Consumer sensory evaluation of silver perch cultured in ponds on meat meal based diets

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MEAT & LIVESTOCK
AUSTRALIA

Report to Meat & Livestock Australia
PRCOP.009
(A product of the FRDC Aquaculture Diet Development Sub-program)
September 1999

NSW FISHERIES

FISHERIES RESEARCH & DEVELOPMENT CORPORATION

NSW Fisheries Final Report Series
No. 20
ISSN 1440-3544

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ACKNOWLEDGEMENTS

We would like to thank other technical and clerical staff at Grafton Research Centre. David Stone, Mark Booth and Rebecca Warner-Smith at PSRC helped with earlier silver perch nutrition research. We are grateful to other staff of the Chemosensory Unit, University of New South Wales. Andrew Rhodes from Select Nutrition (Windsor) assisted with manufacturing diets used at GRC. Helena Heasman assisted with report preparation.

In addition to the financial support provided by Meat & Livestock Australia (mainly for the chemosensory analysis), financial support for this research was provided by the Fisheries Research and Development Corporation (Aquaculture Diet Development Sub-program) and the Grains Research and Development Corporation. All agencies are gratefully acknowledged for providing the support necessary for the coordinated national research on fish meal replacement and aquaculture diet development currently under way in Australia.

EXECUTIVE SUMMARY

Performance and taste of silver perch were compared for fish fed meat meal diets and grown in earthen ponds to market size. Silver perch fingerlings (58.5 g average, 56.3-59.6 g range) were stocked at a density of 15 000 fish ha^{-1} earthen ponds (0.1 ha) and cultured for 187 days to a market size of >400 g $fish^{-1}$. Fish were fed the best diet evaluated in an earlier experiment (95LC2; 5% fish meal) or one of two test diets formulated using a least-cost linear feed formulation program and digestibility coefficients for a range of Australian agricultural products (rendered animal protein meals and wheat were the main ingredients). In the test diets, all of the fish meal was replaced. GRC2 was formulated to similar nutrient specifications to 95LC2 whereas GRC3 contained similar digestible energy but a lower digestible protein which was found to be sufficient in previous research.

Ponds have not yet been harvested but based on large samples of fish (~200/pond), there were no significant difference between the performance of silver perch fed any of the three diets. The mean weights (461 g, 453 g, 433 g), growth rates (mean 2.4, 2.4, 2.3) and assumed FCRs (1.6, 1.7, 1.7) based on expected survival of 95% (as has been recorded in three previous experiments in the same ponds) were similar to the best performance from earlier large-scale trials in the same facilities and well above average performance recorded on commercial farms.

A diet ingredient cost of AUD$0.74 to produce 1 kg of fish using GRC3 is the lowest yet recorded and compares well to that for fish fed GRC2 (AUD$0.77/kg) or 95LC2 (AUD$0.89/kg) during this trial or AUD$1.79/kg for SP35 which is a commercial diet based on fish meal and soybean meal still in use by some farmers.

Sensory evaluation of fish fed all three diets (95LC2, GRC2 and GRC3) during this experiment was conducted to determine whether adult fish consumers will taste a difference in the cooked fish. In addition, sensory evaluation aimed to: 1) determine that if three diets produce a discernible difference in flavour, on what sensory attributes they differed? 2) what relative preference, if any, was shown by the consumers for the three differently treated fish and 3) what sensory attributes drive consumer attributes of the cooked fish? The consumer sensory evaluation was carried out in Sydney in April, 1999 and consisted of a controlled sensory evaluation procedure administered to 45 adults.

The three fish tasted significantly different on 5 out of the 21 sensory attributes. These attributes and the diets ranking (best to worst) are: smell strength GRC3<GRC2<95LC2; weedy flavour strength GRC3<GRC2<95LC2; metallic taste strength GRC3<GRC2<95LC2; aftertaste strength GRC2<GRC3<95LC2; aftertaste liking GRC2>GRC3>95LC2.

The sensory attributes driving the acceptance of the fish and the diets with the highest or best score were: Flesh colour liking 95LC22; Overall appearance liking GRC2; Smell liking GRC3; Flavour liking GRC3; Mud flavour strength GRC3 (lowest); Fresh flavour strength GRC3; Aftertaste liking GRC2.

There was no significant difference between the three fish in terms of the consumers' overall liking of the fish, however, 95LC22 was the poorest performer and GRC3 the best performer on the full sensory profiles.

In conclusion, the independent sensory evaluation indicated that the diet GRC3 should be the diet of preference for highest quality production and GRC2 is a reasonable substitute but produces a less favourable sensory profile on two attributes (weedy and metallic).

1. INTRODUCTION

Silver perch (*Bidyanus bidyanus*) are being farmed in increasing quantities in Australia. They are omnivorous and readily accept pelleted diets, tolerate crowded conditions and perform well in earthen ponds (Rowland et al., 1994, 1995). Continued development depends on the development of cost-effective diets. The major constraints in formulating cost-effective diets are a lack of information on nutritional requirements of fish and the digestibility of suitable feed ingredients (Tacon, 1998; McGoogan and Reigh, 1996). While a large number of fish species are cultured throughout the world, only the nutritional requirements of rainbow trout, *Oncorhynchus mykiss*, and channel catfish, *Ictalurus punctatus*, have been extensively studied (Lall, 1991). One of the consequences of this lack of information is a heavy reliance on high quality fish meal as a protein base for most intensively-farmed aquaculture species (Lovell, 1989).

Unfortunately, more than 90% of the fish meal used in animal feeds in Australia is imported (ABARE, 1998). However, large quantities of agriculture proteins are produced locally. For example approximately 480 kt of meat and bone meal (Australasian Agribusiness Services, 1993), up to 1.4 million t of oilseeds, 2.3 million t of pulses and 19 million t of wheat are produced annually (ABARE, 1998).

Although there is little information on nutritional requirements of silver perch, data for other species, especially other omnivorous species such as channel catfish and tilapia, were used to formulate an experimental diet for silver perch (SP35) (Allan and Rowland, 1992) and this diet formed the basis for early commercial diets available for farmers. This has produced fast growth (>2 g $fish^{-1}$ day^{-1}) and high production (~10 t^{-1} ha^{-1} yr^{-1}) in large-scale farming experiments (Rowland et al., 1994, 1995; Rowland, 1995) but was based on expensive imported fish meal and soybean meal. Additional nutritional research with silver perch has evaluated a large number of Australian agricultural proteins for use in formulated diets. This evaluation has included the determination of digestibility coefficients for dry matter, energy, nitrogen, amino acids and phosphorus for approximately 60 ingredients, including some processed in different ways (Allan et al., 1999b). Growth studies to determine maximum inclusion levels for several protein sources considered to have high potential to replace fish meal have also been completed (Allan and Rowland, 1998; Stone et al., 1999). This research culminated in the formulation of new "least-cost" diets based on Australian agricultural ingredients and the success of one of these diets (95LC2) (Allan et al., 1999c) has led to the commercial manufacture and wide availability to farmers. However, 95LC2 still contains 5% fish meal and relies on grain legumes which are difficult for some feed manufacturers to obtain cheaply in eastern Australia where most of the silver perch are cultured. Research since 95LC2 was successfully developed, also showed that for diets with a similar digestible energy content to 95LC2, digestible protein content could be reduced substantially without reducing growth.

In this experiment we evaluated the performance and sensory properties of silver perch fed diets without fish meal, containing Australian agricultural ingredients widely available in eastern Australia which were selected on a least-cost basis using data on ingredient digestibility and maximum inclusion levels from earlier research (Allan and Rowland, 1998). The two "least-cost" or test diets, differed in nutrient specifications and were compared with a commercially available diet (95LC2) formulated by Allan et al., (1999c). Both the test diets had similar digestible energy contents to 95LC2 (13-14 MJ/kg) and one of the last diets (GRC2) also had similar specifications for digestible protein (31%) and digestible essential amino acids. The second test diet (GRC3) had a reduced digestible protein content of 25%. To ensure that data obtained from this experiment had direct commercial application, the diets were assessed in a large-scale pond trial with fish stocked at commercially-relevant densities and cultured to a market size of greater than 400 g per fish over a 187 day month grow-out period.

While one major goal for fish farmers is to reduce diet costs, the composition and taste of fish must be taken into consideration. Positive consumer acceptance of culture product is a key goal and replacement of fish meal with meat meal in silver perch diets will not be successful if the taste of fish is unacceptable to consumers. To address this, we contacted the Centre for Chemosensory Research at the University of New South Wales to conduct a blind sensory evaluation of fish fed the different diets used in this experiment. This component of the experiment was designed to see if consumers could taste a difference in the fish and if so, on what sensory attributes they differed. Finally, the evaluation was designed to identify those attributes which drive consumer acceptance of cooked silver perch.

2. MATERIALS AND METHODS – POND TRIALS

2.1.Experimental diets

Fish fed one of three diets were compared. The "control" diet was 95LC2 and the two test diets were GRC2 and GRC3. (See Tables 1, 2 and 3 for ingredient composition of experimental diets). The test diets were formulated using the linear least-cost computer program 'Feedmania' (Mania Software, Brisbane, Australia). With least-cost diet formulation, nutrient concentrations and ingredient contents are specified (minimum and/or maximum levels or unrestricted) and then the cheapest mix of ingredients to supply the specified nutrients are selected. For GRC2, similar nutrient specifications to 95LC2 were used for digestible energy, digestible crude protein, digestible phosphorus, digestible essential amino acids and linolenic series fatty acids (these nutrients were not allowed to fall more than 5% less than contents in 95LC2). For GRC3, digestible energy and linolenic series fatty acids were also specified to be within 5% of those for 95LC2 but for digestible protein a minimum content of 25% was specified following results from Allan et al., 1999d. Peanut meal and feather meal were restricted to 5% in GRC2 and GRC3. 95LC2 contained 5% fish meal, 37% meat meal and 18% legumes. GRC2 and GRC3 contained approximately 10% poultry offal meal and 37 and 29% high quality meat and bone meal respectively. All diets also contained wheat and/or wheat by-products and other supplements, including fish oil, vitamins and minerals.

All diets were manufactured by Select Nutrition Pty Ltd (Windsor, NSW, Australia). The diets were ground to $\leq 800\mu m$ particle size and extruded to give 3 or 6 mm diameter sinking pellets.

2.2.Experimental fish

Silver perch were artificially bred at the Grafton Research Centre and the fingerlings raised in earthen ponds using techniques described by Rowland (1995) and Thurstan and Rowland (1995). Before the experiment, fingerlings were fed 95LC2 and treated with 5 g l^{-1} NaCl for five days to ensure they were free of ectoparasites and to prevent fungal infection (Rowland and Ingram, 1991). Immediately prior to stocking, fish were anaesthetised using ethyl ρ-aminobenzoate (20 mg l^{-1}), weighed and distributed among nine ponds by systematic interspersion. A total of 1 500 silver perch (mean weight 58.5 g; range 56.3-59.6 g) were stocked (density of 15 000 fish ha^{-1}) into each 0.1 ha earthen pond. Three replicate ponds were used for each diet.

2.3.Experimental facilities and procedures

Experimental earthen ponds were 0.1 ha with a maximum depth of 2 m. The ponds were aerated using a 1-hp paddlewheel aerator for at least 8 h a day, between 0000 and 0800 h. The ponds were static and water was added every four to five weeks to account for evaporative loss and seepage. Up to 50% of the water in each pond was exchanged during March to alleviate poor water quality (low dissolved oxygen) following the treatment of all ponds with 40 ppm formalin to treat the ectoparasite *Dactylogymus* sp.

The fish were cultured for 187 days from late November (Summer, 1998) through to June (Winter, 1999). Fish were fed up to 4 % body weight d^{-1}. Daily rations were divided evenly and fed twice daily by hand at 0800 h and 1500 h, six days a week. Approximately 100 fish $pond^{-1}$ were sampled monthly, the mean weight determined, the biomass estimated and the ration adjusted accordingly. At the end of the experiment, a large sample of fish (200) were harvested by seine net. Performance was evaluated by mean weight and growth rate. Food conversion ratio (FCR), production per unit pond area and ingredient cost per unit of fish produced were estimated based on expected survival rates of 95%. These were used as all ponds had not been harvested at the time this report was written but repeated experiments using the same facilities over similar seasons had all produced survival rates of ≥95%.

Water quality in each pond was monitored twice daily (0800 and 1500 h) at least three days a week using methods described in (Rowland, 1995).

2.4.Statistical analysis

All experiments were designed for analysis using single-factor ANOVA. Homogeneity of variance was assessed using Cochrans' Test, and multiple comparison among means using Student Newman-Keul's procedure. Mean values were considered significant at $P<0.05$.

3. MATERIALS AND METHODS - SENSORY EVALUATION

At the completion of the experiment, the silver perch were purged for two weeks in tanks supplied with domestic water. Fifteen fish from each of the three ponds for each treatment, were filleted and transported on ice to Sydney prior to analysis. The fish were then kept in a domestic freezer at -20° C until needed. The fish were cooked and evaluated under systematic conditions of blind sensory evaluation, following Australian best practices.

3.1.Participants and questionnaires

The 45 subjects for the evaluation were recruited from the staff of the various tenants at the Australian Technology Park. The Centre was satisfied that the recruiting brief had been met and that the subjects were properly competent to perform the tasks required. The panel composition consisted of 20 female and 25 male consumers of fish, aged 18 to 45 years old, from the A-B socio-economic level of Sydney consumers. None of the subjects had been in a similar product evaluation for at least three months. At the end of the session, each subject received a cash gratuity and refreshments.

With the evaluation of each sample of fish, a questionnaire was completed by each panellist. The questionnaire items consisted of 21 unstructured line scales with end anchors. The attributes for sensory evaluation by the panel were determined in consultation. The 22nd item on each sensory questionnaire was an open ended "comments" item. An example of the questionnaire is appended. The panelist was required to complete the sensory questionnaire in a set sequence, from attributes of visual appearance, through smell, taste, texture, after-taste and overall liking of the product.

A digitiser table and computer were used to measure and tabulate the raw data. The magnitude of the rating was obtained by measuring from the left-hand extremity of the scale to the mark made by the subject then calculating the fraction of that distance proportional to the length of the whole line. This is then expressed as a number with a maximum of 100.

3.2.Just Right scales (JR)

In Item 2, the subject was asked to judge the attribute relative to how he'd like it to be. A score of 50 is "perfect", while any score lower has too little of the attribute, and scores over 50 have too much of the attribute. Just Right scales are shown by the letters JR in brackets on the graphs and tables. The scores are converted to "deviations" (0 to 50) for the correlational analysis.

3.3.Preparation of the fish

The fish was defrosted for 2 hours at room temperature, in batches of three fillets, then placed in a convection oven preheated to 200°C for 7 minutes. The samples were served, skin-side down, one fillet per serve.

3.4.Presentation protocol for the cooked fish

The cooked fish were presented in a modified "booth" environment, minimising communication between subjects during evaluation of products. The order of presentation was randomised to counterbalance order effects. All samples were presented "blind" and were identified by three digit codes. Each sample was served one at a time (monadic sequentially). Three to five minutes passed between each serving and the end of the previously evaluated sample. This gave the subjects time to sip water and refresh their palates.

3.5.Analysis

Details of the protocols, analysis and results are given in the graphical sections of this report in the Appendices. The data were analysed by the following statistical tools: Analysis of Variance (ANOVA), Fisher's Least Significant Difference, a matrix of Pearson's correlation coefficients and Biplots of principal components. These procedures determined whether there were significant differences between the attributes for various products and those attributes that had the most influence on the consumers' assessment of the overall acceptability of each product.

Further information on the statistical methods, and the detailed statistical results are given in the Appendices.

3.6.Confidence levels

The inferences given in the following interpretation of the data are based on the statistical analysis of the group's responses, at a confidence level of 5% or better (e.g. 1%).

4. RESULTS - POND TRIALS

4.1.Survival, growth, FCR and production

Results for overall growth over time for fish fed each diet are presented in Figure 1. Food conversion ratio (FCR) and fish production rates are presented in Table 4. Survival was assumed to be 95% in all ponds. There was no significant difference ($P>0.05$) in the growth, production or FCR of silver perch on the three diets.

4.2.Water quality

Water quality was high in all ponds throughout the experiment, except for a three day period during March. Mean monthly water temperatures ranged from 28.2°C in January to 18.7°C in May, and pH values from 7.3 to 8.4. Dissolved oxygen concentrations (DO) usually exceeded 5 mg/L. Total ammonia-nitrogen (TAN) ranged from 0.3 to 1.5 across all ponds between November and April, but in May TAN reached 2.1 to 3.5 mg/L as phytoplankton blooms died off naturally at the end of autumn.

In March, water quality deteriorated significantly following the application of 40 mg/L formalin to each pond to treat an outbreak of the parasitic monogenean trematode, *Dactylogyrus* sp. Although the disease was effectively treated, there was a rapid decrease of DO 36-40 h post-treatment, with concentrations in four ponds falling below 2 mg/L (Minimum of 1.2 mg/L). The pH decreased in all ponds (to a minimum of 6.3), and TAN rose to 1.5 mg/L or higher in all but one pond.

Increased aeration and water exchange were used to manage the deteriorating water quality, and while silver perch in several ponds showed signs of severe stress, no fish were lost during this episode or over the duration of the experiment.

5. RESULTS - SENSORY EVALUATION

5.1.Sensory analysis

The mean score on the overall liking of the product is taken as the overall acceptance of the product, and is shown in Table 2 in the Appendices (Attribute Scores at a Glance). The three products did not differ significantly from each other on overall acceptance as shown in the ANOVA (see Appendices for details). However, the sensory profiles showed five items on which they were differentiated, and examination of these indicates that at least one of the treatments produces a sensory profile that contains several negative attributes. As this is the product with the lowest acceptance score overall, it would be reasonable to attach most caution to the use of this diet (95LC2) when attempting to produce the best quality product.

Please refer to Table 2 in the Appendices (Attribute Scores at a Glance) for full details of the mean scores on each attribute for each product.

The overall acceptability of the products was above 50 (out of 100) for 95LC2 and above 60 for the other two diet treatments etc. While cooked fish products are unlikely to ever score in the 80s or 90s (unlike candy and deserts), these results should be regarded as indicative of a **favourable** product. It is our experience that a poor product scores at or below 30 on overall acceptance. The acceptance scores for each product and the strengths and weaknesses of each product (derived from the table of means) are shown in Figure 2.

5.2.Drivers

We assume that co-variance between two attributes implies that one "drives" the other (and vice versa), however, this is done in the knowledge that other influences may cause the co-variance. (See notes on the statistics in the Appendices).

The correlational analyses identified seven attributes which significantly drive overall acceptance of the products. With the exception of Mud Flavour Strength, six of these correlations were positive, i.e. the greater the attribute rating, the greater the overall acceptance can be expected. In the exceptional case, the higher the mud flavour strength, the less the sample of fish was liked overall.

Attributes driving overall acceptance (with correlations of $\pm$ 0.292 or larger between any attribute and overall acceptance) are shown underlined in Table 2 in the Appendices (Attribute Scores at a Glance) and in the bottom row of Table 3 in the Appendices (Drivers of Acceptance).

The sensory attributes driving the acceptance of the fish are:

	highest scoring fish
Flesh Colour Liking	*95LC22*
Overall Appearance Liking	*GRC2*
Smell Liking	*GRC3*
Flavour Liking	*GRC3*
Mud Flavour Strength#*	*GRC3 (lowest)*
Fresh Flavour Strength	*GRC3*
Aftertaste Liking#	*GRC2*

* *This correlates negatively with acceptance, so GRC3 is best placed*

 # These attributes differentiate the three fish and drives Overall Liking. They are therefore key predictors of whether the fish will gain consumer acceptance.

The product developer's aim should be to have the company's products differentiated positively from its competition on as many of these drivers as possible. Predominant drivers are underlined (Table 2 in the Appendices). See also Table 3 in the Appendices for significant Pearson's correlation coefficients for "what drives the drivers". For instance, of the attributes by which the three fish products were discriminated by the consumer panel, only Aftertaste Liking was a driver of overall acceptance. However, the other four attributes of which differentiated the fish samples, viz., Smell Strength, Weedy Flavour Strength, Metallic Taste Strength and Aftertaste Strength, correlated significantly with several important drivers (positively with Muddy Flavour Strength, negatively with Fresh Flavour Strength and negatively with Aftertaste Liking) and therefore are associated with the overall acceptance of the product, albeit indirectly. These complex relationships are more easily visualised in the Biplot.

5.3.Other driver relationships

5.3.1 Biplot analysis:

The biplot (Figure 2a in the Appendices) shows the closeness of each product to the main acceptance scores (Q 21), to each other, and to the other attributes. Products B (GRC2) and C (GRC3) lie about equidistant from Q21, however GRC3 is more closely related to the drivers of Fresh Flavour Strength, Flesh Colour Liking and Smell Liking. GRC2 has closer association with Aftertaste Liking. 95LC2 is closely related to the negative driver Muddy Flavour Strength.

The Biplot confirms the other statistical analysis in this study that the least risk for an acceptable product lies with GRC3, the next best is GRC2 and the product to be avoided is 95LC2.

6. DISCUSSION

6.1.Pond trials

The mean daily growth rate of 2.2 g $fish^{-1}$ day^{-1} of silver perch fed 95LC2 was very similar to growth rates (2.0-2.3 g $fish^{-1}$ day^{-1}) achieved using this diet in previous studies by Allan et al., 1999e.

Differences in performance of fish fed the three different diets were not significant ($P>0.05$), but, when the cost of supplying the ingredients for each diet was calculated (cost of ingredients x FCR), the costs were lowest for the test diets. The calculated ingredient cost of $0.70 per kg fish is the lowest yet recorded for rapidly growing silver perch. Ingredient prices were obtained from NSW Agriculture, Sydney Retail Feed Ingredient Prices or directly from ingredient suppliers or feed manufacturers. They do not include freight charges, although clearly all feed mills will have to pay costs of freight for some ingredients.

During this study, Australian agriculture products, mainly rendered animal meals, were successfully used to replace all of the fish meal in silver perch diets. The excellent results with diets GRC2 and GRC3 demonstrate the potential of meat meal, poultry offal meal and wheat to be used as the basis of high performance, low-cost commercial diets for silver perch and confirms the potential shown in earlier digestibility and growth studies. (Allan and Rowland, 1998; Stone et al., 1999).

Other studies have also shown that meat meal, and meat and bone meal can be successfully used to partially replace fish meal in diets of many fishes, including barramundi, sea bream, tilapia, yellowtail, channel catfish and rainbow trout (Davies et al., 1990; Mohsen and Lovell, 1990; Davies et al., 1991; Aquacop et al., 1993; Shimeno et al., 1993a, 1993b; Watanabe et al., 1993; Williams et al., 1997).

In general, meat meal and meat and bone meal have been used to increase diet attractiveness and or palatability (Mohsen and Lovell, 1990; Watanabe et al., 1993). Fish fed all diets grew rapidly and there were no observed differences in attractiveness or palatability of the diets.
The value of meat products for use in aquaculture diets will increase if protein content is increased and ash content reduced. Aquaculture diets typically contain much higher protein:energy ratios than diets for pigs or poultry (crude protein contents are usually 35-50% for diets compared with 15-22% for pig and poultry diets). For this reason, at least some high protein ingredients are required for aquaculture diets. Fish meal is a preferred protein source for aquaculture diets as it has a high protein content, excellent amino acid balance, contains essential fatty acids, has no carbohydrate and, provided it is fresh and well processed, contains no anti-nutritional factors.

Standard meat and bone meal is typically around 50% crude protein, >30% ash and 10-20% fat (Allan, 1994). In general, lower fat contents are desirable as saturated animal fats are undesirable in most aquaculture diets. Low ash, high protein meat meals have shown promise as protein sources to replace fish meal in diets for rainbow trout (*Oncorhynchus mykiss*) and yellowtail (*Seriola quinqueradiata*) (Shimeno et al., 1993a; 1993b; Watanabe et al., 1993). Clearly, the value of all meat products in aquaculture diets will depend upon consistency of composition and on the absence of deleterious compounds such as hair or wool (which tend to clog up feed manufacturing equipment). Heat damage in rendering plants can also reduce digestibility of amino acids, e.g. lysine, and reduce the value of meat meal for use in aquaculture diets.

Australia is well placed to utilise agricultural products in aquafeeds. Approximately

450 000 t/y of meat meal is produced while more than 19 million t of wheat is produced.

6.2.Sensory evaluation

Although the direct analysis of overall liking scores failed to differentiate the products in terms of overall consumer acceptance, the sensory profiles gave a very strong indication that the three diets are very different in the resulting perceived quality of the cooked fish and clear directions for further development on a preferential basis. **GRC3** deserves the most attention for future commercial development as this diet produced the best product for human appreciation and market position. Silver perch fed on this diet had a sensory profile that was sound in all 21 measured items used in this study. **GRC2** was a good diet and while it is good in terms of aftertaste, it has a couple of weaknesses (weedy and metallic flavours) which indicate it should not be used in preference to GRC3. **95LC2** produced a level of acceptance that might be regarded as favourable and produced the most acceptable flesh colour of the three diets. Unfortunately, the number of weak points in its profile rated it overall as the poorest of the three diets.

The results of this research demonstrates that rendered animal protein ingredients including meat meal and poultry offal meal, and wheat can form the basis for high-performance, low-cost diets for intensive pond-culture of silver perch.

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Table 1. Ingredient composition of experimental diets for silver perch

Ingredient	95LC2	98GRC2	98GRC3	Cost ($/t)
Fishmeal	5	0	0	1500
Fish oil	3.2	3.2	7.6	1021
Blood meal	0	1.7	0	1000
Meat meal	36.9	37.5	29.4	325
Poultry offal meal	0	10.3	10.6	550
Feather meal	0	5	5	450
Soybean meal	0	5	0	480
Canola meal	5	0	0	295
Peanut meal	5	5	0	325
Lupins (dehulled)	7.4	0	0	517
Field peas (dehulled)	10.4	0	0	350
Corn gluten meal	5.2	0	0	750
Wheat	0	10.58	25.9	188
Mill run	20.2	20	20	150
Vit/Min premix	1.5	1.5	1.5	
DL methionine	0.3	0.1	0	

Table 2. Composition of vitamin premix added at 0.75% (i.e. 7.5 g/kg)

Raw Material	iu or mg/kg diet*	Active ingredient	iu or mg/kg diet
Fat soluble vitamins:			
Vitamin A 500	16 000 iu	Vitamin A	8 000 iu
Vitamin D3 500	2 000 iu	Vitamin D3	1 000 iu
Vitamin E 50 Adsorbate	250.0	Vitamin E	125.0
Hetrazeen FC (22.75 Menadione)	72.53	Vitamin K3	16.5
Waste soluble vitamins:			
Thiamine Hcl 89.3% (B1)	11.73	Thiamine (B1)	10.0
Riboflavin S/D 80% (B2)	31.88	Riboflavin (B2)	25.5
Pyridoxine Hcl 81% (B6)	18.51	Pyridoxine (B6)	15.0
Cal D Pantothenate	61.00	D Pantothenate	55.0
Biotin 2%	50.00	Biotin	1.0
Niacin (Nicotinamide)	201.01	Niacin	200.0
Folic acid 80% S/D	5.00	Folic acid	4.0
Vitamin B12 1%	2.00	Vitamin B12	0.02
Vitamin C Stay C 25% (ascorbyl-2-polyphosphate)	1 000.00	Vitamin C (ascorbic acid activity)	250.0
Choline chloride 60%	2 500.00	Choline chloride	1 500.0
Inositol	603.86	Inositol	600.0
Mould inhibitor (Myocurb)	200.00	Mould inhibitor	200.0
Ethoxyquin 66% (antioxidant)	303.03	Ethoxyquin	200.0
Carrier/filler	2 189.45		
	7 500.00		

Table 3. Composition of mineral premix added at 0.75% (i.e. 7.5 g/kg)

Raw Material	mg/kg diet	Active Ingredient	mg/kg diet
Potassium iodide 68% I	0.684	I	0.465
Copper sulphate 30% Cu	12.00	Cu	3.00
Ferrous sulphate 30% Fe	100.0	Fe	30.00
Magnesium sulphate 10% Mg	5096.84	Mg	500.00
Manganese sulphate 36% Mn	27.78	Mn	10.0
Sodium selenite (diluted to 1%) Se	33.0	Se	0.33
Zinc sulphide 36% Zn	277.78	Zn	100.00
Filler (wheat bran)	1951.96		
	7500.00		

Table 4. Final weight, growth rate, food conversion ratio, production rate and diet ingredient cost for silver perch (stocked at 58 g/fish) fed one of three diets for 143 days[1]

Diet	Final Weight (g)	Growth Rate (g fish^{-1} day^{-1})	FCR[2]	Production[2] (t ha^{-1})	Ingredient Cost[2] (AUD$ kg fish^{-1})
95LC2	461 ± 9.7[a]	2.4 ± 0.05[a]	1.6	6.5 ± 0.14[a]	0.79
GRC2	453 ± 6.1[a]	2.4 ± 0.03[a]	1.7	6.5 ± 0.10[a]	1.73
GRC3	433 ± 6.9[a]	2.3 ± 0.05[a]	1.7	6.2 ± 0.11[a]	0.70

[1] Values are means ± SEM for 3 replicate ponds. Means in columns which share the same superscript were not significantly different (P>0.05; ANOVA; SNK).

[2] Assumed survival = 95%. Ingredient cost based per kg fish based on total ingredient cost multiplied by FCR. Ingredient prices were from NSW Agriculture (Sydney Retail Feed Ingredient Price Survey) or feed manufacturers (high quality fish meal).

Figure 1. Growth of silver perch in o.1 ha ponds at Grafton Research Centre. Values are means ± SEM (N = 3). For weight at harvest, means with the same letter were not significantly different (*P*>0.05; ANOVA; SNK).

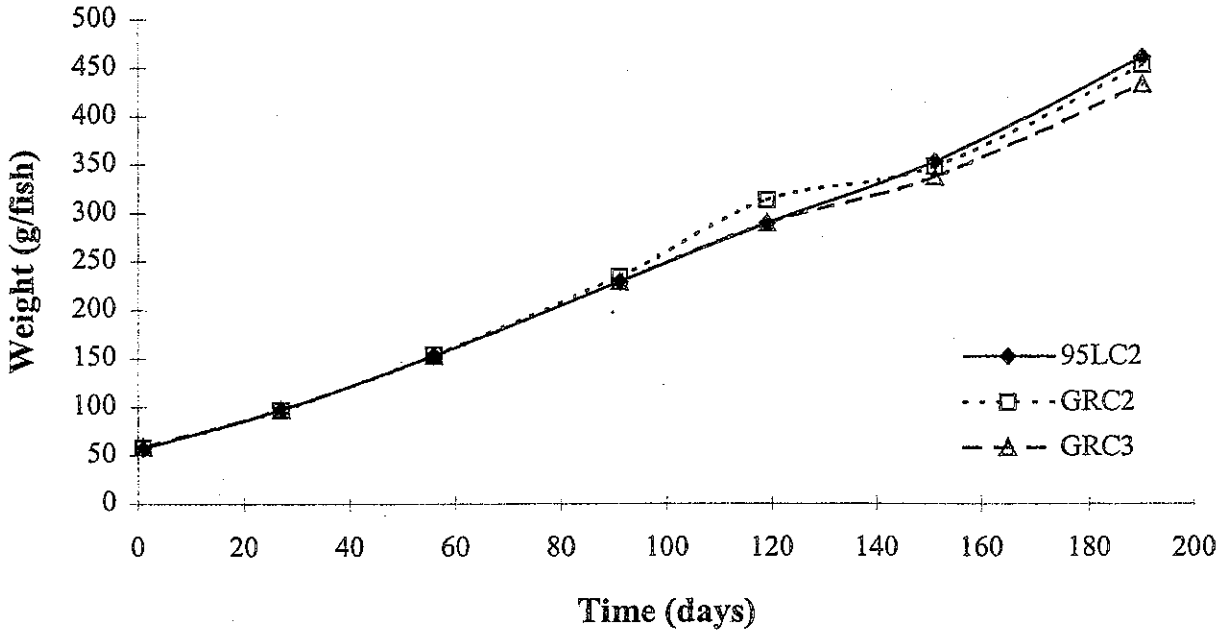
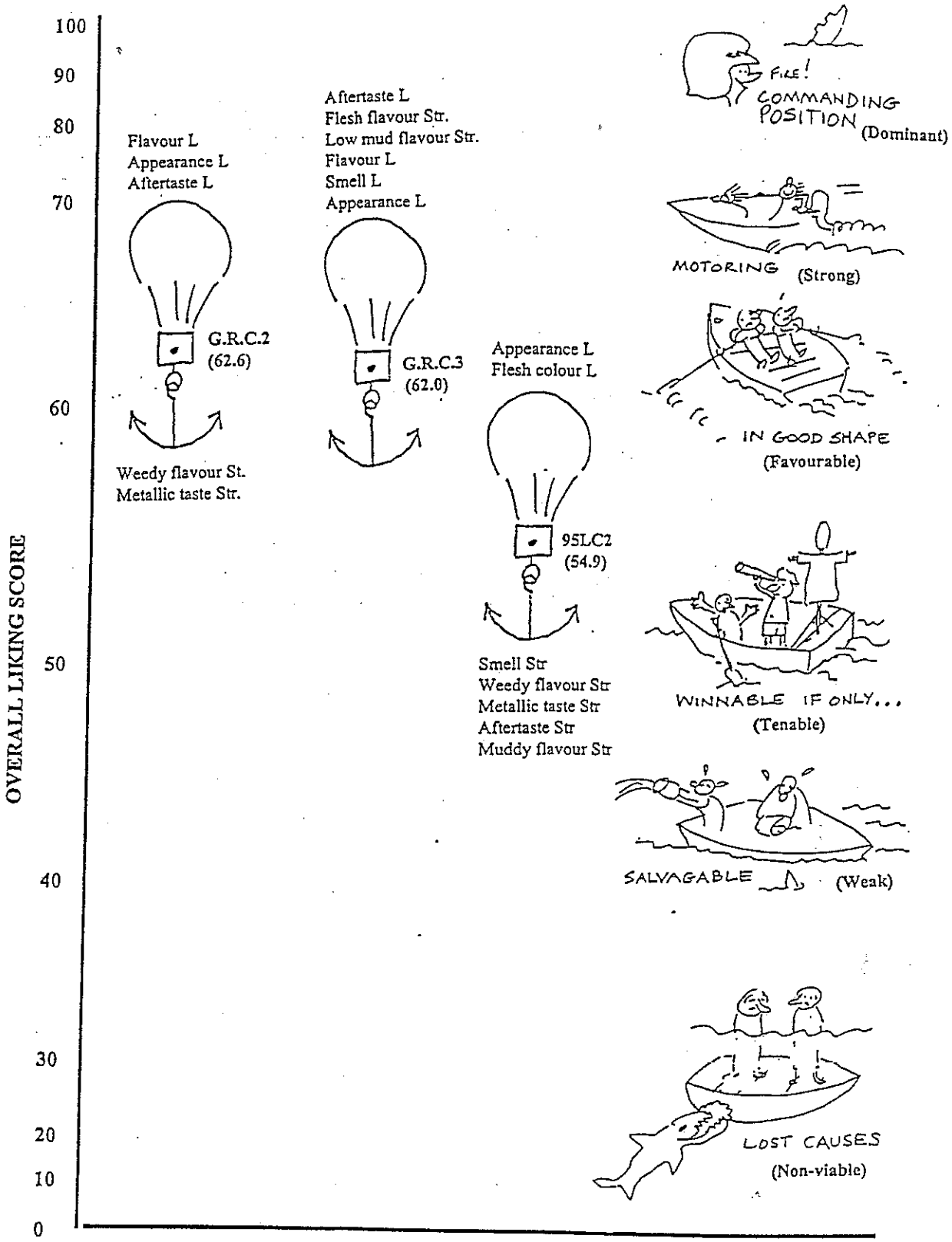


Figure 2. Acceptance scores for each product and the strengths and weaknesses of each product (derived from the table of means)



8. APPENDICES

Appendix 1 The Products

Appendix 2. The People

Appendix 3 Attribute Scores at a Glance

Appendix 4 Drivers of Acceptance

Appendix 5 Product Profiles at a Glance

Appendix 6 Attribute Profiles at a Glance

Appendix 7 Comments on the Products

Appendix 8 The Questionnaires and Sensory Ballots

Appendix 9 Statistical Analysis

Appendix 10 Notes on Statistics used in this Study

Appendix 11 Consultancy Agreement between Meat & Livestock Australia and New South Wales Fisheries PRCOP.009

THE

PRODUCTS

N.S.W. Fisheries Product Numbers	Testing Codes
GRC2	815 (B)
GRC3	923 (C)
95LC2	136 (A)

THE

PEOPLE

Fish Panelists

April 1999

SUBJECT NUMBER	SEX	AGE
1	M	50
2	F	46
3	F	30
4	F	23
5	F	29
6	F	40
7	F	36
8	F	35
9	F	52
10	F	30-45
11	F	21
12	F	42
13	F	20
14	M	38
15	M	60
16	M	24
17	M	42
18	F	20
19	F	20
20	F	24
21	M	20
22	F	21
23	M	29
24	M	19
25	F	21
26	F	27
27	M	23
28	M	20
29	M	18
30	M	29
31	M	29
32	M	46
33	M	31
34	F	21
35	M	23
36	M	26
37	F	19
38	M	51
39	M	60
40	M	20
41	M	48
42	M	23
43	M	28
44	M	53
45	M	33

Age Distribution n

18-25 = 19
26-35 = 11
36-45 = 5
46-55 = 7
56-60 = 2
30-45 = 1
Total = **45**

Female = 20 = 44.4%
Male = 25= 55.6%

ATTRIBUTE SCORES AT A GLANCE

TABLE 2. MEAN ATTRIBUTE RATINGS FOR 3 FISH SAMPLES

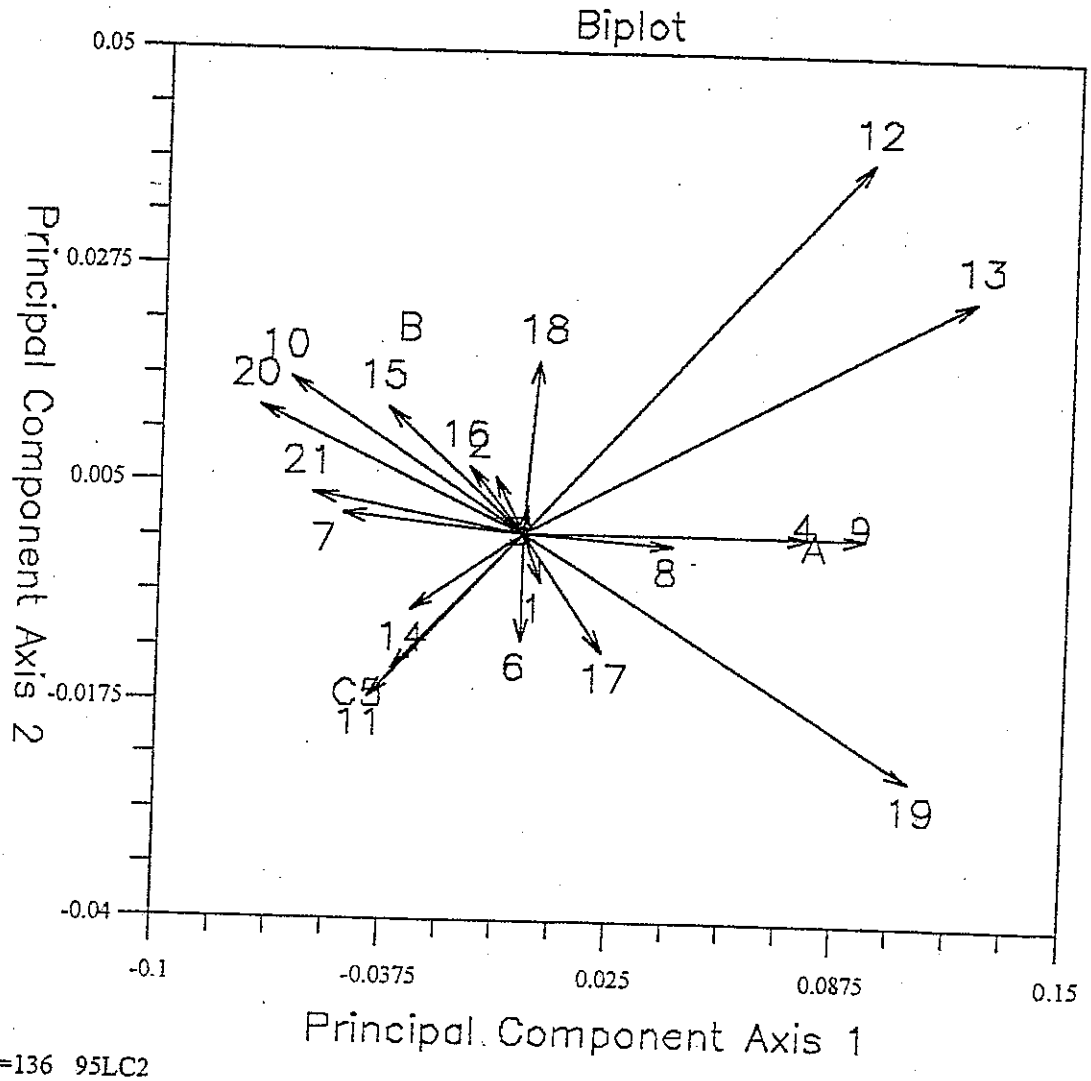
ATTRIBUTE (LSD)	95LC2	GRC2	GRC3
flesh colour liking*	52.78	51.60	52.18
colour liking jr	51.71	53.42	52.27
overall appearance liking	50.20	50.44	50.22
smell strength (7.8)	50.67	43.89	42.44
smell liking	52.07	55.24	58.98
fresh smell liking	54.22	53.53	55.89
flavour liking	52.31	58.58	59.22
fish flavour strength	49.36	45.02	45.07
^^muddy flavour strength	42.69	35.44	34.91
sweet flavour strength	32.64	38.16	37.16
meaty flavour strength	45.20	48.60	51.89
^^weedy flavour strength (6.6)	35.18	31.31	27.93
^^metallic taste strength (7.4)	34.04	28.58	25.67
fresh flavour strength	52.96	55.93	57.60
soft-hard	35.11	39.44	38.02
dry-moist	55.58	58.64	57.91
^^stringy	31.20	29.76	30.53
smooth-rough	38.58	39.67	37.64
aftertaste strength (8.4)	54.13	42.87	44.40
aftertaste liking (7.8)	50.84	60.40	59.13
overall liking	54.91	62.60	62.02

* Attributes that are underlined are significant drivers of overall liking
^^ these correlate negatively with overall liking and aftertaste liking

DRIVERS OF ACCEPTANCE

TABLE 3. SIGNIFICANT PEARSON CORRELATIONS FOR FISH (r>0.292, r<-0.292)

	flesh colour liking	colour liking jr	overall appearance liking	smell strength	smell liking	fresh smell liking	flavour liking	fish flavour strength	muddy flavour strength	sweet flavour strength	meaty flavour strength	weedy flavour strength	metallic taste strength	fresh flavour strength	soft-hard	dry-moist	stringy	smooth-rough	aftertaste strength	aftertaste liking
colour liking jr	0.319																			
overall appearance likin	0.646	0.387																		
smell strength																				
smell liking	0.295		0.379																	
fresh smell liking			0.364		0.493															
flavour liking	0.326				0.272															
fish flavour strength				0.289																
muddy flavour strength				0.388			-0.368													
sweet flavour strength																				
meaty flavour strength				0.245					0.293											
weedy flavour strength									0.541											
metallic taste strength						-0.353			0.398			0.363								
fresh flavour strength						0.443	0.494						-0.308							
soft-hard															-0.315					
dry-moist												0.311				-0.418				
stringy									0.318						0.358	-0.477	0.458			
smooth-rough								0.412	0.417											
aftertaste strength																				
aftertaste liking	0.354		0.332		0.455	0.305	0.639		-0.330			-0.306	-0.300	0.486			-0.300			
overall liking	0.400		0.343		0.376		0.715		-0.349					0.486						0.814



A=136 95LC2
B=815 GRC2
C=923 GRC3

1 – flesh colour liking
2 – colour liking
3 – overall appearance liking
4 – smell strength
5 – smell liking
6 – fresh smell liking
7 – flavour liking
8 – fish flavour strength
9 – muddy flavour strength (-)
10 – sweet flavour strength
11 – meaty flavour strength
12 – weedy flavour strength (-)
13 – metallic taste strength (-)
14 – fresh flavour strength
15 – soft-hard
16 – dry-moist
17 – stringy (-)
18 – smooth-rough
19 – aftertaste strength
20 – aftertaste liking
21 – overall liking

Figure 2a

(-) = Negative correlation with 21 in Table 2

PRODUCT PROFILES AT A GLANCE

FIGURE 3. MEAN ATTRIBUTE RATINGS FOR 3 FISH SAMPLES

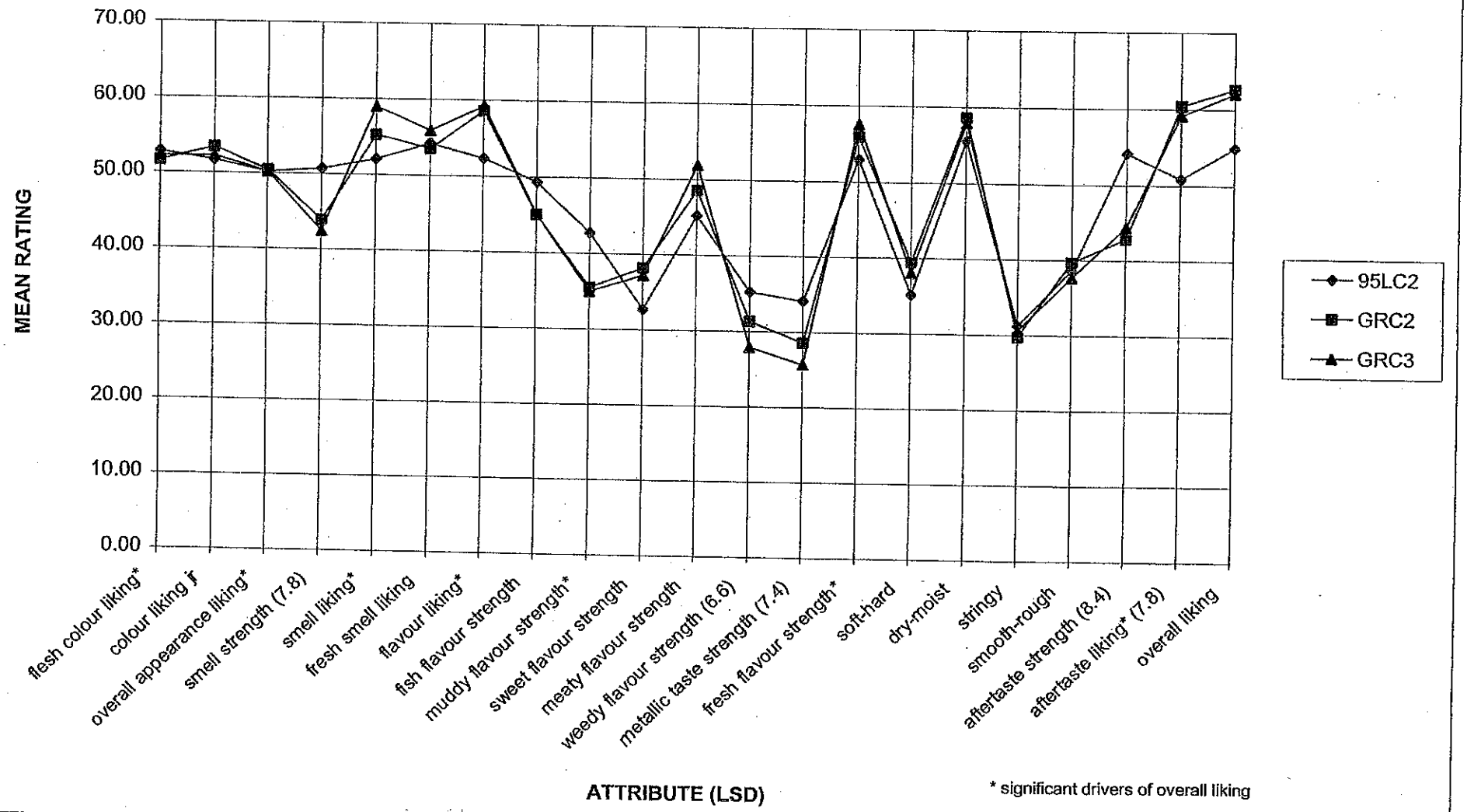


FIGURE 4. MEAN ATTRIBUTE RATINGS FOR FISH SAMPLE 95LC2

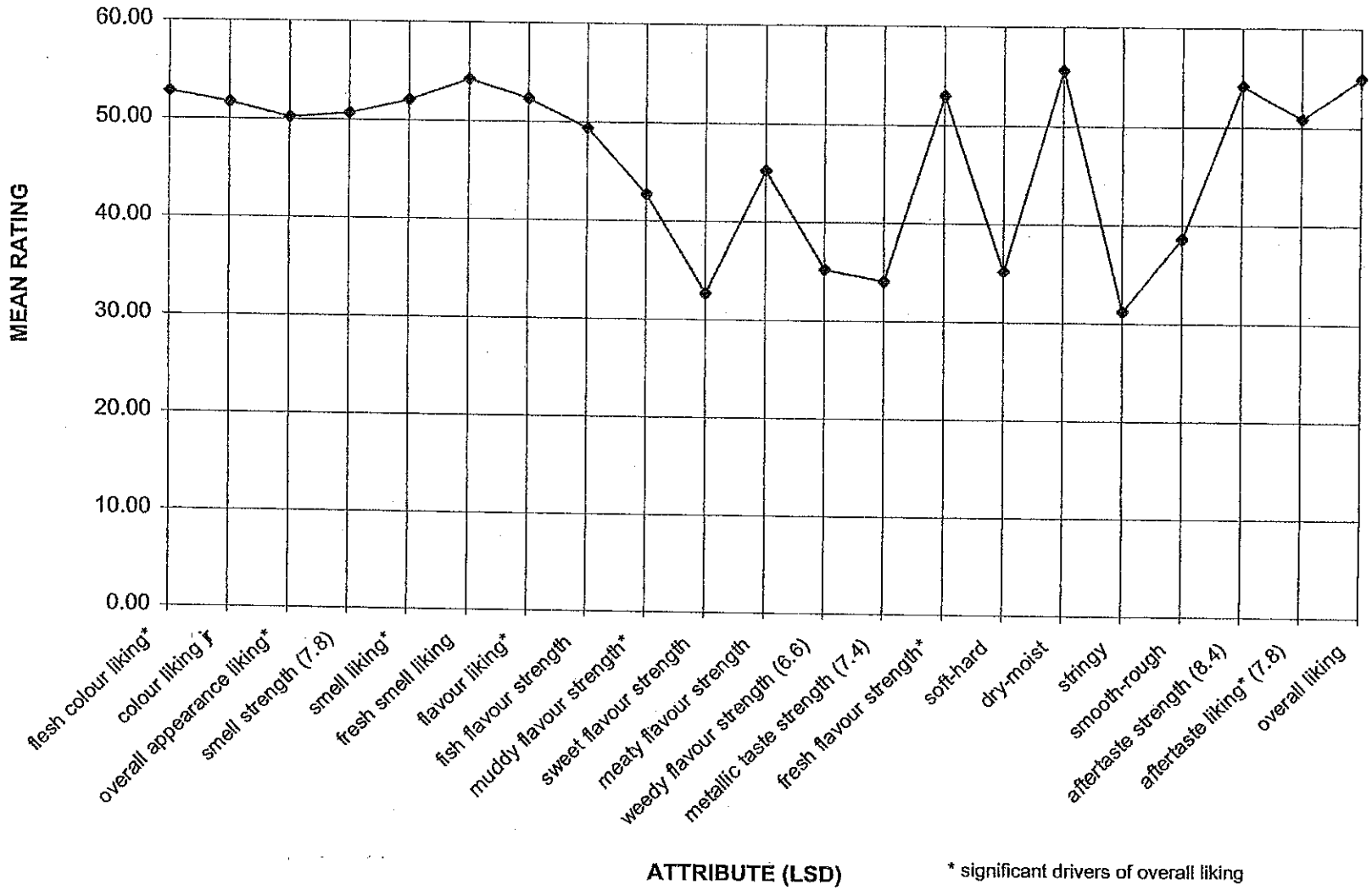


FIGURE 5. MEAN ATTRIBUTE RATINGS FOR FISH SAMPLE GRC2

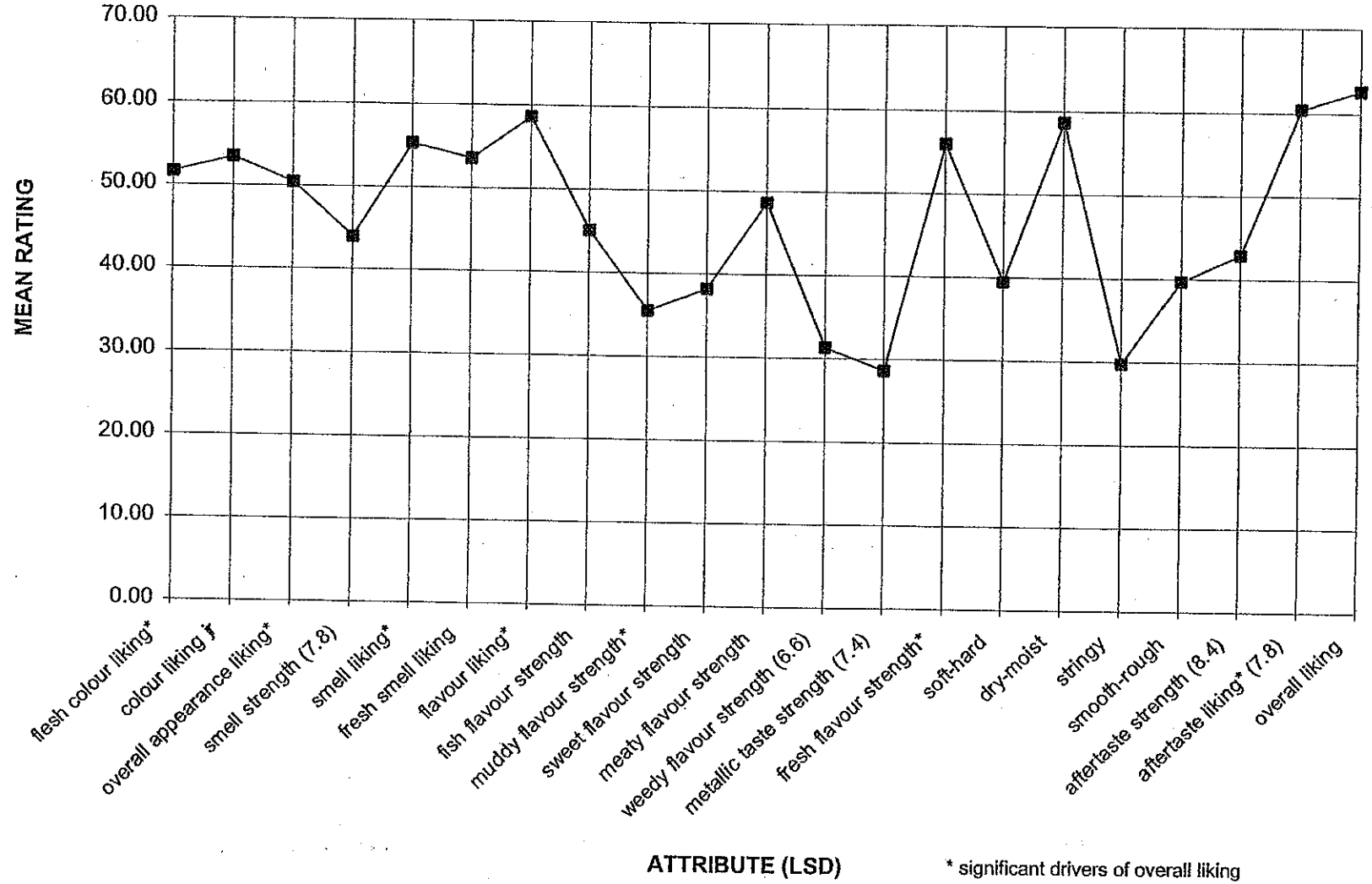
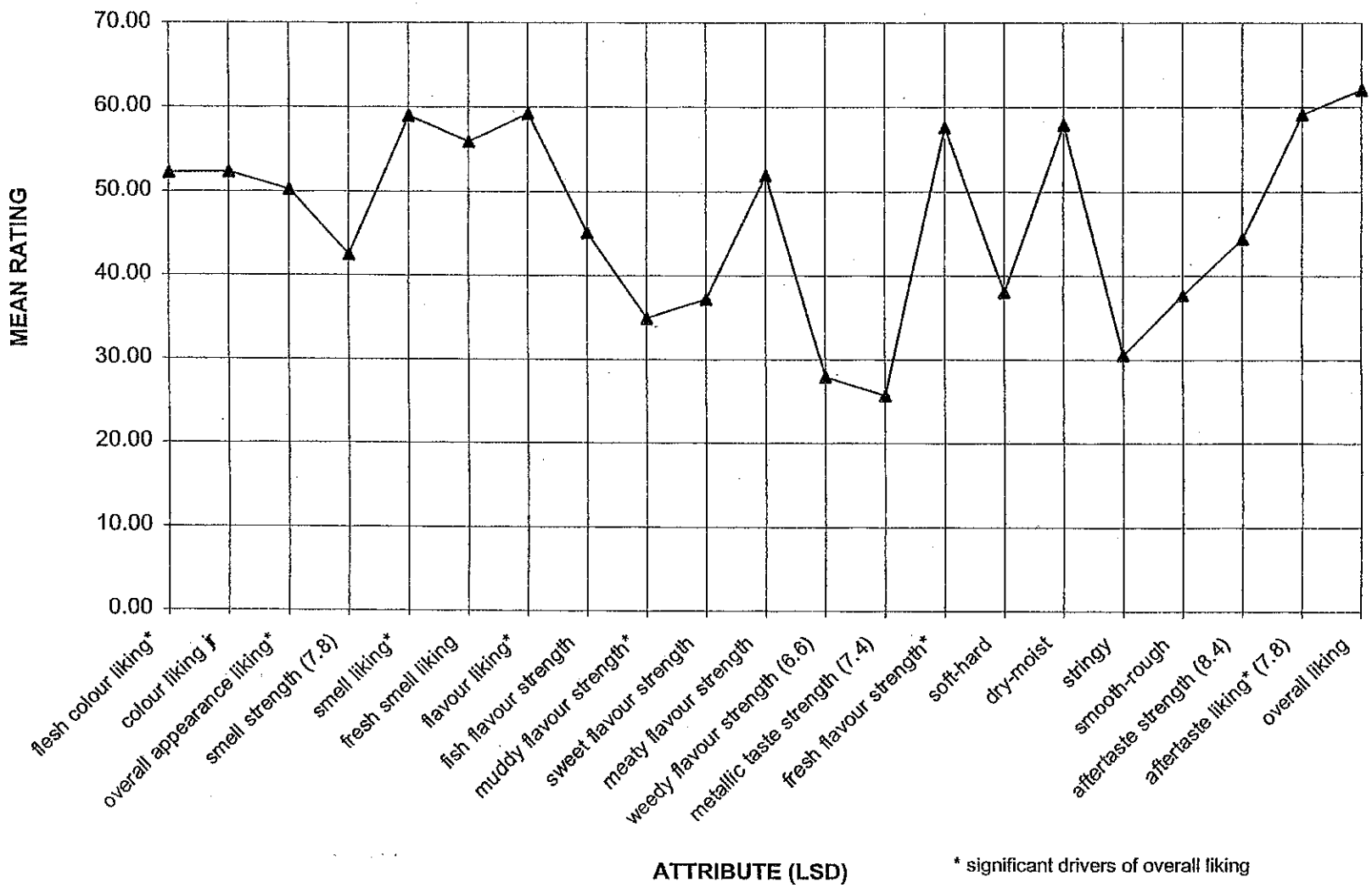
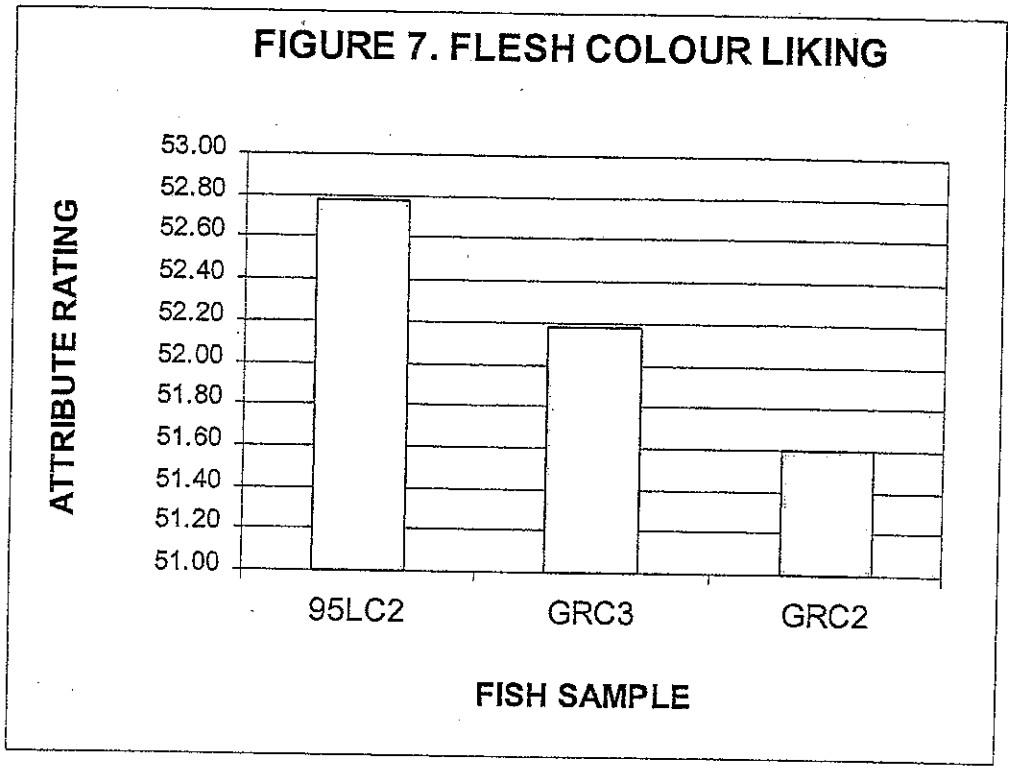
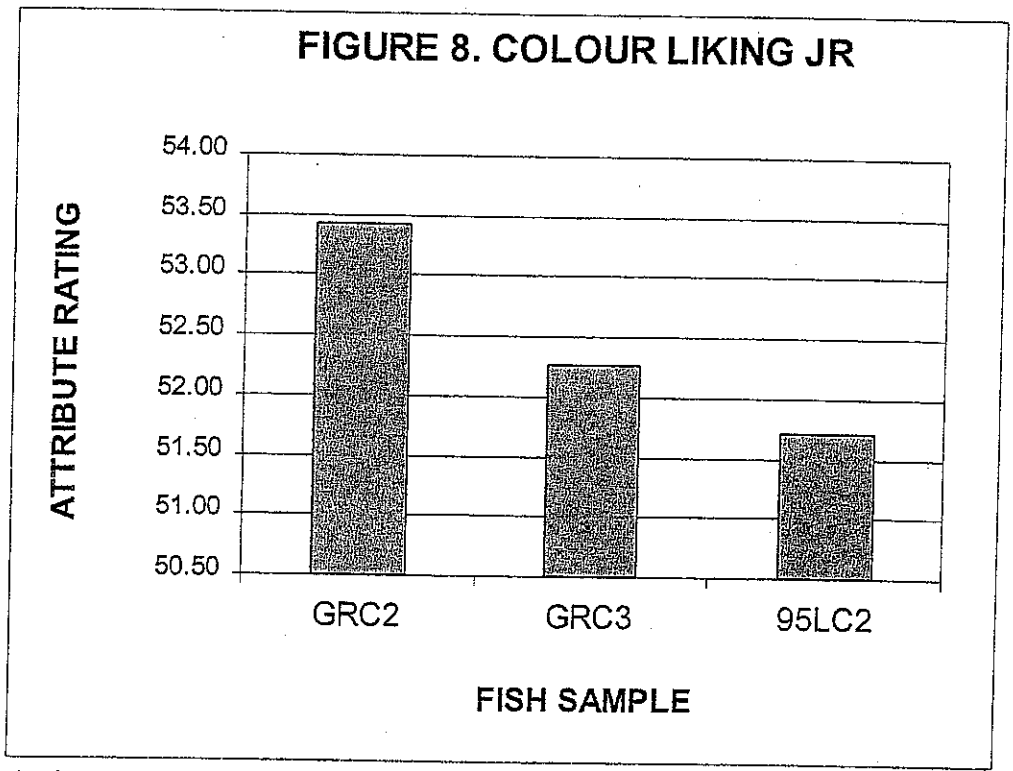


FIGURE 6. MEAN ATTRIBUTE RATINGS FOR FISH SAMPLE GRC3

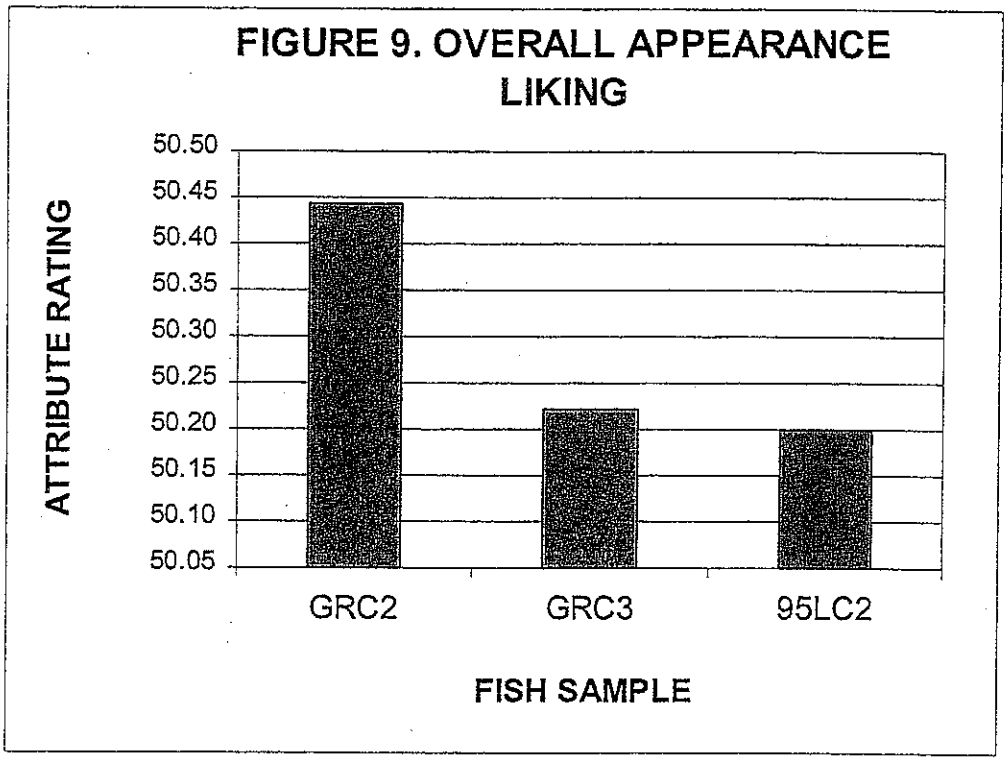


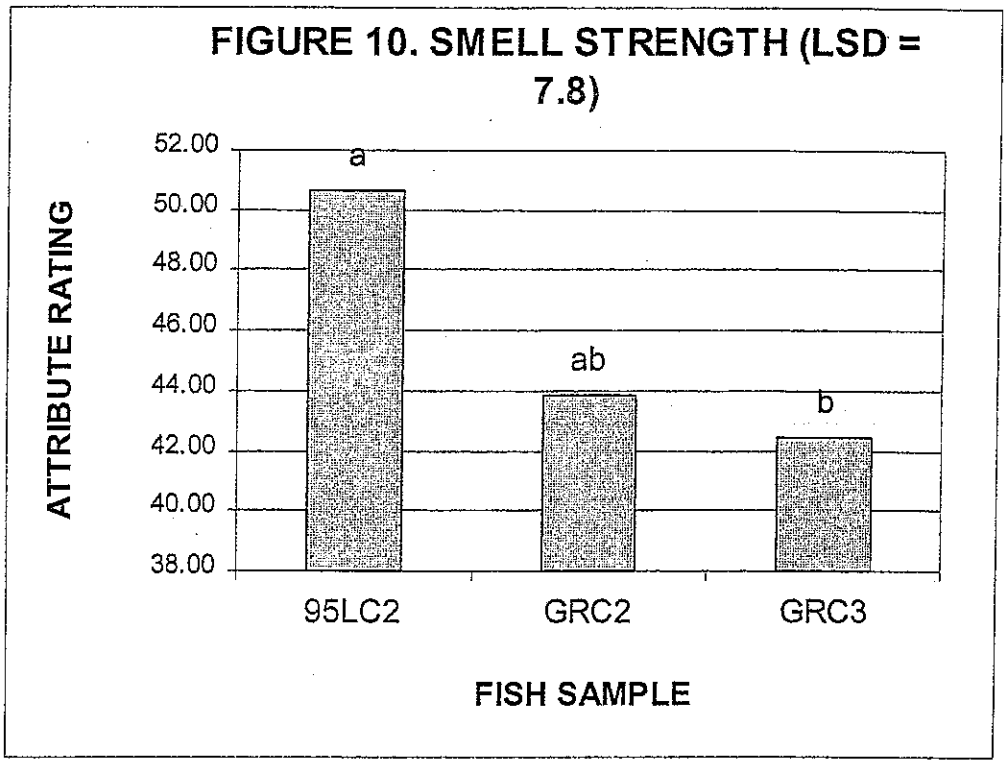
ATTRIBUTE PROFILES FOR EACH PRODUCT





The ideal score on a "just right" scale is 50





Mean values with different letters (a,b,c) are statistically significantly different at $P<0.05$

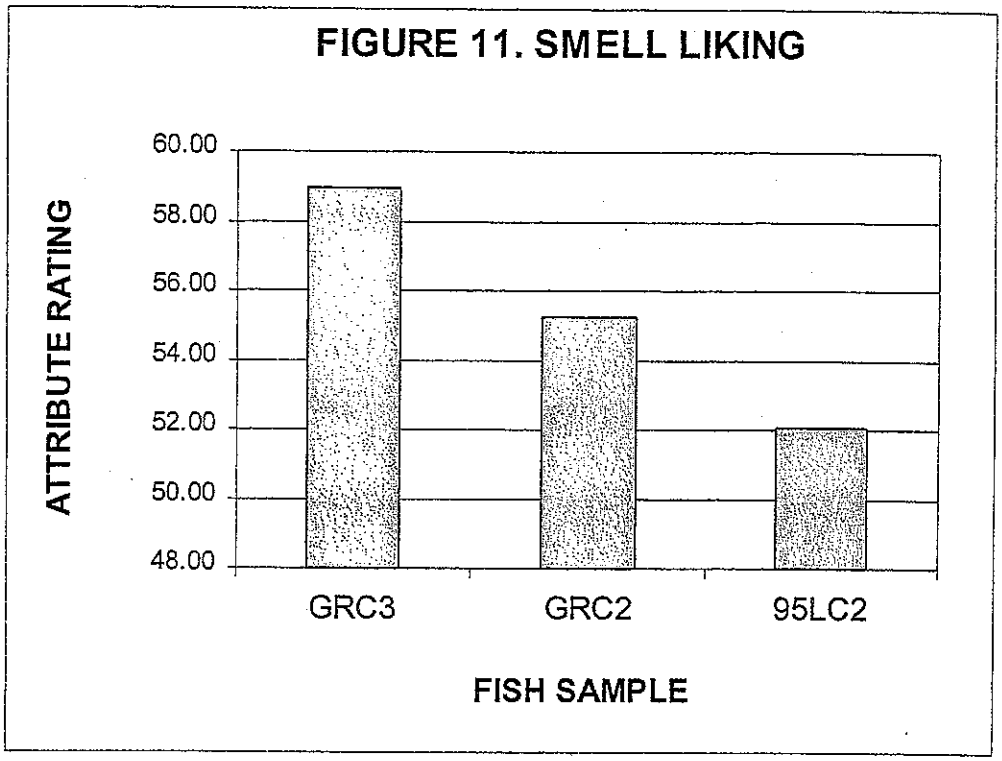


FIGURE 11. SMELL LIKING
ATTRIBUTE RATING
60.00
58.00
56.00
54.00
52.00
50.00
48.00
GRC3
GRC2
95LC2
FISH SAMPLE

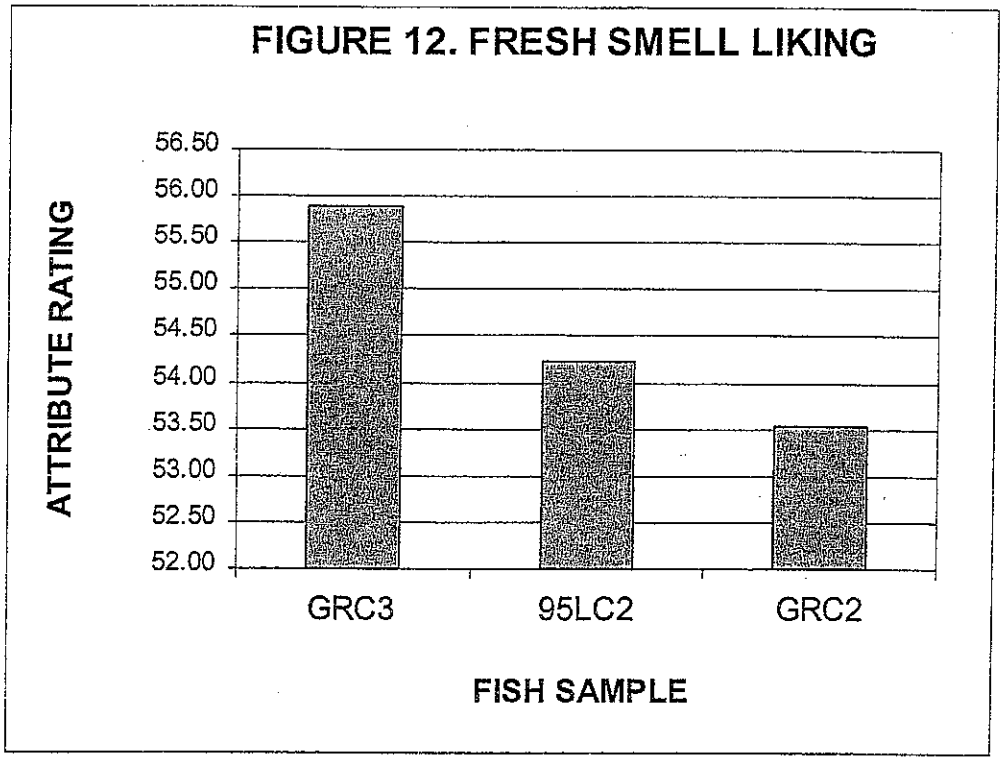


FIGURE 12. FRESH SMELL LIKING
ATTRIBUTE RATING
56.50
56.00
55.50
55.00
54.50
54.00
53.50
53.00
52.50
52.00
GRC3
95LC2
GRC2
FISH SAMPLE

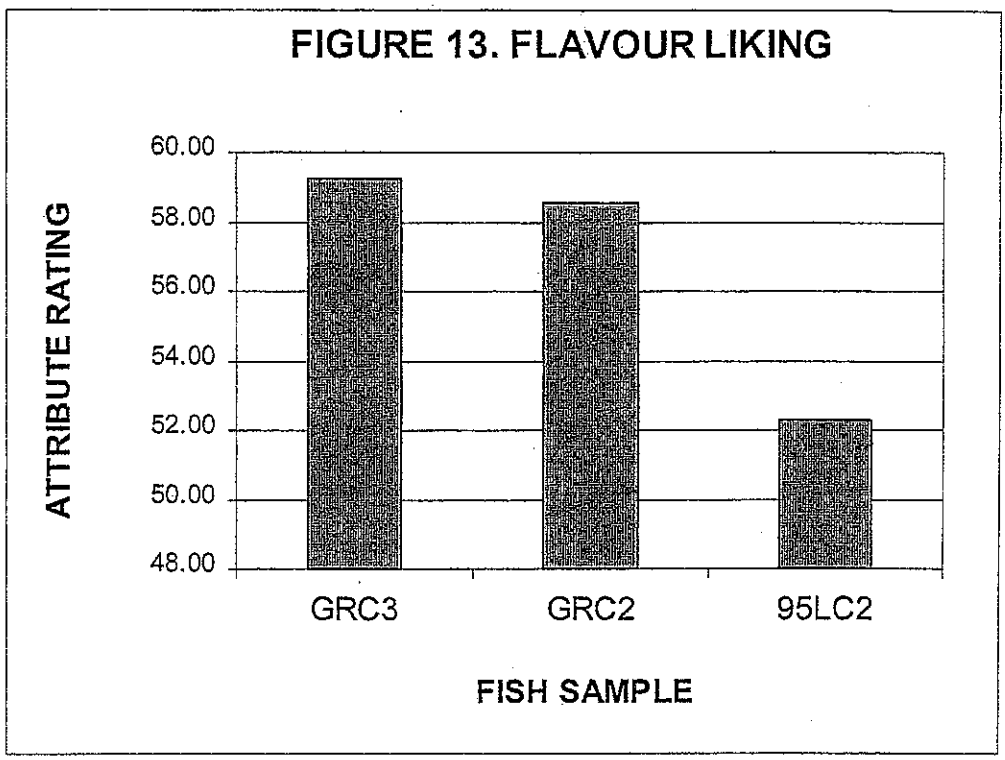


FIGURE 13. FLAVOUR LIKING
ATTRIBUTE RATING
60.00
58.00
56.00
54.00
52.00
50.00
48.00
GRC3
GRC2
95LC2
FISH SAMPLE

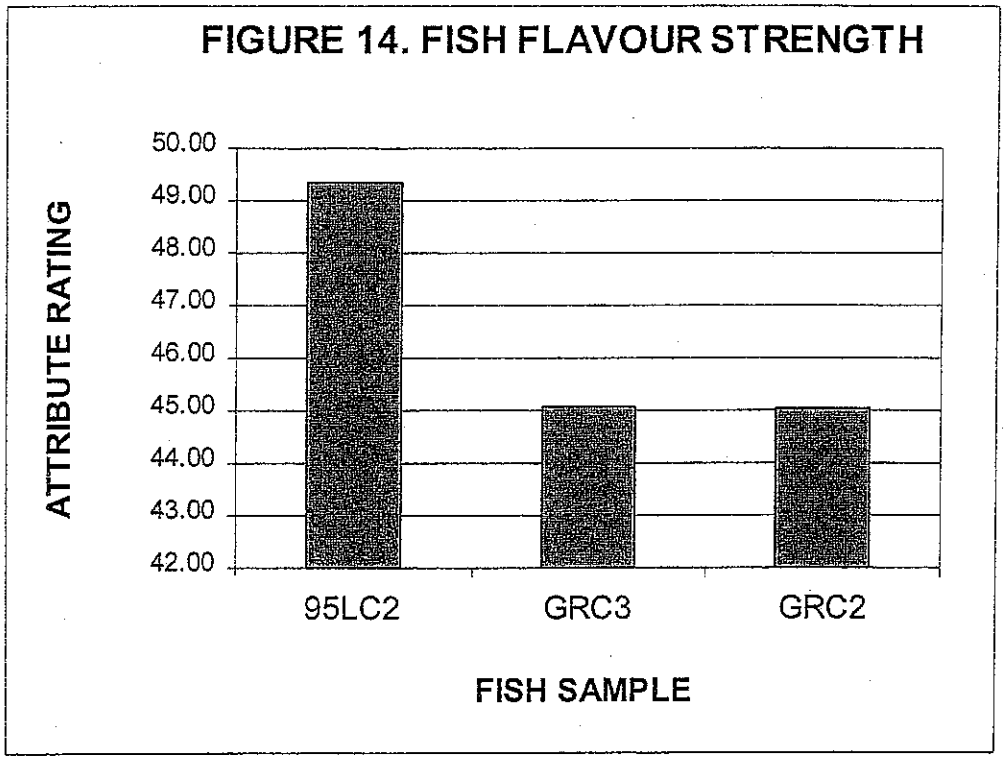


FIGURE 14. FISH FLAVOUR STRENGTH
ATTRIBUTE RATING
50.00
49.00
48.00
47.00
46.00
45.00
44.00
43.00
42.00
95LC2
GRC3
GRC2
FISH SAMPLE

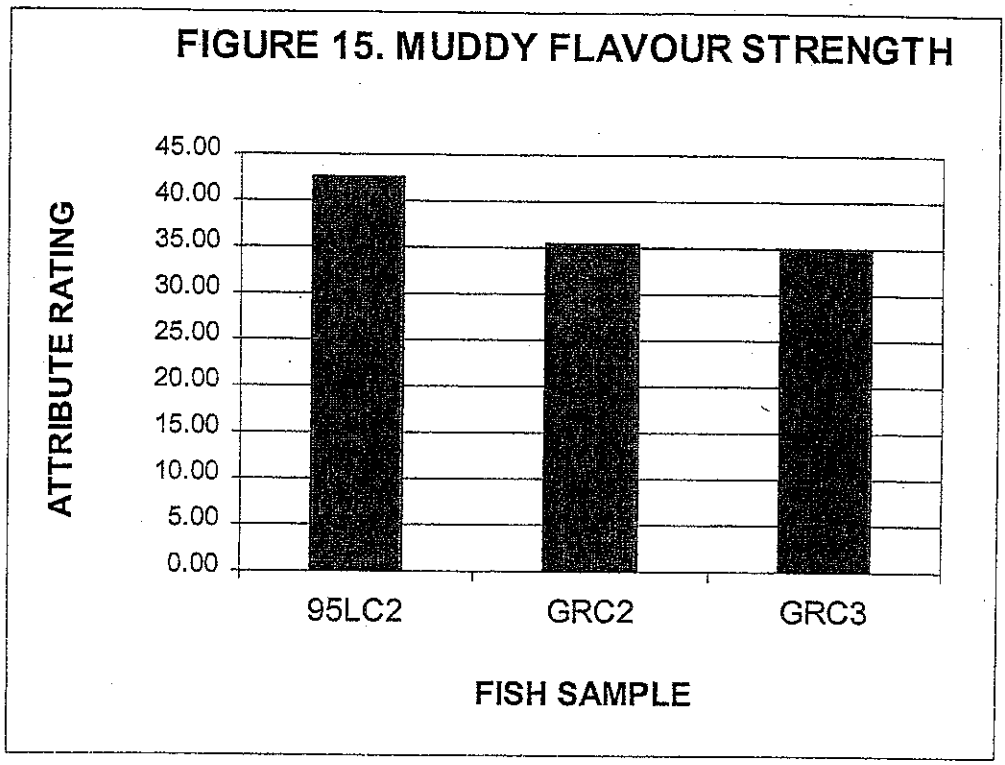


FIGURE 15. MUDDY FLAVOUR STRENGTH
ATTRIBUTE RATING
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
95LC2
GRC2
GRC3
FISH SAMPLE

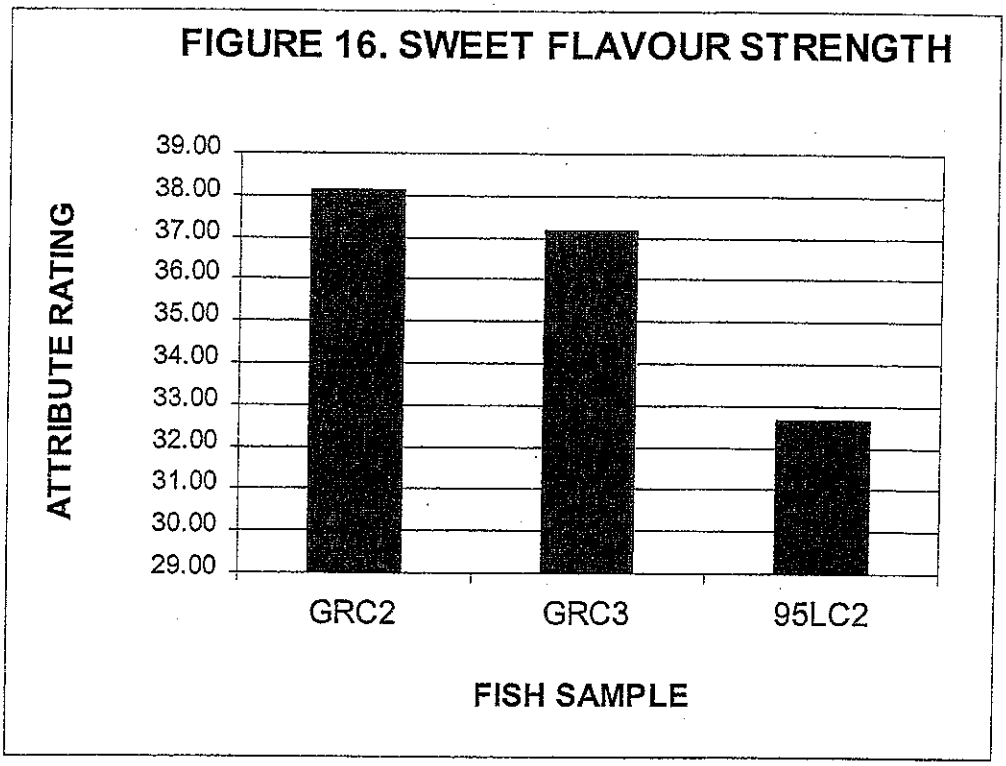


FIGURE 16. SWEET FLAVOUR STRENGTH
ATTRIBUTE RATING
39.00
38.00
37.00
36.00
35.00
34.00
33.00
32.00
31.00
30.00
29.00
GRC2
GRC3
95LC2
FISH SAMPLE

FIGURE 17. MEATY FLAVOUR STRENGTH

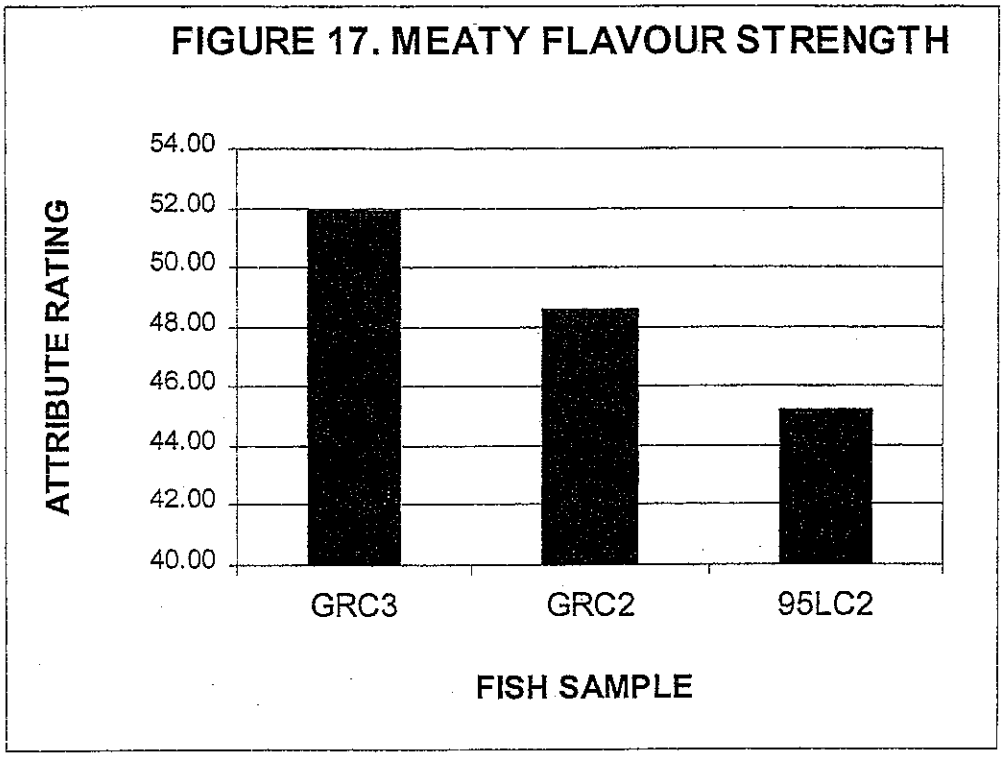
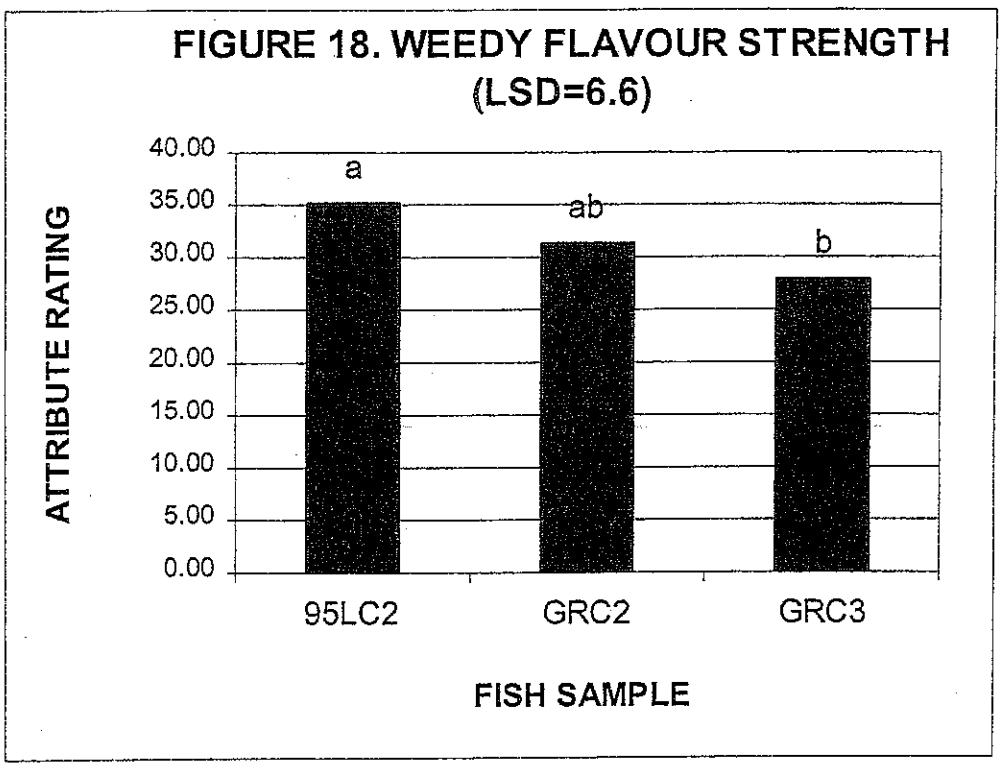


FIGURE 18. WEEDY FLAVOUR STRENGTH (LSD=6.6)



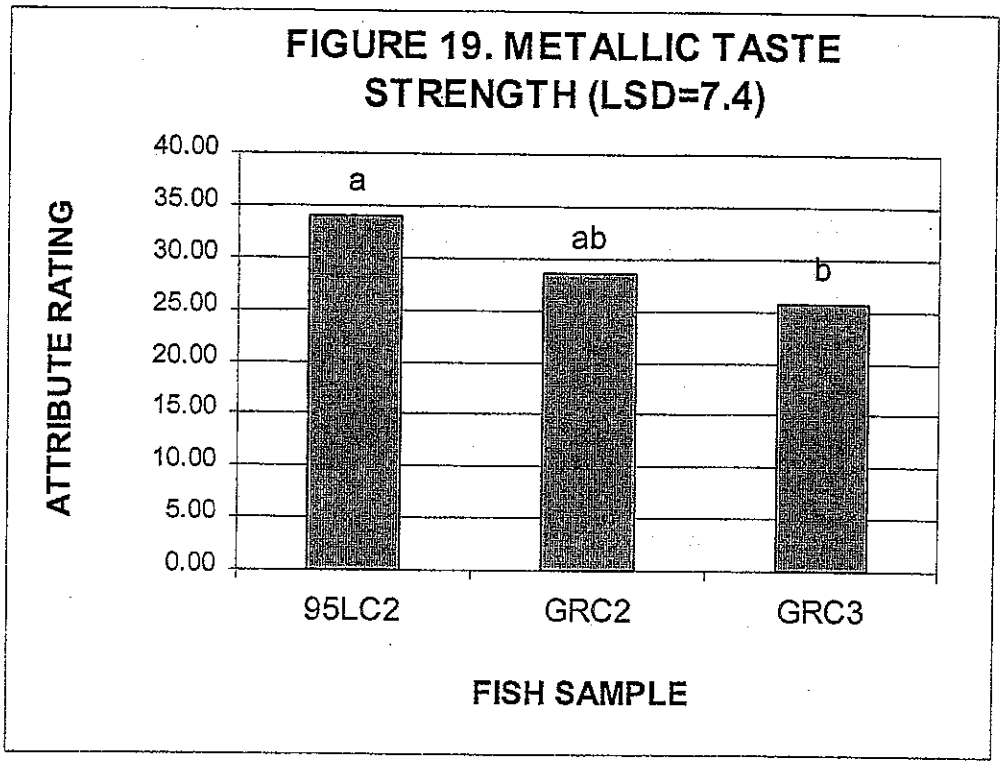


FIGURE 19. METALLIC TASTE STRENGTH (LSD=7.4)
ATTRIBUTE RATING
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
a
ab
b
95LC2
GRC2
GRC3
FISH SAMPLE

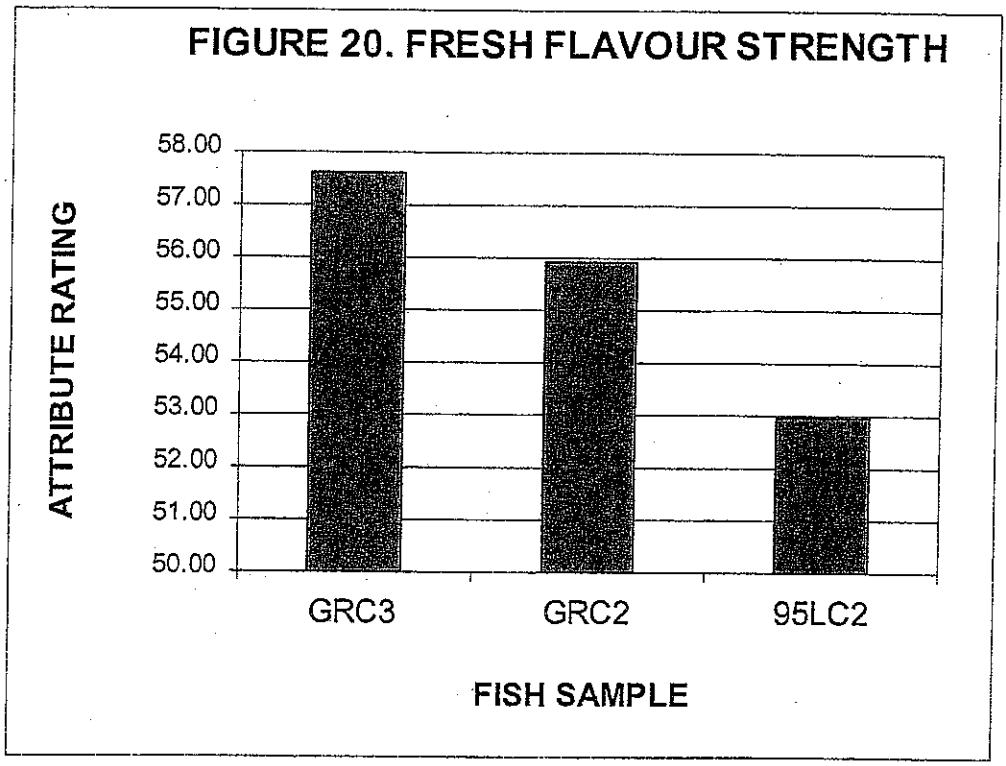


FIGURE 20. FRESH FLAVOUR STRENGTH
ATTRIBUTE RATING
58.00
57.00
56.00
55.00
54.00
53.00
52.00
51.00
50.00
GRC3
GRC2
95LC2
FISH SAMPLE

FIGURE 21. SOFT-HARD

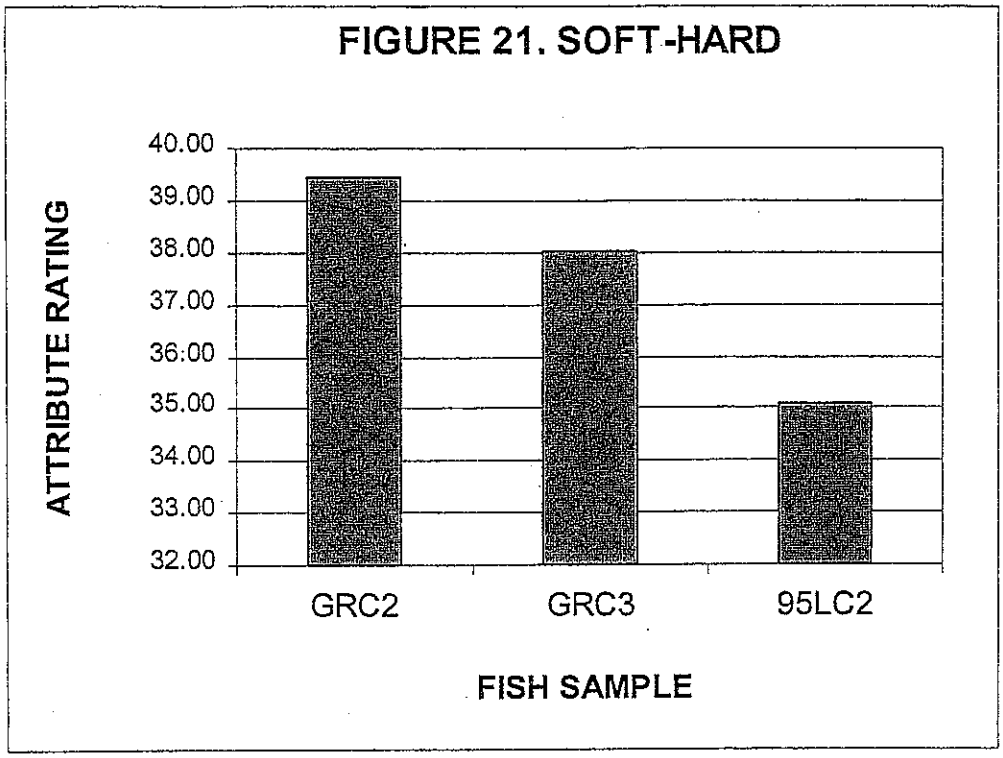
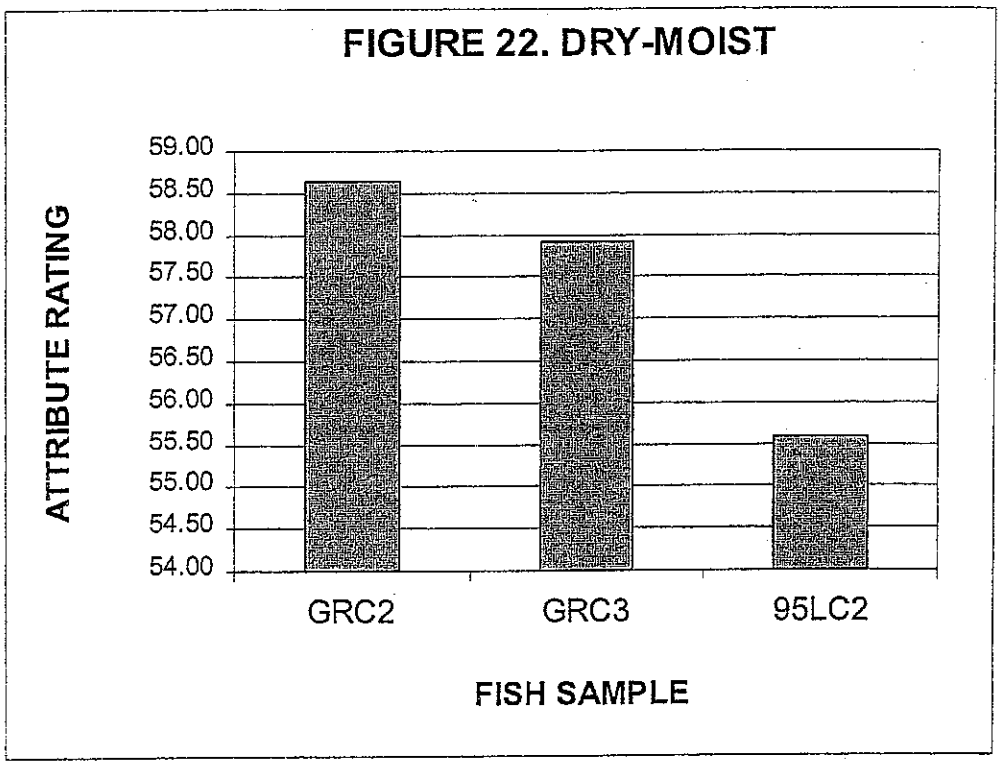


FIGURE 22. DRY-MOIST



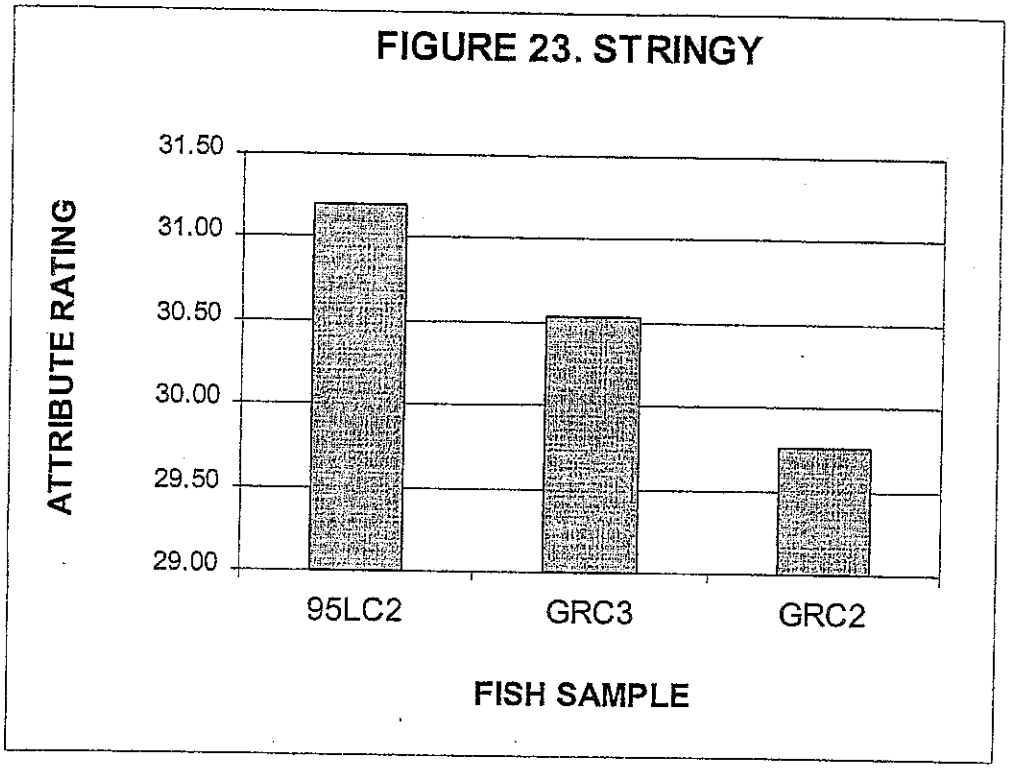


FIGURE 23. STRINGY
ATTRIBUTE RATING
31.50
31.00
30.50
30.00
29.50
29.00
95LC2
GRC3
GRC2
FISH SAMPLE

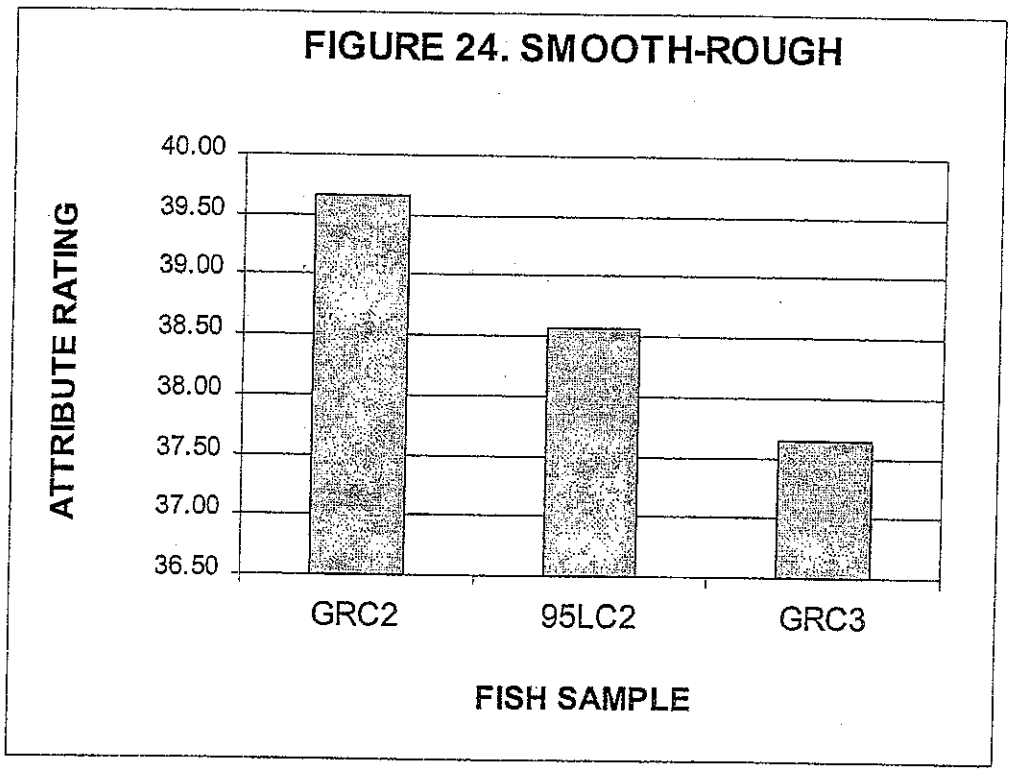


FIGURE 24. SMOOTH-ROUGH
ATTRIBUTE RATING
40.00
39.50
39.00
38.50
38.00
37.50
37.00
36.50
GRC2
95LC2
GRC3
FISH SAMPLE

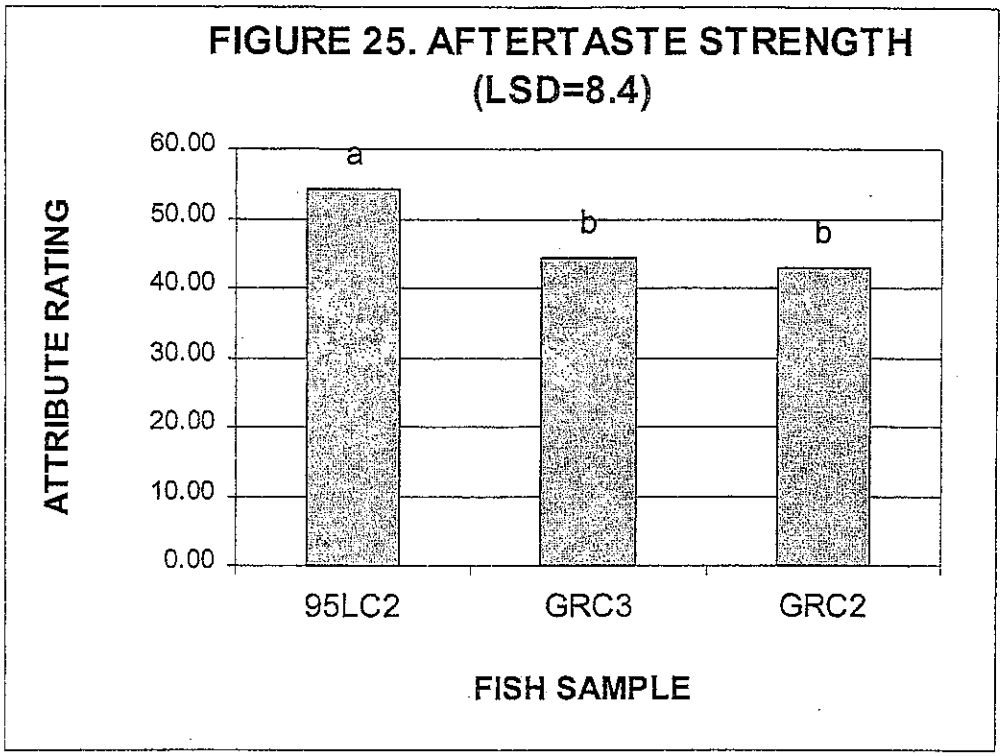


FIGURE 25. AFTERTASTE STRENGTH
(LSD=8.4)
ATTRIBUTE RATING
60.00
50.00
40.00
30.00
20.00
10.00
0.00
a
b
b
95LC2
GRC3
GRC2
FISH SAMPLE

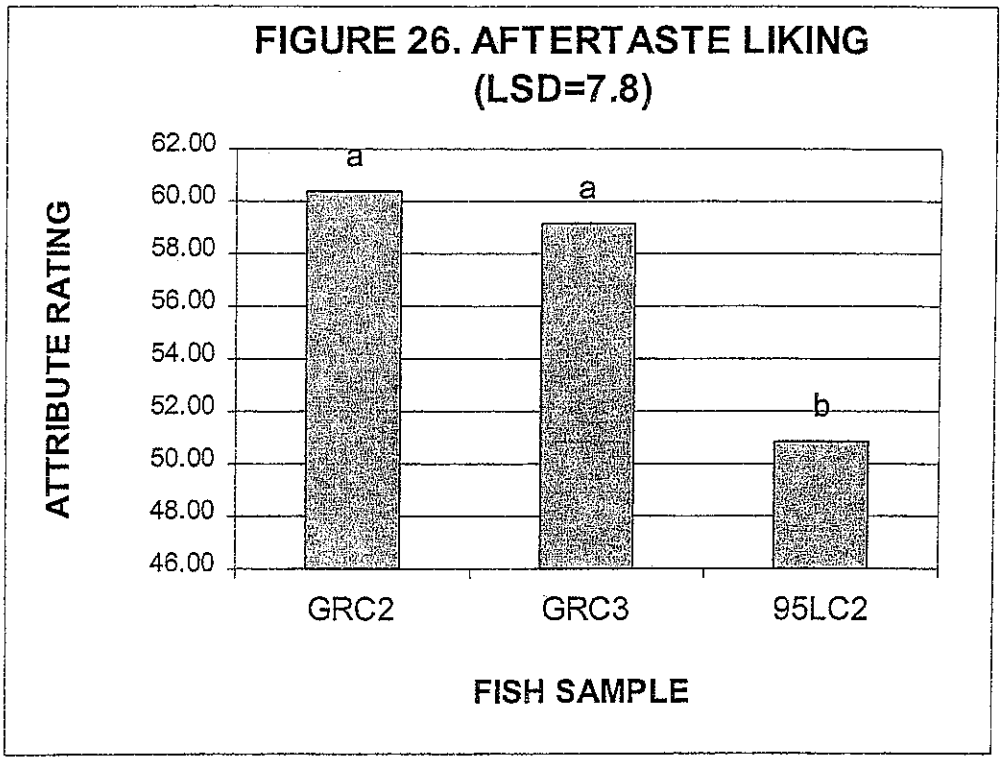


FIGURE 26. AFTERTASTE LIKING
(LSD=7.8)
ATTRIBUTE RATING
62.00
60.00
58.00
56.00
54.00
52.00
50.00
48.00
46.00
a
a
b
GRC2
GRC3
95LC2
FISH SAMPLE

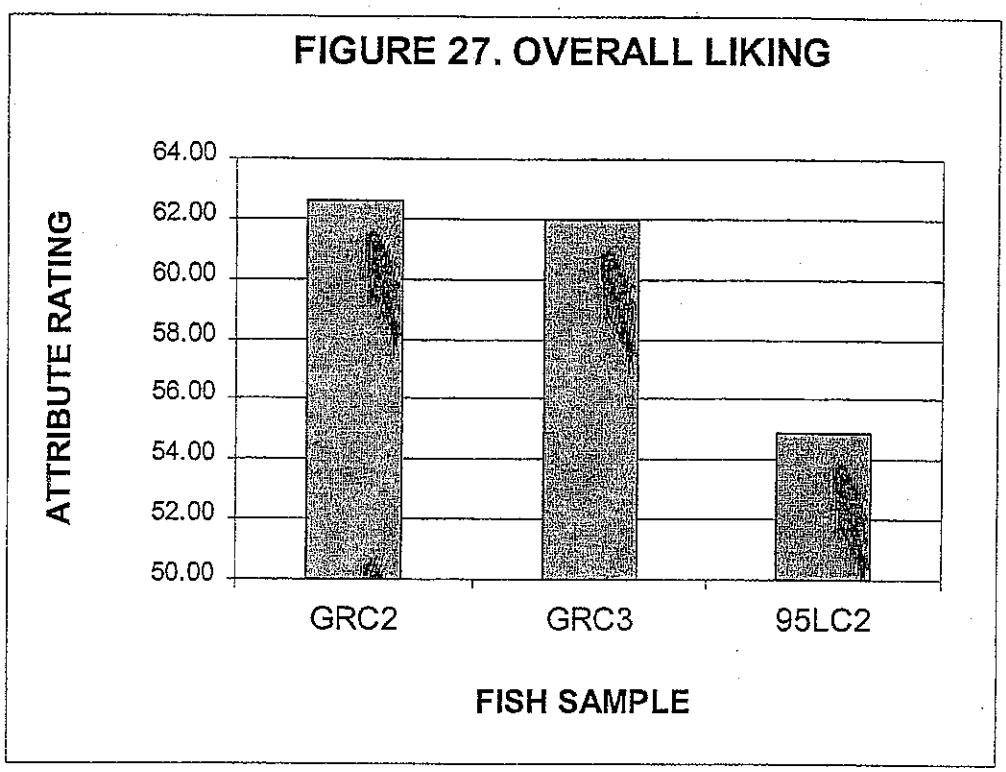


FIGURE 27. OVERALL LIKING
ATTRIBUTE RATING
64.00
62.00
60.00
58.00
56.00
54.00
52.00
50.00
GRC2
GRC3
95LC2
FISH SAMPLE

COMMENTS ON THE PRODUCTS

Fish evaluation. Comments.

Question 22 *"Are there any other comments you wish to make about this product?"*

Sample No.: 815

SUBJ. NO.	COMMENTS.
2	Not as nice as 136
9	Fatty Taste (skin?)
11	Not much taste at all
23	Well cooked – it makes a big difference
25	I like it better than the first one because I think it was fresher.
27	This one looked the best and tasted the most "fishy" out of the three
28	This fish did not have any noticeable qualities that would attract me to it. In my opinion it is quite dry... average.
32	Too many bones
33	Some bones in sample
35	Doesn't look as fresh as first sample.

Sample No.: 923

SUBJ. NO.	COMMENTS.
2	In question 6 I attempted to tell you there was little or no smell
3	I don't know if this sample was from a different part of the fish, but I didn't really like the appearance of this sample.
4	I really think it's quite a bland taste – I wouldn't want to eat a lot of this product.
6	None at all – I think it is favourable
11	The appearance was very oily, but it didn't taste that way.
22	A little bland, with a metallic aftertaste.
24	Don't like the smell.
25	This is how I like my fish generally (not too fishy smelling or tasting) but I think it is not very fresh fish.
27	Not quite as nice looking as number 136
28	This product is fairly soft, but it feels a little rubbery in the mouth, and does not leave a sensational after taste.
34	I was expecting more flavour.
35	Quite nice to eat but the fact that I'm hungry might have something to do with it.
37	Not as nice as 136
38	I don't know what "meaty" flavour is in a fish.
44	Less dry and stringy. Sweeter/moister. Tastes fresher.

Sample No.: 136

SUBJ. NO.	COMMENTS.
2	Delightful
3	The dark brown colour running through the fish does not look appetising. The fish had a delicate flavour, which I liked.
6	This one was not as good as the previous. I think I could detect muddy taste.
11	The appearance is slightly off-putting, but taste is good.
12	Tasted old and frozen
20	It has bones in it!
22	Better than previous sample 923 – a lot more moist and tender. Will be nice with a really nice sauce.
24	Smell kind of turns you off. It's … tasteless. Tastes like old chewing gum, only it dissolves.
25	I think this is the freshest of the three, however it doesn't look so.
27	Not a bad fish.
33	I find colour consistency important in my first impression with fish. You might consider evaluating this aspect also.
35	Looks good, but doesn't taste as good.
44	Slight dryness coming through. Moisture ok. Not a strong taste. Slight weediness.
45	There was a strong metallic odour in this sample.

THE QUESTIONNAIRES AND SENSORY BALLOTS

Fish — Centre for ChemoSensory Research

Sample No.: Subject No.:

Look at the sample: (mark your opinion on the line like this ___/___)

1. How much do you like the flesh colour of the fish in this sample?

Extremely dislike — Extremely like

2. How much do you like the colour of this sample?

Extremely dark — Just Right — Extremely light

3. How much do you like the overall appearance of this sample?

Extremely dislike — Like extremely

Now please *smell* the sample.

4. How strong is the smell of this sample?

No smell at all — Extremely smelly

5. How much do you like the smell of this sample?

Extremely dislike — Like extremely

6. How strong is the freshness smell of this sample?

Not at all fresh — Extremely fresh

Now please *taste* the sample.

7. How much do you like the taste of the fish flavour of this sample?

Extremely dislike — Like extremely

8. How strong is the fishy flavour of this sample?

Not at all fishy — Extremely fishy

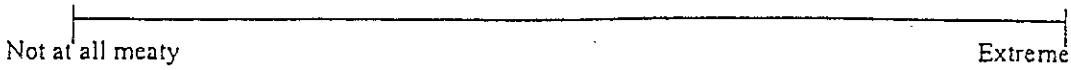
9. How strong is the muddy flavour in this sample?

Not at all muddy — Extremely muddy

10. How strong is the sweet flavour in this sample?

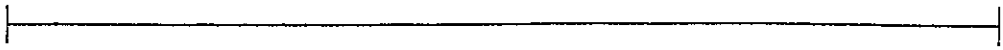
Not at all sweet — Extremely sweet

11. How strong is the meaty flavour in this sample?



Not at all meaty — Extremely meaty

12. How strong is the weedy-herbaceous flavour of this sample?

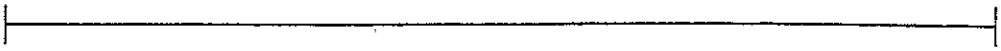


Not at all weedy-herbaceous — Extremely weedy-herbaceous

13. How strong is the metallic taste of this sample?

Not at all metallic — Extremely metallic

14. How strong is the fresh flavour of this sample?



Extremely unfresh — Extremely fresh

15. How soft-hard is the fish sample?

Extremely soft — Extremely hard

16. How dry-moist is the fish sample?

Extremely dry — Extremely moist

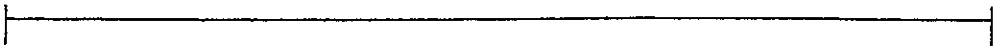
17. How stringy is the fish sample?

Not at all stringy — Extremely stringy

18. How smooth-rough is this fish sample?

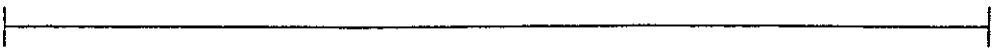
Extremely smooth — Extremely rough

19. Rate the strength of the aftertaste of this sample.



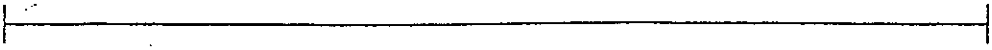
No aftertaste — Very Strong aftertaste

20. How much do you like the aftertaste of this sample?



Extremely dislike — Like extremely

21. How much do you like this product overall?



Extremely dislike — Like extremely

22. Are there any other comments you wish to make about this product?

_____

STATISTICAL ANALYSIS

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q01

Source	DF	SS	MS	F	P
fish	2	31.2	15.6	0.06	0.945
consumer	44	16500.4	375.0	1.36	0.111
Error	88	24254.8	275.6		
Total	134	40786.4			

Means

fish	N	Q01
136	45	52.778
815	45	51.600
923	45	52.178

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q02

Source	DF	SS	MS	F	P
fish	2	68.6	34.3	0.15	0.863
consumer	44	13059.6	296.8	1.27	0.167
Error	88	20497.4	232.9		
Total	134	33625.6			

Means

fish	N	Q02
136	45	51.711
815	45	53.422
923	45	52.267

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q03

Source	DF	SS	MS	F	P
fish	2	1.6	0.8	0.00	0.997
consumer	44	24344.4	553.3	1.86	0.007
Error	88	26137.7	297.0		
Total	134	50483.7			

Means

fish	N	Q03
136	45	50.200
815	45	50.444
923	45	50.222

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q04

Source	DF	SS	MS	F	P

fish	2	1734.4	867.2	2.56	0.083
consumer	44	20676.7	469.9	1.38	0.098
Error	88	29862.9	339.4		
Total	134	52274.0			

Means

fish	N	Q04
136	45	50.667
815	45	43.889
923	45	42.444

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q05

Source	DF	SS	MS	F	P
fish	2	1077.0	538.5	1.34	0.268
consumer	44	16381.1	372.3	0.93	0.605
Error	88	35405.0	402.3		
Total	134	52863.1			

Means

fish	N	Q05
136	45	52.067
815	45	55.244
923	45	58.978

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q06

Source	DF	SS	MS	F	P

fish	2	132.0	66.0	0.22	0.802
consumer	44	29658.8	674.1	2.26	0.001
Error	88	26248.7	298.3		
Total	134	56039.4			

Means

fish	N	Q06
136	45	54.222
815	45	53.533
923	45	55.889

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q07

Source	DF	SS	MS	F	P
fish	2	1311.7	655.9	1.63	0.201
consumer	44	26390.8	599.8	1.49	0.056
Error	88	35339.6	401.6		
Total	134	63042.1			

Means

fish	N	Q07
136	45	52.311
815	45	58.578
923	45	59.222

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q08

Source	DF	SS	MS	F	P

fish	2	557.6	278.8	0.91	0.407
consumer	44	32378.4	735.9	2.40	0.000
Error	88	27023.7	307.1		
Total	134	59959.7			

Means

fish	N	Q08
136	45	49.356
815	45	45.022
923	45	45.067

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q09

Source	DF	SS	MS	F	P
fish	2	1698.9	849.5	2.30	0.106
consumer	44	41931.3	953.0	2.58	0.000
Error	88	32487.1	369.2		
Total	134	76117.3			

Means

fish	N	Q09
136	45	42.689
815	45	35.444
923	45	34.911

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q10

Source	DF	SS	MS	F	P

fish	2	775.8	387.9	1.75	0.179
consumer	44	36924.0	839.2	3.79	0.000
Error	88	19476.2	221.3		
Total	134	57176.0			

Means

fish	N	Q10
136	45	32.644
815	45	38.156
923	45	37.156

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q11

Source	DF	SS	MS	F	P
fish	2	1006.8	503.4	2.06	0.133
consumer	44	46507.2	1057.0	4.33	0.000
Error	88	21495.2	244.3		
Total	134	69009.2			

Means

fish	N	Q11
136	45	45.200
815	45	48.600
923	45	51.889

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q12

Source	DF	SS	MS	F	P
fish	2	1182.6	591.3	2.41	0.096
consumer	44	46854.3	1064.9	4.34	0.000
Error	88	21582.7	245.3		
Total	134	69619.7			

Means

fish	N	Q12
136	45	35.178
815	45	31.311
923	45	27.933

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q13

Source	DF	SS	MS	F	P
fish	2	1628.2	814.1	2.65	0.076
consumer	44	47333.1	1075.8	3.50	0.000
Error	88	27011.8	307.0		
Total	134	75973.1			

Means

fish	N	Q13
136	45	34.044
815	45	28.578
923	45	25.667

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q14

Source	DF	SS	MS	F	P
fish	2	498.2	249.1	0.63	0.537
consumer	44	33776.4	767.6	1.93	0.005
Error	88	35043.1	398.2		
Total	134	69317.7			

Means

fish	N	Q14
136	45	52.956
815	45	55.933
923	45	57.600

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q15

Source	DF	SS	MS	F	P
fish	2	439.1	219.6	0.93	0.397
consumer	44	22108.3	502.5	2.14	0.001
Error	88	20702.2	235.3		
Total	134	43249.7			

Means

fish	N	Q15
136	45	35.111
815	45	39.444
923	45	38.022

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q16

Source	DF	SS	MS	F	P
fish	2	230.8	115.4	0.45	0.642
consumer	44	29855.7	678.5	2.62	0.000
Error	88	22773.2	258.8		
Total	134	52859.7			

Means

fish	N	Q16
136	45	55.578
815	45	58.644
923	45	57.911

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q17

Source	DF	SS	MS	F	P
fish	2	47.0	23.5	0.11	0.899
consumer	44	38605.1	877.4	3.96	0.000
Error	88	19483.6	221.4		
Total	134	58135.7			

Means

fish	N	Q17
136	45	31.200
815	45	29.756
923	45	30.533

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q18

Source	DF	SS	MS	F	P
fish	2	92.2	46.1	0.15	0.864
consumer	44	25210.8	573.0	1.82	0.009
Error	88	27704.5	314.8		
Total	134	53007.5			

Means

fish	N	Q18
136	45	38.578
815	45	39.667
923	45	37.644

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q19

Source	DF	SS	MS	F	P
fish	2	3360.4	1680.2	4.22	0.018
consumer	44	35934.3	816.7	2.05	0.002
Error	88	35002.9	397.8		
Total	134	74297.6			

Means

fish	N	Q19
136	45	54.133
815	45	42.867
923	45	44.400

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q20

Source	DF	SS	MS	F	P
fish	2	2424.3	1212.1	3.52	0.034
consumer	44	31576.2	717.6	2.09	0.002
Error	88	30287.7	344.2		
Total	134	64288.2			

Means

fish	N	Q20
136	45	50.844
815	45	60.400
923	45	59.133

Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values						
fish	fixed	3	136	815	923				
consumer	fixed	45	1	2	3	4	5	6	7
			8	9	10	11	12	13	14
			15	16	17	18	19	20	21
			22	23	24	25	26	27	28
			29	30	31	32	33	34	35
			36	37	38	39	40	41	42
			43	44	45				

Analysis of Variance for Q21

Source	DF	SS	MS	F	P
fish	2	1650.3	825.2	2.29	0.107
consumer	44	34575.1	785.8	2.18	0.001
Error	88	31714.4	360.4		
Total	134	67939.7			

Means

fish	N	Q21
136	45	54.911
815	45	62.600
923	45	62.022

MTB > corr c1-c21

Correlations (Pearson)

	Q01	Q02	Q03	Q04	Q05	Q06	Q07	Q08
Q02	0.319							
Q03	0.646	0.387						
Q04	-0.009	-0.050	0.036					
Q05	0.295	0.143	0.379	-0.052				
Q06	0.254	0.189	0.364	-0.192	0.493			
Q07	0.326	0.055	0.219	-0.117	0.272	0.259		
Q08	-0.059	-0.137	-0.012	0.289	-0.171	-0.066	0.098	
Q09	-0.118	-0.037	-0.151	0.388	-0.133	-0.265	-0.368	0.220
Q10	-0.027	0.044	0.098	0.020	-0.008	0.180	0.261	0.153
Q11	0.085	0.004	-0.016	0.245	-0.031	-0.262	-0.059	0.174
Q12	-0.026	-0.036	-0.030	0.199	-0.227	-0.181	-0.261	0.237
Q13	-0.101	0.012	-0.257	0.012	-0.170	-0.353	-0.170	0.022
Q14	0.160	0.094	0.150	-0.053	0.172	0.443	0.494	0.191
Q15	-0.051	-0.085	-0.080	-0.054	-0.126	-0.009	-0.026	0.033
Q16	0.109	0.075	0.196	0.106	0.111	0.140	0.130	-0.005
Q17	-0.159	0.009	-0.069	0.163	-0.217	-0.161	-0.217	0.104
Q18	-0.069	-0.018	-0.063	0.122	-0.096	-0.126	-0.174	0.163
Q19	-0.202	-0.085	-0.151	0.290	-0.225	-0.185	-0.150	0.412
Q20	0.354	0.127	0.332	0.037	0.455	0.305	0.639	0.013
Q21	0.400	0.138	0.343	0.021	0.376	0.254	0.715	-0.011

	Q09	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Q10	-0.040							
Q11	0.293	0.132						
Q12	0.541	0.055	0.286					
Q13	0.398	0.042	0.206	0.363				
Q14	-0.255	0.172	-0.163	-0.188	-0.308			
Q15	0.061	0.061	0.095	0.133	0.140	-0.113		
Q16	-0.031	0.096	-0.058	-0.075	-0.096	0.227	-0.315	
Q17	0.277	0.065	0.147	0.311	0.191	-0.291	0.177	-0.418
Q18	0.318	0.024	0.237	0.213	0.163	-0.237	0.358	-0.477
Q19	0.417	0.101	0.086	0.192	0.253	-0.049	0.036	0.007
Q20	-0.330	0.248	-0.007	-0.306	-0.300	0.486	-0.132	0.211
Q21	-0.349	0.263	-0.020	-0.218	-0.202	0.486	-0.091	0.205

	Q17	Q18	Q19	Q20
Q18	0.458			
Q19	0.213	0.191		
Q20	-0.300	-0.244	-0.250	
Q21	-0.271	-0.218	-0.231	0.814

MTB >

NOTES ON STATISTICS USED IN THIS STUDY

Notes on Statistics used in this study

1. Analyses of Variance (ANOVA)

The following ANOVA tables show the results of analysis of the factors that determine the variability (variance) of the data. For example if the judges are making their own individual judgements then the analysis will show a low P value (i.e. a value close to zero, which was the case in the analyses). Similarly, if the differences between the products were determining variability then the analysis will show a low P value (i.e. a value close to zero: again this was the case in all analyses). We can therefore conclude that the samples were a source of significant variance in the data as were the judges. This is consistent with the concept of judges making their own individual assessments on a range of products that are inherently different. This procedure needs to be gone through in order to justify doing the kinds of statistical tests that follow.

2. Means and LSDs

The mean (arithmetic average) scores for each product are shown below each ANOVA summary table in the following detailed statistics. The means show the magnitude of the response of the group as a whole to the particular attribute of the product. The LSD is the lowest value of a difference between any two means that are statistically significant at the 0.05 level of "risk".
"Significantly different" refers to the likelihood that the difference occurs by chance not more than five times in a hundred - the so-called 5% level. In brief, one can assume with confidence that two group scores (means) are truly different if they achieve the chosen 5% 'significance level'. If you had reason to be very cautious, (say, if you were going to invest capital on the basis of the scores) you could reject the differences at the 5% level and accept only those at, say, the 1% level. However, 5% is the conventional confidence criterion and the statistics shown here are referred to it for 'significance'.

3. Correlations

In order to see whether the subjects' scores (for all products in the range, pooled) on any particular attribute, might influence the size of their scores on any another attribute, correlation coefficients were calculated for combinations of all attributes, as well as for overall acceptability. These are shown in the Pearson Correlation matrix. The concept and interpretation of correlations will be explained below.

A correlation coefficient of 0 indicates that the size of one variable has no bearing on the size of another, while a coefficient of +1 or -1 shows that the two variables co-vary in a perfect relationship: they get bigger together if the coefficient is positive, but if the coefficient is negative, then one variable gets bigger while the other gets smaller. When attributes co-vary, we should be careful in assuming that one *causes* the size of another. They may vary, as it were, in harmony, because they are truly interlinked - one "driving" the other; or because a common but hidden and unknown cause makes them co-vary; or they may simply co-vary because separate causes are acting on them independently and they are correlated by dint of coincidence.

With this in mind we must moderate our assumption that co-variance implies one variable drives another, despite the fact that in the ensuing interpretation we will look at co-variance with this optimistic attitude. For example if sweetness covaries with overall acceptability, it is fair, but not strictly necessarily correct, interpret this observation as "sweetness is necessary for, or driving, overall acceptability." How large (i.e. how close to 1) must a correlation coefficient be to be regarded as 'significant' - that is, that the observation itself is not a product of a fluke or the vagaries of fuzzy observations: that it is worth taking a risk on? - this can be determined from appropriate statistical tables. For the sample size here (df = n-2, i.e., 43), a coefficient of +/- **0.292** can be regarded as significant at the 5% level.

Why does the correlation matrix taper off from left to right?

The data in the correlation matrix table is "triangular, or pennant shaped" simply because the data repeats itself on both the top half and the bottom half of the table (a mirror image). To avoid unnecessary repetition only the bottom half is shown. We also leave out of the table those correlation coefficients that are not significant, according to the rule shown above.

4. Biplots

Biplots have a similar basis and purpose to a principal components analysis, that is, to identify complex relationships between many factors that contribute to the total variance in a set of data. They can suggest which attributes contribute to the identity of the product and which products are closely or distantly related to each other. They produce a "map" of the products being evaluated such that similar products are close in any direction in 2-D, i.e., radially, to each other. The number of dimensions to use in a biplot depends on the eigenvalues of the correlation or covariance matrix (equivalent to how much variance is explained by the first two components of a principal components analysis) but usually biplots with 2 dimensions are sufficiently informative. An advantage of the biplot over a principal components plot is that both products *and* attributes are shown (hence name *bi* plot).

How far apart do attributes have to lie before they are no longer significantly related?

There are no well known rules for what is "close" on the biplot map and grouping of products and/or attributes is ultimately a subjective decision by the researcher. As the biplot produces a summary of the products-by-attributes matrix of means, it is often *a useful generator of ideas about what is related to what* rather than a way of confirming certain relationships. The longer an arrow in a biplot the more "important" the associated quantity is in the description of the matrix of means.

If the Pearson's correlation matrix indicates something different from the Biplot, which do I believe?

The Biplot is suggestive only, with no available significance test, being based on multiple dimensions, whereas the Pearson's correlations are linear relationships between two variables only and the relationship can be made subject to a significance test. If the relationship is shown by the Pearson's coefficient but is not clear in the Biplot, the Pearson's coefficient should be heeded.

So why use Biplots?

Biplots show you where relationships exist between products and attributes in very complex data sets. They also illustrate these in a useful 2-D graph.
They help you to understand why products are the same or different from each other in terms of the full set of complex inter-relationships. These are not always clear in a linear correlation matrix.

5. Graphs

The main body of data is represented in figures which show profiles of all the attribute means for each product. The mean score for the panel on each of the attributes is shown as a bar on each chart.

To compare the profiles of two or more products, you might like to make transparencies of the profiles and overlay them. This exercise is useful if you wish to see how closely some products come to resembling one another and what the essential differences are between them. To determine whether observed differences are significant, refer to the Least Significant Difference (LSD) scores for the attribute of interest (see main table of mean scores).

You are now equipped with the concepts and cautions which will allow reasonable interpretations, judgements and risks to be taken on the basis of your own reading of the results of this study.

CONSULTANCY AGREEMENT
BETWEEN
MEAT & LIVESTOCK AUSTRALIA
AND
NEW SOUTH WALES FISHERIES

PRCOP.009

CONSULTANCY AGREEMENT

BETWEEN

MEAT & LIVESTOCK AUSTRALIA
ACN 081 678 364

NEW SOUTH WALES FISHERIES

PRCOP.009

"Consumer sensory evaluation of silver perch, cultured in ponds on meat meal based diets"

CONSULTANCY AGREEMENT

THIS AGREEMENT IS MADE ON 199

PARTIES

MEAT AND LIVESTOCK AUSTRALIA LIMITED ACN 081 678 364 of Level 1, 165 Walker Street, North Sydney, New South Wales (**MLA**)

NEW SOUTH WALES FISHERIES, Port Stephens Research Centre, Taylors Beach Road, Taylors Beach, NSW, 2316 (**Consultant**)

BACKGROUND

MLA has agreed to engage the Consultant to provide the Services and the Consultant has agreed to accept the engagement on the terms of this agreement.

AGREEMENTS

1. DEFINITIONS AND INTERPRETATION

1.1 Definitions

1.1.1 Where commencing with a capital letter:

Contract Material means all material brought into existence for the purpose of providing the Services;

Intellectual Property means all patents, trade marks, designs and plant breeder's rights (whether registered or not), copyright, know-how, trade secrets and EL rights subsisting in the Contract Material or arising out of the provision of the Services;

MLA Material means all material provided by MLA to the Consultant for the purpose of this agreement;

Nominated Persons means the persons named in the schedule and such other persons approved in writing by MLA to perform the work in respect of the Services on behalf of the Consultant;

Proposal means the proposal from the Consultant to MLA referred to in the schedule;

Services means the services to be provided by the Consultant specified in the schedule; and

Year 2000 Compliant means that the operation, performance and functionality of all software and goods are not and will not be affected by dates prior to, during and after the year 2000 and that, in particular:

(a) date-based functionality behaves consistently for dates prior to, during and after the year 2000;

(b) no date interrupts or will cause any interruption in operation; and

(c) all leap years are recognised.

1.1.2 Where a word or phrase is given a defined meaning another part of speech or other grammatical form in respect of that word or phrase has a corresponding meaning.

1.2 Presumptions of interpretation

Unless the context otherwise requires a word which denotes:

(a) the singular denotes the plural and vice versa; and

(b) a person includes an individual, a body corporate and a government.

1.3 The Proposal

If there is any inconsistency between the provisions of this agreement and those of the Proposal, the provisions of this agreement prevail.

1.4 Successors and assigns

A person includes the trustee, executor, administrator, successor in title and assign of that person. This clause must not be construed as permitting a party to assign any right under this agreement.

2. APPOINTMENT OF THE CONSULTANT

2.1 Appointment

MLA appoints the Consultant to provide the Services in accordance with the Proposal and the timetable set out in the schedule on the terms set out in this agreement, and the Consultant accepts the appointment.

2.2 Nominated Persons

The Consultant:

(a) must, subject to the terms of this agreement, cause only the Nominated Persons to perform the work in respect of the Services on behalf of the Consultant;

(b) undertakes that the Nominated Persons will during the term of this agreement perform this work to the best of their skill and ability; and

(c) must provide each Nominated Person with a copy of this agreement and take all reasonable steps to explain it to them.

3. OBLIGATIONS OF THE CONSULTANT

3.1 Liaison

The Consultant must:

(a) liaise with MLA in providing the Services; and

(b) if requested by MLA, provide reasonable details of the Consultant's proposed course of action and strategies,

for the purpose of enabling MLA to review the performance of the Consultant's obligations under this agreement.

3.2 Directions

The Consultant must comply with all reasonable and lawful directions of MLA from time to time concerning the Services.

3.3 Comply with all laws

The Consultant must comply with all relevant laws and regulations when performing the Consultant's obligations under this agreement.

3.4 Insurance

3.4.1 The Consultant must at all times maintain:

(a) adequate workers' compensation insurance as required by law for its employees;

(b) professional indemnity insurance in the amount specified in the schedule; and

(c) such other insurance cover as MLA may from time to time reasonably require.

3.4.2 Each insurance policy obtained by the Consultant under clause 3.4.1 must note MLA as a named insured under the policy.

3.4.3 The Consultant must, on request by MLA, produce evidence of the currency of the insurance policies referred to in this clause 3.4.

4. FEES AND EXPENSES

4.1 Fees

MLA must pay the Consultant for providing the Services the fee specified in the schedule, provided that Services to which each payment relates are completed to the reasonable satisfaction of MLA.

4.2 Expenses

MLA must reimburse the Consultant for all reasonable travel and telecommunication expenses incurred by the Consultant in providing the Services provided that the Consultant:

(a) obtains MLA's prior written consent before incurring any travel or accommodation expenses not specified in the Proposal; and

(b) gives MLA:

(i) details of the expenses incurred, together with evidence acceptable to MLA on reasonable grounds of the incurring of those expenses, including receipts for expenses over $20; and

(ii) all assistance reasonably required by MLA to verify the expenses incurred.

4.3 Payment

MLA must, subject to this clause 4, pay the fees and expenses referred to in clauses 4.1 and 4.2 in the following manner:

(a) the Consultant must after the end of each period specified in the schedule provide to MLA an invoice setting out details of:

(i) the Services provided, time worked and fees payable; and

(ii) expenses incurred,

in that period; and

(b) MLA must pay the invoice within 1 month of receipt of it.

5. CONFIDENTIALITY

5.1 Consultant to maintain

The Consultant must not during or after the term of this agreement:

(a) except in the proper course of performance of this agreement, disclose to any person without the previous consent in writing of MLA the terms of this agreement or any MLA Material or Contract Material; or

(b) use or attempt to use any MLA Material or Contract Material in any manner which may cause injury or loss to MLA or in any manner other than that contemplated by this agreement.

5.2 Third party disclosure

The Consultant must take all such reasonable precautions as are necessary to maintain the confidentiality of the MLA Material and the Contract Material and must:

(a) prevent its disclosure directly or indirectly to any person other than in accordance with this agreement; and

(b) prior to disclosure to any person of any MLA Material or Contract Material in accordance with this agreement, obtain a written undertaking of confidentiality from that person in the same terms as this clause 5.

6. INTELLECTUAL PROPERTY

6.1 Assignment

6.1.1 The Consultant assigns all Intellectual Property to MLA as and when it is created, whether existing as at the date of this agreement or created afterwards.

6.1.2 Where the Consultant engages an agent or contractor to provide any of the Services, the Consultant must ensure that the agent or contractor assigns to MLA all Intellectual Property as and when it is created, whether existing as at the date of this agreement or created afterwards.

6.2 Licence to the Consultant

MLA grants the Consultant a royalty free licence to use the Intellectual Property and the intellectual property rights in the MLA Material for the purpose of enabling the Consultant to provide the Services.

7. WARRANTY

The Consultant warrants that:

(a) the provision of the Services will not infringe any other person's intellectual property rights and that MLA will be entitled to use the Contract Material without the consent of any other person;

(b) it, its officers and employees, the Nominated Persons and all agents and contractors have the necessary experience, skill and ability to properly provide the Services on the terms contained in this agreement;

(c) the Services will be provided in a professional manner and conform to a standard of competence equal to that normally employed by consultants of good standing for services of a magnitude and nature similar to the Services; and

(d) all software and goods provided by it as part of the Services will, without any modification, be Year 2000 Compliant.

8. MATERIAL

8.1 MLA Material

The MLA Material remains the property of MLA and, on termination of this agreement, the Consultant must immediately return the MLA Material and all copies of it to MLA.

8.2 Contract Material

On termination of this agreement, the Consultant must immediately deliver the Contract Material and all copies of it to the MLA.

8.3 Safekeeping

The Consultant is responsible for the safekeeping and maintenance of the MLA Material and the Contract Material and must ensure that the MLA Material and the Contract Material are used, copied, supplied or reproduced only for the purposes of this agreement.

9. RELATIONSHIP OF THE PARTIES

9.1 No partnership

Nothing contained in this agreement creates an agency, partnership, joint venture or employment relationship between MLA and the Consultant or any of their respective employees, agents or contractors.

9.2 No holding out

Neither the Consultant nor any person acting on behalf of the Consultant may hold itself out as being entitled to contract or accept payment in the name of or on account of MLA.

9.3 Exclusion

MLA's only liability is as expressly stated in this agreement. To the extent permitted by law, all other liability is excluded.

10. SUBCONTRACTORS

10.1 Consent

The Consultant must not without the prior written consent of MLA engage agents or contractors to assist the Consultant in providing the Services.

10.2 Terms

If the Consultant engages an agent or a contractor to assist the Consultant in providing the Services the terms of engagement must be approved by MLA and must contain terms requiring the agent or contractor to:

(a) undertake obligations of confidentiality in terms substantially the same as the terms of clause 5;

(b) assign to MLA the intellectual property in any materials created under the engagement; and

(c) maintain such insurance in such amounts as MLA may specify.

11. CONFLICT OF INTEREST

The Consultant must not, during the term of this agreement:

(a) act as a consultant to any person who carries on or is involved in any capacity in an activity or business; or

(b) carry on or be involved in any capacity in an activity or business,

which is competitive with or detrimental to any business or activity carried on by MLA or in which MLA is involved.

12. INDEMNITY

The Consultant indemnifies MLA against all damages, losses, costs and expenses incurred by MLA arising out of:

(a) any breach by the Consultant of this agreement; or

(b) any act or omission of the Consultant, its employees, the Nominated Persons and all agents and contractors in connection with this agreement.

13. TERMINATION

13.1 Notice

MLA may, on 1 month's notice to the Consultant, terminate this agreement.

13.2 Default

If the Consultant:

(a) goes into liquidation, has a receiver or receiver and manager appointed to it or any part of its assets, enters into a scheme of arrangement with creditors or suffers any other form of external administration;

(b) fails, within 7 days after receipt of notice, to remedy any breach of its obligations under this agreement which is capable of remedy; or

(c) breaches any provision of this agreement which is not capable of remedy,

MLA may, by notice to the Consultant, terminate this agreement and recover from the Consultant all damages, losses, costs and expenses suffered by MLA.

14. DISPUTE RESOLUTION

14.1 Dealing with disputes

14.1.1 The parties must, without delay and in good faith, attempt to resolve any dispute which arises out of or in connection with this agreement prior to commencing any proceedings.

14.1.2 If a party requires resolution of a dispute it must do so in accordance with the provisions of this clause 14 and the parties acknowledge that compliance with these provisions is a condition precedent to any entitlement to claim relief or

remedy whether by way of proceedings in a court of law or otherwise in respect of such disputes.

14.2 Resolution by management

14.2.1 If a party requires resolution of a dispute it must immediately submit full details of the dispute to the chief executive officer of the other party.

14.2.2 If the dispute is not resolved within 1 month of submission of the dispute to them, or such other time as they agree, the provisions of clause 14.3 will apply.

14.3 Conciliation

14.3.1 Disputes must be submitted to conciliation in accordance with and subject to the Institute of Arbitrators Australia Rules for the Conduct of Commercial Conciliations.

14.3.2 A party may not commence proceedings in respect of the dispute unless the dispute is not settled by conciliation within 1 month of submission to conciliation, or such other time as the parties agree.

15. MISCELLANEOUS

15.1 Notices

15.1.1 A notice under this agreement must be in writing and may be given to the addressee by:

(a) delivering it to the address of the addressee;

(b) sending it by pre-paid registered post to the address of the addressee; or

(c) sending it by facsimile to the facsimile number of the addressee,

and the notice will be deemed to have been received by the addressee on receipt.

15.1.2 A facsimile is deemed to have been received on production of a transmission report by the machine from which the facsimile was sent which indicates that the facsimile was sent in its entirety to the facsimile number of the addressee.

15.2 Amendment

This agreement may only be varied by the written agreement of the parties.

15.3 Assignment

The Consultant may only assign a right under this agreement with the prior written consent of MLA.

15.4 Entire agreement

15.4.1 This agreement embodies the entire understanding and agreement between the parties as to its subject matter.

15.4.2 All previous negotiations, understandings, representations, warranties, memoranda or commitments in relation to, or in any way affecting, the subject matter of this agreement are merged in and superseded by this agreement.

15.5 Further assurance

Each party must promptly execute all documents and do all things that the other party from time to time reasonably requests to effect, perfect or complete this agreement and all transactions incidental to it.

15.6 Governing law and jurisdiction

15.6.1 This agreement is governed by and must be construed in accordance with the laws of New South Wales.

15.6.2 Each party:

(a) irrevocably and unconditionally submits to the non-exclusive jurisdiction of the courts of New South Wales and all courts which have jurisdiction to hear appeals from those courts; and

(b) waives any right to object to proceedings being brought in those courts for any reason.

15.7 Legal costs

The parties must each pay their own legal and other expenses relating directly or indirectly to the negotiation, preparation and execution of this agreement and all documents incidental to it.

SCHEDULE

1. Consultant

NEW SOUTH WALES FISHERIES
Port Stephens Research Centre
Taylors Beach Road
TAYLORS BEACH NSW 2316

Attn: Geoff Allan

Phone (02) 4982 1189
Fax (02) 4982 1107

2. Background

Research under the Fisheries Research and Development Corporation Sub-program on Aquaculture Diet Development and its precursor the Fishmeal Replacement in Aquaculture Diets sub-program has made rapid progress identified Australian agricultural ingredients which can be used in silver perch diets. Diets with only 5% fishmeal, based on meatmeals, grain legumes and wheat, have been developed. These diets out-perform earlier fishmeal based diets and are now being made by several commercial feed manufacturing companies for several hundred dollars a tonne less. Diets based on meatmeal and wheat (containing no fishmeal) are currently being evaluated at the NSW Fisheries Grafton Research Centre.

As changing ingredient composition affects sensory characteristics of the fish flesh, and hence market acceptance, there is a need to undertake consumer sensory evaluation of fish fed these diets.

3. Objectives

By 30 June 1999 the Consultant shall have submitted a report in which performance and sensory characteristics of silver perch fed two meat meal based diets (a) with no (0%) fishmeal, and (b) with fish fed a previously developed 5% fishmeal diet are compared.

4. Methodology

An experiment with silver perch, cultured to a market-size of about 400-500g/fish (a common commercial market size) is under way to compare meat meal diets. The control diet has 5% fishmeal and also includes lupins and field peas as protein sources. This diet was developed during the current and previous Aquaculture Diet Development Sub-programs and is now being manufactured commercially by at least two feed manufacturers.

The experiment is being run in 9 earthen ponds (each 0.1 ha) at the Grafton Research Centre. This a commercially valid trial: the ponds are similar to many commercial ponds and fish are taken through to market size at commercial stocking densities.

Rigorous sensory evaluation of the fish flesh will be undertaken to determine if the silver perch fed three different diets are perceived by adult consumers as tasting similar or different, and if the differ, on what sensory attributed they differ. The relative preference by consumers of the three types of fish and what sensory attributes drive consumer acceptance will also be determined.

A questionaire of approximately 20 items will be developed and to fish consumers (non smokers) at the Centre for Chemosensory Research (University of NSW) under controlled conditions. The sensory evaluation procedures will conform to world's best practice.

4. Timetable

	MILESTONES	DATE FOR COMPLETION	ACHIEVEMENT CRITERIA
1	Project Commencement	15/5/99	
2	Chemosensory evaluation completed.	30/5/99	MLA notified Chemosensory evaluation has been completed
3	Final report completed and delivered to MLA.	30/6/99	Final report received and accepted by MLA.

5. Payment Schedule

An amount of $16,755 shall be paid to the Consultant in acceptance of the final report.

EXECUTED AS AN AGREEMENT

Signed for and on behalf of **Meat and Livestock Australia Limited** in the presence of:

J Bull	
Signature of witness	Signature of authorised person
Tom Bull	COLIN PITT General Manager Processing and Product Innovation Meat and Livestock Australia
Name of witness (print) Office held	Name of authorised person (print)

Signed for and on behalf of **NEW SOUTH WALES FISHERIES** in the presence of:

Helena M. Heasman	
Signature of witness	Signature of authorised person
HELENA M. HEASMAN C.O. 3/4.	Dr Geoff Allan (Principal Aquaculture Research)
Name of witness (print) Office held	Name of authorised person (print)
	30/6/99

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