.

Table 11

Product	% Liked Best				
	Total Sampled	**Tasters of Whiting**	**Tasters of Haddock**	**Tasters of Coley**	**Tasters of Cod**
(Base)	**(144)**	**(108)**	**(108)**	**(108)**	**(108)**
Formed Whiting	18	24	16	18	15
Formed Haddock - Mince	31	28	41	28	26
Formed Coley	20	16	20	27	18
Cod Block	31	32	23	28	42

The cod block portion and formed haddock portion containing 50% mince were considered best by an equal number of respondents within the sample followed in order of preference by formed whiting and coley portions.

Analysis by SRA showed that amongst female respondents the cod, haddock and whiting portions were liked best equally, and that younger respondents (16 - 44) favoured the haddock and older respondents (45+) the cod.

4.3.2 Texture

Table 12 shows the texture rating of products and selected statements applying to the products. Texture was rated on a six point scale, highest best.

Table 12

	Formed Whiting	Formed Haddock (fillet + mince)	Formed Coley	Cod Block
(Base)	(108)	(108)	(108)	(108)
Mean Texture Rating (0 - 6, highest best)	3.61	3.87	3.51	3.99
Selected Statements				
Difficult to bite into at first	6	2	4	3
Moist texture	43	42	44	38
Dry texture	18	19	7	18
Solid texture	42	44	19	24
Flaky texture	16	18	28	52
Difficult to chew	19	8	4	11
Soft texture	30	26	47	38
Watery texture	14	17	26	12
Crumbly texture	10	19	22	24
Rubbery texture	35	18	15	18

The texture of the haddock and cod portions was considered good. For the haddock portion this can be attributed to its firm, but not rubbery, texture and for the cod to its flaky texture.

The texture of the whiting and coley portions was considered less good in comparison with the haddock and cod. For the whiting this was attributed to rubbery texture on which one-third of the respondents commented and for the coley on soft and watery texture.

4.3.3 Taste

Table 13 lists the statements made by respondents applying to the taste of the four products.

Table 13

Comment	Formed Whiting %	Formed Haddock/ % Mince	Formed Coley %	Cod Block %
Bland or Tasteless	40	30	37	40
Strong	15	16	16	8
Artificial	22	17	20	9
Natural	30	41	30	44
Sweet	7	4	4	7
Stale	4	6	10	3
Fresh	34	37	26	50
Wholesome	20	17	18	27

The cod and haddock portions received slightly more comments of a positive nature, particularly with respect to freshness and naturalness, than did the whiting or coley portions.

4.3.4 Overall Product Rating

Table 14 shows how the four products were rated by respondents overall by assigning each prodcut a score on a scale one to six (highest best).

Table 14

Rating	Whiting %	Haddock %	Coley %	Cod %
Excellent (6)	7	8	6	14
Very Good (5)	21	28	21	24
Good (4)	21	21	17	27
Fair (3)	25	28	29	19
Poor (2)	19	12	21	13
Very Poor (1)	6	3	6	4
Mean Rating	3.56	3.84	3.42	3.96

Whiting

The overall opinion of the whiting product was fair to good. Main negatives were texture and the lack of taste.

Haddock

The overall opinion of the haddock product was good. Its taste and texture were favourably commented upon.

Coley

The overall opinion of the coley product was fair to good. Main negative was colour which was considered off-putting.

Cod

The overall opinion of the cod product was good. Its flaky texture and taste being favourably commented upon. It was the marginally best received product slightly ahead of the haddock product.

4.4 Discussion of Results

A significant result of the trials is the relatively small differences in the overall consumer ratings of the four products (Table 14), with only half a point on a six point scale separating them. Even the least regarded of the products, the formed whiting, was considered the best product by no less than 18% of all respondents.

There was however a consistent trend to rate the cod and haddock portions higher than the whiting and coley, both in terms of taste and texture.

The rating of the texture of the formed haddock portion as being almost on a par with the cod block portion and superior to formed whiting and coley is surprising as the haddock portion contains 50% added mince.

It might be concluded that product texture, within limits, is not necessarily of great significance to overall product acceptability and that consumer regard for certain texture characteristics is in any case highly subjective.

5 CONCLUSIONS

5.1

The poor product texture criticised in previous acceptability trials was not reproduced in these trials, whatever the combination of product/process variables. It is clear that by sensible control of these variables a product of satisfactory texture can be readily produced.

5.2

Of the variables investigated cold storage without glazing in bulk packs of poor quality was the most harmful to product texture. Good packaging and freezing practice is therefore required.

5.3

The Koppens VM 400 forming machine used tends to smash the fillet material on the return stroke of the feed ram, resulting in inconsistent degradation of product texture when this material passes into the former. This problem is overcome by the machine modification developed during the trials.

5.4

Despite the fact that the consumer acceptability trials were carried out at a single site in a traditional cod favouring area there was surprisingly little difference in overall consumer ratings for formed portions of whiting fillet, coley fillet, and 50/50 haddock fillet/mince compared to sawn portions from cod fillet laminated block.

The number of respondents who commented on the cod portion as being 'fresh' tasting, (50% and far more than such comment on the other portions) is also surprising as the cod portion was marginally the least fresh. It is possible that in this case we are encountering an element of recognition (by cod eaters) which they equate with being the norm and fresh as the north west is an area that traditionally favours cod in preference to haddock.

5.5
Overall preference was for the formed portions of 50/50 haddock fillet/mince on a par with the sawn portions from cod fillet laminated block.

5.6
The 50/50 haddock fillet/mince portion was rated highly on texture, despite the findings of the production trials which indicated that the inclusion of this quality of mince broke down the "structural" quality of the product texture, indicating that consumer regard for certain texture characteristics is in any case highly subjective.

5.7
On the basis of these findings formed portions from relatively low cost raw material, provided it is of good quality, should achieve consumer acceptability.

APPENDIX 3

TEXTURE PROFILE

Initial Characteristics:
Response to the properties of the material on the first bite.

Wateriness:
The release of water on compression. This is the initial response and is to be distinguished from succulence.

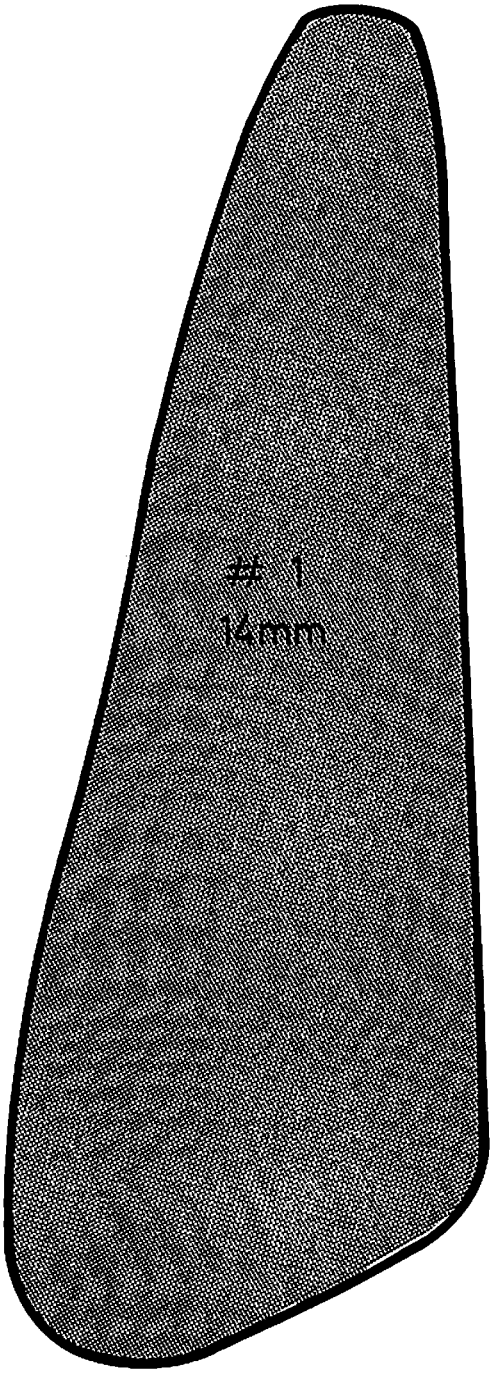
0	no water released but not necessarily dry
5	wet, sample releases water very readily.

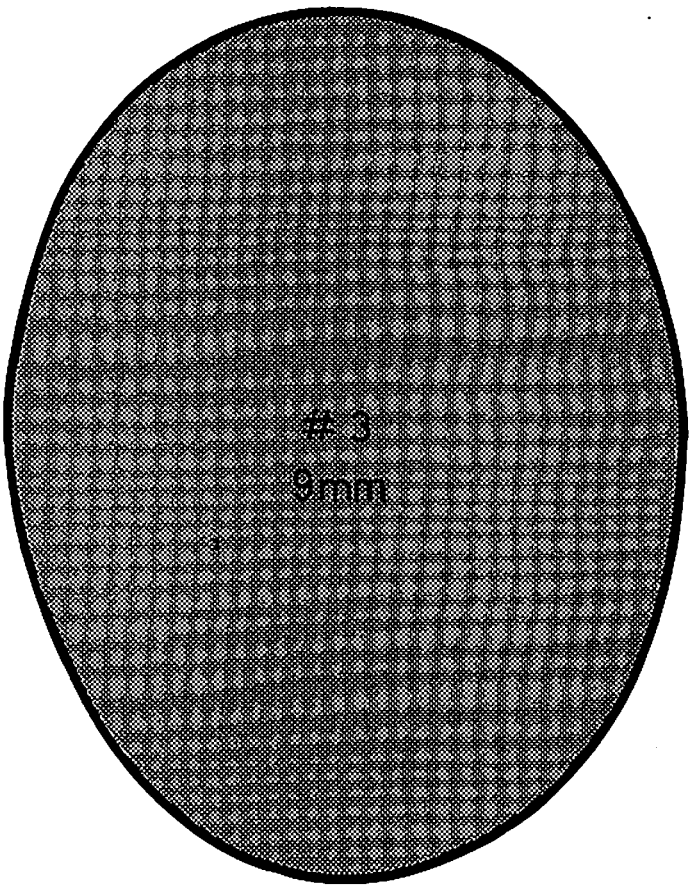
Firmness:
The force required to compress the material between the molar teeth or between tongue and palate.

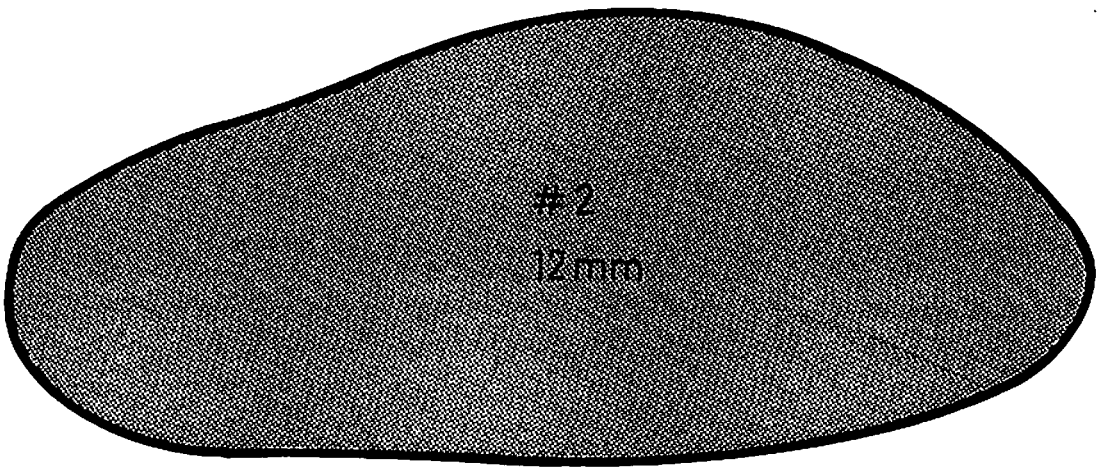
0	very soft, very easily compressed
5	firm, high resistance to compression.

Springiness:
The ability of the material to return to its original shape after deformation. Compress the substance slightly between the molor teeth or between tongue and palate and note how the material returns to its original shape.

0	completely plastic, retains its deformed state
5	springy, returns to its original shape.







Shapes and Thickness of Portions (full size)

Appendix 1

Secondary Characteristics:
Response to the properties of the material after chewing a few times.

Fibrousness:
Property of separating into filamentous structural elements.

0	not fibrous
1	short fibres, almost mealy
5	long fibres.

Toughness:
Resistance to breakdown on chewing to a state suitable for swallowing.

0	very tender, very easily broken down
10	very tough, needs chewing for a long time.

Succulence:
The sensation of juiciness in the mouth.

0	very dry, tends to educe the moisture in the mouth
5	succulent, juicy, tends to increase the moisture in the mouth.

Structure:
The sensation of structure/shape of material to first bite.

0	no distinct structure or shape (least like a natural fillet)
10	structured, flakey, lumps (most like a natural fillet).

APPENDIX 4

SUMMARY OF TEXTURE PROFILE ANALYSIS RESULTS

COMPOSITES -I FULL PANEL 4 TASTERS, T.R.S. SEE APPENDIX 2 FOR CODES

FACTOR	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	R	S	T
Wateriness	3.0	2.8	3.0	2.6	2.0	1.9	1.8	1.8	2.6	2.5	2.4	2.1	2.5	1.9	2.2	2.2	2.3	2.5	2.4
Firmness	2.8	3.0	2.4	1.3	2.8	1.3	3.3	2.3	3.3	2.3	2.6	2.3	2.4	1.3	3.2	2.8	2.4	3.2	2.8
Springiness	2.7	3.0	2.0	0.9	2.2	0.8	2.5	2.2	2.9	2.1	2.0	1.8	1.9	1.2	2.4	2.3	2.1	3.0	2.6
Fibrousness	2.4	2.6	2.1	1.4	2.0	1.3	2.2	2.0	2.5	2.5	2.3	2.1	2.3	1.3	3.0	2.4	2.1	2.8	2.6
Toughness	6.3	5.6	5.2	2.7	4.6	3.1	6.6	5.0	5.3	5.0	5.0	3.8	4.0	3.1	5.6	5.0	4.7	6.7	6.1
Succulence	2.3	1.9	2.5	3.6	2.3	2.8	1.9	2.2	2.0	2.2	2.1	2.1	2.4	2.9	1.9	2.2	2.1	1.8	2.0

CONTROL FILLETS -I 4 TASTERS T.R.S.

	A	C	D	E	F	G	H	L	M	N	P	R	S	T
Wateriness	2.0	1.3	1.6	1.8	1.8	1.1	1.8	1.5	1.0	1.5	1.8	1.2	2.0	1.8
Firmness	2.8	2.2	1.8	1.8	1.8	2.8	2.3	2.1	1.6	1.2	2.8	2.3	3.4	3.4
Springiness	2.1	1.8	1.1	1.5	1.2	2.2	1.8	1.6	1.2	0.8	2.0	2.0	3.0	3.0
Fibrousness	2.0	2.2	2.0	2.0	1.5	2.1	2.0	2.0	1.6	2.0	2.2	2.0	3.0	2.2
Toughness	5.8	5.0	3.8	3.8	3.2	6.0	4.0	4.1	4.1	2.2	5.0	4.5	6.5	6.8
Succulence	2.1	1.8	2.3	1.8	2.5	2.5	2.2	2.1	2.0	2.4	1.5	2.0	1.8	3.0

COMPOSITES -II 2 TASTERS I.D.U.

	1	2	3	4	5	6	7	8	9	10	11
Wateriness	3.4	3.1	2.3	2.5	3.4	3.3	2.9	3.4	2.9	2.8	1.8
Firmness	3.0	3.1	2.4	2.5	2.6	3.1	1.8	2.9	2.9	2.7	2.0
Springiness	3.2	2.9	2.4	2.0	2.2	3.2	1.9	2.3	3.0	2.3	2.0
Structure	4.8	6.5	7.0	6.0	5.3	4.5	3.7	4.0	7.3	6.8	4.0
Fibrousness	2.7	3.2	2.9	2.4	2.3	2.5	1.7	1.9	3.4	3.3	2.0
Toughness	5.5	5.5	4.5	4.0	3.3	4.8	3.7	4.5	5.8	5.5	4.3
Succulence	2.0	1.8	2.9	2.7	3.3	2.4	1.4	1.8	2.4	2.9	1.9

CONTROL FILLETS -II 2 TASTERS I.D.U.

	2	4	5	6	9	10
Wateriness	2.3	2.8	2.0	2.0	3.8	2.8
Firmness	2.5	2.5	2.0	3.0	3.3	2.3
Springiness	2.5	1.8	2.5	2.8	3.0	2.5
Structure	9.0	7.5	7.5	6.0	7.0	7.5
Fibrousness	3.5	2.5	2.0	2.3	2.0	3.3
Toughness	5.5	4.5	3.5	5.0	7.0	4.5
Succulence	2.0	2.5	2.3	2.5	3.0	3.3

APPENDIX 2

SUMMARY OF PROCESSING VARIABLES

CODE	SPECIES	SIZE GRADE	PLATE THICKNESS	SHAPE	PHOSPHATE	PRESSURE	
			mm			bar	
A	H	4	14	1	-	60	
B	H	4	14	1	yes	60	
C	W	4	14	1	-	60	
D	W	4	14	1	yes	60	
E	W	4	14	1	-	80	
F	W	4	14	1	yes	80	
G	H	4	14	1	-	80	
H	H	4	14	1	yes	80	
I	H	4	12	2	-	60	
J	H	4	12	2	-	80	
K	H	4	12	2	-	80	
L	H	4	12	2	yes	60	
M	W	4	12	2	-	60	
N	W	4	12	2	yes	60	
O	H	4	12	2	-	60	
P	H	4	12	2	-	40	
Q	H	4	12	2	-	40	
R	H	4	9	3	-	60	
S	H	2	12	2	-	60	
T	H	2	12	2	yes	60	
1	H	4	12	2	-	50	
2	H	4	12	2	yes	50	
3	H	4	12	2	yes	20	
4	W	4	12	2	-	40	* aged 4 days
5	W	4	12	2	yes	40	* aged 4 days
6	H	4	12	2	-	40	
7	H	4	12	2	-	40	* 100% mince
8	H	4	12	2	-	40	* 50% mince
9	H	4	12	2	-	50	
10	C	large	12	2	-	70	
11	H	4	12	2	-	60	* modified hopper